San Francisco Bay Regional Water Enhancement Program IRWM Round 2 Implementation Proposal

Attachment 3 References

Project 1. Bay Area Regional Conservation and Education Program

1. Water Conservation Market Penetration Study, EBMUD, 2001
2. Handbook of Water Use and Conservation, Amy Vickers, 2002
3. CUWCC MOU Exhibit 6, ULFT Savings Assumption, CUWCC, 1992
4. Potential Best Management Practices, CUWCC, 2006
5. California Energy Commission
6. Bern, Kansas Clothes Washer Study, US Department of Energy, 1998
7. Bay-Friendly Landscape Guidelines, Sustainable Practices for the Landscape Professional, StopWaste.org, 2008
8. Large Landscape Water Audit Savings Study, Contra Costa Water District, 1994
9. Water Use Classification of Landscape Species (WUCOLS), UC Cooperative Extension, 1994
10. Xeriscape Conversion Study, Southern Nevada Water Authority, 2005
11. Aquacraft, Inc. 2011. California Single-Family Water Use Efficiency Study.
12. California Urban Water Conservation Council. 2004. *BMP Costs & Savings Study: A Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices.* Sacramento, CA: Prepared by A & N Technical Services, Inc. for California Urban Water Conservation Council.
13. Aquacraft, Inc. 2009. *Evaluation of California Weather-Based "Smart" Irrigation Controller Programs*. July 1. Presented to the California Department of Water Resources by the Metropolitan Water District of Southern California and the East Bay Municipal Utility District.
14. ET Controller Unit Savings, MWDOC, 2004
15. Dukes, M.D. 2012. Water conservation potential of landscape irrigation smart controllers. Transactions of the ASABE 55(2): 563-569. Pages 565 and 566.

16. SFPUC Retail Water Conservation Plan, SFPUC 2011.

17. SFPUC. 2009. Water Supply Availability Study for the City and County of San Francisco.

18. BAWSCA. 2009. Water Conservation Implementation Plan. September.

19. Water Conservation Master Plan, EBMUD, 1994.

20. CCWD Future Water Supply Implementation Final EIR, 1999.

21. East Bay Municipal Utility District. 2012. *Water Supply Management Program 2040 Plan.* Oakland, California: East Bay Municipal Utility District.

22. SCVWD. 2008. *Water Use Efficiency Strategic Plan*.

23. SCVWD CVPIA Water Conservation Plan, 2005

24. 2009. Water Conservation Implementation Plan; pages 7-9–7-10 and 8-11–8-12

25. 2012. Annual Water Conservation Report, FY 2010-11 BAWSCA Water conservation Programs Annual Report Final February 24, 2012; pages 15 and 49-50

26. Advisory Committee. 2013. California Water Plan Update 2013. Draft. Page 3-13. Accessed March 5, 2013 at: http://www.waterplan.water.ca.gov/docs/cwpu2013/2012-ac-draft/Vol3_Ch03_UrbanWUE_AdvisoryCommitteeDraft_ss.pdf

27. American Water Works Association. 2013. "Drip Calculator." Accessed March 5, 2013 at http://www.awwa.org/resources-tools/public-affairs/public-information/dripcalculator.aspx

28. CALGreen Code, Water efficiency requirements begin on page 17

29. ConSol. 2010. Water Use in the California Residential Home. January. Accessed March 5, 2013 at http://www.cbia.org/go/cbia/?LinkServID=E242764F-88F9-4438-9992948EF86E49EA

30. Dukes, M.D. 2012. Water conservation potential of landscape irrigation smart controllers. Transactions of the ASABE 55(2): 563-569.

    a. Page 565: Table 1. Summary of smart irrigation controller studies and irrigation savings in plot-scale scientific studies.

    b. Page 566: Table 2. Summary of smart irrigation controller pilot tests and irrigation savings in home/commercial landscapes.

31. Koeller and Company. 2008. *Toilet Replacement Programs in the U.S*. May 1.

32. Koeller and Company. 2010. Interactions Among AB 715 (Laird 2007), SB 407 (Padilla 2009), and CALGreen Building Standards. pp. 2, 6.

33. Koeller and Company. 2010. *Toilet and Urinal Fixtures in the California Codes*.

34. Koeller and Company. 2012. *High-Efficiency Plumbing Fixture Direct Install Water Savings Analysis*. For Santa Clara Valley Water District and California Urban Water Conservation Council. October.

35. Koeller and Company. 2012. *Water Savings from Toilet Fixture Replacements – Santa Clara Valley Water & Sonoma County Wat*er. December.

36. Alliance for Water Efficiency. 2010. *Water Conservation Tracking Tool Version 1.2 User Guide: A Tool for Planning and Tracking Urban Water Conservation Programs*. August. Pages 92,96, 108, 138-145, 158-161, 166-168, 172-174, 225-227 and 228-230.

37. SCVWD. FY 2005-2006. *Water Use Efficiency Program Annual Report*.

38. San Francisco PUC (SFPUC) and RPD. 2009. San Francisco *Parks Water Conservation Plan, Final Report.* Pages 2-1 to 2-15.

Project 2. East Bayshore Recycled Water Project Phase 1A (Emeryville)

1. East Bay Municipal Utility District. 2000. *Facilities Plan for the East Bayshore Recycled Water Project*. December.
2. East Bay Municipal Utility District. 2010. *Urban Water Management Plan*. June.
3. East Bay Municipal Utility District. 2012. *Water Supply Management Program 2040 Plan.* Oakland, California. April.

See Attachment 3, Project 1 References

4. Parsons. 2001. *East Bayshore Recycled Water Project Final EIR*. Oakland, California. May.

Project 3. Lagunitas Creek Watershed Sediment Reduction and Management Project

1. CDFG. 2011 and 2013. *California Department of Fish and Game, Marin County, Lagunitas Creek Watershed, Stream Habitat Assessment Reports: Unnamed Tributaries 1, 2, and 3 of Lagunitas Creek*.

2. DFG. 1998. *California Salmonid Stream Habitat Restoration Manual* – Excerpt.

3. Google Maps. 2013. *Bay Area Ridge Trail map.*

4. MMWD. 2011. *Lagunitas Creek Stewardship Plan*.

5. MMWD and Ettlinger, et al. 2009. *Lagunitas Creek Salmon Spawner Survey Report 2008-2009*.

6. MMWD and Ettlinger, et al. 2012. *Juvenile Salmoind Population Monitoring Report, Lagunitas Creek: Fall 2011*.

7. NOAA, National Marine Fisheries Service. 2012. *Federal Central California Coast Coho Recovery Plan* – Executive Summary. September.

8. O'Connor Environmental. 2012. *Sediment and Streambed Monitoring Plan for Lagunitas Creek* For MMWD.

9. Stetson Engineers. 2002. *San Geronimo Creek Watershed Sediment Sources Site Assessment*. For MMWD.

10. Stetson Engineers. 2012. *Lagunitas Creek Unpaved Roads Sediment Source Site Assessment*. Draft, for MMWD and CDFW.

11. Stetson Engineers. 2013. *Jewell Creek Culvert Replacement Project*: 100-year flow analysis and 50% design submittal. For MMWD.

12. Stillwater Sciences. 2007. *Middle Lagunitas Creek Watershed Sediment Delivery Analysis.* For County of Marin.

13. Stillwater Sciences. 2008. *Lagunitas Limiting Factors Analysis: Limiting Factors for Coho Salmon and Steelhead*. For Marin Resource Conservation District.

Project 4. Marin/Sonoma Conserving Our Watersheds: Agricultural BMP Projects

1. California Department of Fish and Wildlife (CDFW). 2010. California Salmonid Stream Habitat Restoration Manual. 4th Edition. Available: http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp

2. *Groundwork: A Handbook for Small-Scale Erosion Control in Coastal California*.

3. Marin Resource Conservation District. 2010. *Marin Coastal Permit Coordination Program Initial Study and Mitigated Negative Declaration for Marin Coastal Watersheds Permit Coordination Program*. November. Prepared by Prunuske Chatham, Inc. (SCH # 2004052008)

4. Lewis, D., M. Lennox, N. Scolari, L. Prunuske, C. Epifanio. 2011. A Half Century of Stewardship: a programmatic review of conservation by Marin RCD & partner organizations (1959-2009). Prepared for Marin Resource Conservation District by U.C. Cooperative Extension, Novato CA. 99 - Page iv. http://cemarin.ucdavis.edu/files/130468.pdf

5. Natural Resources Conservation Service. 2011. Conservation Practice Specifications and Standards; BMPs #560 Access Roads, #575 Animal Trail and Walkway, #342 Critical Area Planting, #382 Fence, #393 Filter Strip, #396 Fish Passage, #395 Fish Stream Improvement, #410 Grade Stabilization Structure, #412 Grassed Waterway, #468 Lined Waterway, #516 Pipeline, #350 Sediment Basin, #574 Spring Development, #580 Streambank Protection, #584 Stream

Channel Stabilization, #587 Structure for Water Control, #614 Trough/Tank, #620 Underground Outlets, and #638 Water and Sediment Control Basin. June.

6. Southern Sonoma County Resource Conservation District. 2008. *San Antonio Creek Watershed Plan* http://www.sscrcd.org/pdf/San%20Antonio%20Creek%20Plan%20(3-31-08)_web.pdf

7. Tomales Bay Watershed Council. 2003. *Tomales Bay Watershed Stewardship Plan: A Framework for Action*. http://www.tomalesbaywatershed.org/stewardship_framework.pdf

8. Lennox, M., N. Scolari, and D. Lewis. 2010. Riparian Zone Monitoring Plan. Prepared by University of California Cooperative Extension for Marin Resource Conservation District, Point Reyes Station CA. 75 p. http://cesonoma.ucdavis.edu/files/76316.pdf

Project 5. Napa Milliken Creek Flood Damage Reduction and Fish Passage Barrier Removal

1. HDR Engineering. 2010. *Preliminary results for the Milliken Creek crossing at Silverado Resort*. November.

2. HSI Hydrologic Systems. 2007. *Milliken Creek Flood Mitigation and Restoration Analysis*. December.

3. Napa County Resource Conservation District. 2012. *Milliken Creek Steelhead Habitat Modeling and Instream Flow Study*. December.

4. Riechers and Spence Associates. 2011. *Cost Benefit Evaluation for Milliken Creek Flood Mitigation Measures*. December.

Project 6. North Bay Water Reuse Program—Sonoma Valley CSD 5th Street East/McGill Road Recycled Water Project

1. California Department of Public Health. 2001. *California Health Laws Related to Recycled Water, "The Purple Book," Excerpts from the Health and Safety Code, Water Code, and Titles 22 and 17 of the California Code of Regulations.* Last Update: June 2001.

2. CDM Smith. 2012 (October). *North Bay Water Reuse Program Phase 2 Project Definition Scoping Study Report.* Prepared for North Bay Water Reuse Authority.

3. Environmental Science Associates (ESA). 2006 (September). *Sonoma Valley Recycled Water Project Draft. Environmental Impact Report* (SCH# 2005092083). Prepared for the Sonoma Valley County Sanitation District.

4. Environmental Science Associates (ESA). 2006 (December). *Sonoma Valley Recycled Water Project Final. Environmental Impact Report.* Certified by Sonoma Valley County Sanitation District, 12/06 (SCH# 2005092083). Prepared for the Sonoma Valley County Sanitation District.

5. Environmental Science Associates (ESA). 2009. *Draft North San Pablo Bay Restoration and Reuse Project Environmental Impact Report/Environmental Impact Statement* (SCH# 2008072096). Prepared for Bureau of Reclamation and North Bay Water Reuse Authority.

6. Environmental Science Associates (ESA). 2009. *Final North San Pablo Bay Restoration and Reuse Project Environmental Impact Report/Environmental Impact Statement* (SCH# 2008072096). Prepared for Bureau of Reclamation and North Bay Water Reuse Authority.

7. M.Cubed. 2007 (May). *Importance of Recycled Water to the San Francisco Bay Area.* Prepared for Bay Area Clean Water Agencies.

8. Sonoma County Water Agency. 2010. *Urban Water Management Plan 2010.*

9. Sonoma County Water Agency. 2007. *Sonoma Valley Groundwater Management Plan.*

10. Sonoma County Water Agency. 2005. *Sonoma Valley Recycled Water Feasibility Study; On Behalf of Sonoma Valley County Sanitation District, Valley of the Moon Water District, City of Sonoma*. December 2005.

11. Sonoma County Water Agency and Bureau of Reclamation. 2008. *Phase 3 Engineering and Economic/ Financial Analysis Report for the North San Pablo Bay Restoration and Reuse Project.*

12. SVCSD Recycled Water Line at McGill Road 90% Complete Project Designs.

Project 7. Oakland Sausal Creek Restoration Project

1. City of Oakland. 2007. *Sausal Creek Restoration Project at Dimond Canyon, California River Parkways Grant Application*. Prepared by City of Oakland Watershed Improvement Program.

2. HortScience, Inc. 2012. *Tree Management Report: Sausal Creek Restoration Project in Dimond Park, Oakland, CA*. Prepared for Restoration Design Group LLC. Retrieved February 24, 2013, from City of Oakland: http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak039116.pdf

3. Demgen, F, J. Hagar, and T. Cooke. 1998. *Technical Memorandum Aquatic Resource Inventory of Oakland Streams*. Prepared for City of Oakland. October 1.

4. Hagar, J. 2011. "Sausal Creek Restoration Project at Dimond Canyon": Letter evaluating fish habitat to Kristin Hathaway, CSM, City of Oakland Watershed Program Specialist, City of Oakland Public Works Agency. Prepared for Restoration Design Group by Hagar Environmental Science. April 12.

5. Lowe, M. 2012. *Sausal Creek Restoration at Dimond Park: Biological Resources Survey Report*. Prepared for City of Oakland by ESA Biological Resources and Land Management Group. December 10.

6. Marcus, L. 2010. *Sausal Creek Watershed Enhancement Plan*. Prepared by Laurel Marcus and Associates, New Fields River Basin Services, Hydrologic Systems, Inc. for the City of Oakland. Retrieved February 24, 2013, from Friends of Sausal Creek: http://www.sausalcreek.org/Plan/SCWEP.pdf

7. Ng, C and Dare, C. 2011. *Geotechnical Study, Sausal Creek Restoration Project in Dimond Park*. Prepared by FUGRO CONSULTANTS, Inc. for City of Oakland.

8. Paulsell, K. 2010. "The Fish Story." August. Retrieved April 22, 2011, from Friends of Sausal Creek: http://www.sausalcreek.org/sausal/nature_pdf/Fish_Story.pdf

9. Restoration Design Group, LLC. 2011. *Sausal Creek Restoration Project in Dimond Park, Design Basis Memorandum*. Prepared by Erik Stromberg, RDG, for City of Oakland. April 29.

10. Restoration Design Group, LLC. 2012. *Sausal Creek Restoration Project in Dimond Park, Final Review Hydraulic Memorandum*. Prepared by Erik Stromberg, RDG, for City of Oakland. April 16.

Project 8. Pescadero Water Supply and Sustainability Project

1. County of San Mateo. 2013. "Part B – Technical Specifications." Water Supply Well and Storage Reservoir 75% Specifications. Draft. March.

2. County of San Mateo, Department of Public Works. 2011. Pescadero Community Water System (County Service Area No. 11) Public Meeting, October 19. http://www.co.sanmateo.ca.us/publicworks/Divisions/Flood%20Control,%20Lighting,%20Sewer%20and%20Water/Water%20Services/CSA11%2010%2019%202011%20Public%20Meet%20Pres.pdf

3. County of San Mateo, Department of Public Works. 2011. Pescadero Community Water System – County Service Area No. 11 (CSA11) August 2011 Water Outage Report.

4. County of San Mateo, Department of Public Works. 2012. Adoption of Water Rates and Charges for County Service Area No. 11, Pescadero Area. May 30, 2012. http://www.co.sanmateo.ca.us/publicworks/Divisions/Flood%20Control,%20Lighting,%20Sewer%20and%20Water/Water%20Services/CSA11%20BOS%20Adopt%20Rates%202012-06-26%20.pdf

5. HydroScience Engineers. 2012. "Proposal for Engineering Services – CSA 11 Water Supply Project." Dated November 8 (updated December 18) from Curtis Lam to Edelzar Garcia.

6. HydroScience Engineers, Inc. 2013. Technical Memorandum #1: Water Supply Reliability.

7. Kennedy/Jenks/Chilton. 1986. Project Description: Water System for the Pescadero Rural Service Center, County of San Mateo.

8. Koretsky King Associates. 1976. Community Water Plan for the Town of Pescadero, County of San Mateo. September.

9. Pescadero Municipal Advisory Council. 2011. Meeting Minutes September 13, 2011. Calculated internally using references from East Bay Municipal Utility District. http://pescaderocouncil.files.wordpress.com/2011/10/pmacsept13minutes2011.pdf

10. Pescadero Municipal Advisory Council. 2012. Meeting Minutes December 11, 2012. http://pescaderocouncil.files.wordpress.com/2013/01/pmac-meeting-minutes-dec-11-2012.pdf

11. Rural Community Assistance Corporation. 2013. "Pescadero (CSA 11) Community Median Household Income Survey Results."Final results letter from Karen D. McBride to Carole Foster. March 15, 2013.

12. San Mateo County, County Service Area 11. 2013. (Pescadero) "Water Supply Project Storage Tank and Well 75% Submittal." March.

13. San Mateo County Health Department. 2006. Community of Pescadero, Pescadero Sewer Project Income Survey Results and Request for Eligibility Determination, SCG No. 959. http://pescaderocouncil.files.wordpress.com/2012/01/pescadero-2006-income-survey.pdf

14. San Mateo County Planning and Building Department. 1986. San Mateo County General Plan, Chapter 10: Water Supply. http://www.co.sanmateo.ca.us/planning/genplan/index.html

15. San Mateo Local Agency Formation Commission. 2011. Municipal Service Review and Sphere of Influence Update for County Service Area 11 (Pescadero). October 12. http://www.co.sanmateo.ca.us/Attachments/lafco/pdfs/2011_10_19_lafco_agenda_item4.pdf

16. Todd Engineers. 2002. Assessment of Source Water for the Pescadero Water System - CSA 11. Prepared for Department of Public Works, San Mateo County, California. http://www.co.sanmateo.ca.us/publicworks/ContentUnassigned/CSA11%20Assessment%20Report%20March%2002.pdf

17. Winzler & Kelly Consulting Engineers. 2009. Pescadero Fire Flow Analysis Memorandum. May 1. http://www.co.sanmateo.ca.us/Attachments/lafco/pdfs/lafco_pescadero_comm_fireflow_final_analysis.pdf

Project 9. Petaluma Flood Reduction, Water & Habitat Quality, and Recreation Project for Capri Creek

1. City of Petaluma. 1996. *Petaluma River Access and Enhancement Plan.* Available: http://cityofpetaluma.net/pubworks/fp-river-enhancement.html

2. City of Petaluma. 2008. *City of Petaluma: General Plan 2025.* May. Available: http://cityofpetaluma.net/cdd/plan-general-plan.html

3. City of Petaluma. 2010. *City of Petaluma Floodplain Management Plan*. October.

4. Naphtali H. Knox & Associates, Inc. and Wagstaff and Associates. 1989. *Corona/Ely Specific Plan*. Prepared for the City of Petaluma. May 1.

5. Sonoma County Water Agency. *Sonoma County Water Agency Petaluma River Watershed Master Drainage Plan* (project location on map no. 29 of document).

6. The Southern Sonoma County Resource Conservation District and the people of the Petaluma Watershed. 1999. *Petaluma Watershed Enhancement Plan*. July. Available: http://www.sscrcd.org/publications.php#pwep

7. USACE. *Hydrologic Engineering Center's River Analysis System (HEC-RAS) Analysis Report.* Includes illustrated cross-sections for creating flood terrace and season wetlands areas.

8. Waxman Environmental Consulting & Services, Questa Engineering Corporation, and City of Petaluma, Planning Department. 1996. *Restoration Design and Management Guidelines for the Petaluma River Watershed: Volume I and Volume II, Restoration and Revegetation Design*. July.

9. WEST Consultants, Inc. 2013. Capri Creek Terracing XP-Storm Evaluation Results Summary. February 13. To Pamela Tuft and Kent Carothers, City of Petaluma.

Project 10. Redwood City Bayfront Canal and Atherton Channel Flood Improvement and Habitat Restoration Project

1. Moffatt & Nichol (M&N). 2012. *Bayfront Canal and South Bay Salt Ponds S5/R5 Flood Mitigation Feasibility Study*. Prepared for City of Redwood City. May 22.

2. URS. 2012. *Opportunities and Constraints for Ravenswood Pond Complex, South Bay Salt Ponds Restoration, Phase II*. Prepared for State Coastal Conservancy. June 28.

Project 11. Regional Groundwater Storage and Recovery Project Phase 1A - South Westside Basin, Northern San Mateo County

1. City of San Francisco. 2009. *EIR Notice of Preparation for Regional Groundwater Storage and Recovery (GSR) Project*. (Case 2005.0164E).

2. MWH, Inc. 2007. *San Francisco Public Utilities Commission Water System Improvement Program Groundwater Conjunctive Use Project - WSIP Project CUW30103 - Final Alternatives Analysis Report*. For San Francisco Public Utilities Commission (SFPUC). October.

3. MWH, Inc. 2008. *San Francisco Public Utilities Commission Water System Improvement Program Groundwater Conjunctive Use Project - WSIP Project CUW30103 - Conceptual Engineering Report*. For SFPUC. November.

4. SFPUC. 2012. *South Westside Basin Groundwater Management Plan*. July. http://sfwater.org/Modules/ShowDocument.aspx?documentid=3104.

Project 12. Richmond Breuner Marsh Restoration Project

1. California Regional Water Quality Control Board. 2011. *Plan/Goal: San Francisco Bay Basin (Region 2) Water Quality Control Plan*. San Francisco. http://www.waterboards.ca.gov/sanfranciscobay/basin_planning.shtml

2. California State Coastal Conservancy. 2007. *Strategic Plan.* http://scc.ca.gov/strategic-plan-2007/

3. East Bay Regional Park District. 2012. *Breuner Marsh Restoration and Public Access Improvement Project 60% Plans. Richmond, California*. November 1, 2012.

4. Monroe, M, Olofson PR, Collins JN, Grossinger RM, Haltiner J, and Wilcox C. 1999. *Baylands Ecosystem Habitat Goals Report Recommendations.* U. S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif. http://www.sfei.org/node/2123/

5. Natural Heritage Institute. 2007. *The Rheem Creek Watershed Assessment and Conceptual Restoration Plan*. http://www.n-h-i.org/uploads/tx_rtgfiles/7734_RheemWA.pdf

6. National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, and California Department of Fish and Game. 2010. *Castro Cove/Chevron Richmond Refinery Damage Assessment and Restoration Plan/Environmental Assessment*. June. http://bit.ly/PlgTBh

7. San Francisco Bay Joint Venture. 2013. *Restoring the Estuary: A Strategic Vision for the Restoration of Wetlands and Wildlife in the SF Bay Area*. http://www.sfbayjv.org/strategy.php

8. San Francisco Estuary Institute. 2009. *Comprehensive Conservation and Management Plan*. http://www.sfei.org/CCMPPhase6

Project 13. Roseview Heights Infrastructure Upgrades for Water Supply and Quality Improvement, Santa Clara County

1. Alvarez & Associates. 2011. *Water Easement*. APN 612-07-027. 10517 Crothers Road, San Jose, CA 95127. November.

2. Alvarez & Associates. 2011. *Water Easement*. APN 612-07-033. 10515 Crothers Road, San Jose, CA 95127. November.

3. Alvarez & Associates. 2011. *Water Easement*. APN 612-07-034. 10495 Crothers Road, San Jose, CA 95127. November.

4. Binkley Associates, Inc. 2012. *Roseview Heights Mutual Water Company Water Tank and Pipeline Replacement Project Civil Engineering Drawings*. September.

5. California Department of Public Health. 2012. "Replacement of the Bon Vista and Crothers Tanks Domestic Water Supply Permit Requirements Roseview Heights Mutual Water Company, Water System No. 4300562." October 10. (CDPH design acceptance letter.)

6. Murray Engineers, Inc. 2009. *Geotechnical Investigation, New Water Tank.* APN 612-07-019. Crothers Road, Santa Clara County, California. Prepared for Roseview Heights Water Company. October.

7. Murray Engineers, Inc. 2011. *Geotechnical Investigation, New Water Tank.* APN 612-50-039. Bon Vista Court, Santa Clara County, California. Prepared for Roseview Heights Water Company. May.

8. Roseview Heights Mutual Water Company. 2013. *Water and Power Usage 1999, 2004–2012*. Prepared by Tim Schacher, Board President. January 19.

Project 14. San Francisco Bay Climate Change Pilot Projects Combining Ecosystem Adaptation, Flood Risk Management and Wastewater Effluent Polishing

1. ESA PWA and Peter Baye. 2012. *Oro Loma Wet Weather Equalization, Treatment Wetland and Ecotone Demonstration Project, Initial Feasibility Study*. July 29, 2012.

2. San Francisco Bay Conservation and Development Commission (BCDC). 2011. *Staff Report: Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline*. October 6, 2011.

Project 15. San Francisco International Airport Reclaimed Water Facility

1. CH2M Hill. 2012. "Technical Memorandum 2," "Technical Memorandum 3," "Technical Memorandum 4," and "Technical Memorandum 5." Prepared for San Francisco International Airport. September.

2. Department of Public Works Bureau of Engineering. 2009. *San Francisco International Airport Recycled Water Project Alternatives Analysis Report*. Prepared for San Francisco Airport Commission. June 15.

3. Stanford University. 2012. *San Francisco Airport Tertiary Treatment Plant Life Cycle Analysis*. December.

Project 16. San José Green Streets & Alleys Demonstration Projects

1. City of San José. *Envision San José 2040 General Plan: Building a City of Great Places*.

2. City of San José. 2008. *Spartan Keyes Neighborhood Improvement Plan Amendment.* December. http://www.sanjoseca.gov/DocumentCenter/View/3015

3. City of San José Department of Public Works. 1992. *Standard Details City of San Jose Department of Public Works*.

4. City of San José Public Works. 2013. *Traffic Control Manual*. http://www.sanjoseca.gov/index.aspx?NID=3464

5. Conceptual designs for the San José Green Streets & Alleys Demonstration Projects.

6. Natural Resources Defense Council. 2009. *A Clear Blue Future: How Greening California Cities Can Address Water Resources and Climate Challenges in the 21st Century*. August. http://www.nrdc.org/water/lid/

7. San Mateo Countywide Water Pollution Prevention Program. 2009. *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook, 1st Edition*. January. http://www.flowstobay.org/ms_sustainable_streets.php

8. Selbig and Bannerman. 2007. *Evaluation of Street Sweeping as a Stormwater-Quality-Management Tool in Three Residential Basins in Madison, Wisconsin*. USGS Report 2007-5156.

Project 17. San Pablo Rheem Creek Wetlands Restoration Project

1. CCWD. 2011. *Shortcut Pipeline Improvement Project, Initial Study/Mitigated Negative Declaration*. Available: http://www.ccwater.com/files/SCPL%20.pdf. September.

2. Kamman Hydrology & Engineering. 2012. *Hydrologic Sufficiency Analysis Rheem Creek Mitigation Bank, Richmond CA*. October.

3. Natural Heritage Institute. 2007. *Rheem Creek Watershed Assessment and Conceptual Restoration Plan*. Available: http://www.n-h-i.org/uploads/tx_rtgfiles/7734_RheemWA.pdf.

4. Olberding Environmental. 2013. *Baseline Mitigation and Monitoring Report 2013 for the Parkway Commerce Center Property*. Contra Costa County, California. January.

Project 18. St. Helena Upper York Creek Dam Removal and Ecosystem Restoration Project

1. City of St. Helena. 2007. *Draft Environmental Impact Report, Upper York Creek Ecosystem Restoration Project, Napa County, California.* Prepared by Prunuske Chatham, Inc. April 20, 2007. SCH #2006092096.

2. Department of Water Resources (DWR). 2004. *Final Environmental Impact Report for the City of St. Helena York Creek Diversion Modification Project.* January 14, 2004.

3. Eastman, B. 2003. *Historical Resources Evaluation Report for the Proposed Removal of an Earthen Dam and Diversion Structure on York Creek near the City of St. Helena in Napa County, California*. Prepared for the City of St. Helena by Bright Eastman, Anthropological Studies Center, Sonoma State University, Rohnert Park, California.

4. U.S. Army Corps of Engineers (Corps). 2005. *Upper York Creek Dam Removal Project Section 206: Aquatic Ecosystem Restoration Without Project Hydrology Certification Basin Hydrology Assessment.* U.S. Army Corps of Engineers, San Francisco District, South Pacific Division. March 2005.

5. U.S. Army Corps of Engineers (Corps). 2006. *Draft Detailed Project Report: Upper York Creek Ecosystem Restoration Project, Napa County, California* (DPR). U.S. Army Corps of Engineers, San Francisco District, South Pacific Division. December 15, 2006.

Project 19. Students and Teachers Restoring a Watershed (STRAW) Project—North and East Bay Watersheds

1. California Department of Fish and Game. 2010. *California Salmonid Stream Habitat Restoration Manual, 4th edition*. July. http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

2. ECONorthwest. 2012. *Handbook for Estimating Economic Benefits of Environmental Projects*. December.

3. Glazebrook, J.D., M.S., R.M.A., Catriona MacGregor. 2007. *Valuation of STRAW: An Independent Evaluation by Pathfinder International Consulting.* May.

4. Kreitinger, K. and T. Gardali. 2006. *Bringing the Birds Back: A Guide to Habitat Enhancement in Riparian and Oak Woodlands for the North Bay Region*. California Partners in Flight Regional Bird Conservation Plan No. 1, http://www.prbo.org/calpif.

5. Lennox, M., N. Scolari, and D. Lewis. 2010. Riparian Zone Monitoring Plan. Prepared by University of California Cooperative Extension for Marin Resource Conservation District, Point Reyes Station CA. 75 p. http://cesonoma.ucanr.edu/files/76316.pdf.

   See Attachment 3, Project 4 References

6. Marin County Community Development Agency, Planning Division. 2004. *Marin County Watershed Management Plan*. April.
   http://www.co.marin.ca.us/depts/CD/main/comdev/Watershed/WMP_Pt1.pdf
   http://www.co.marin.ca.us/depts/CD/main/comdev/Watershed/WMP_Pt2.pdf

7. Marin Resource Conservation District and Marin County Stormwater Pollution Prevention Program. 1987. *Groundwork—A Handbook for small-scale erosion control in coastal California, 2nd edition.*

8. Monroe, et al. 1999. *Goals Project. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project.* U. S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif. http://www.sfei.org/node/2123

9. Napa County. 2011. *Integrated Water Resource Management Planning Framework*. April.http://www.napawatersheds.org/files/managed/Document/5054/Napa%20County%20IRWM%20Planning%20Framework%20-%20Report.pdf

10. Nutters, Heidi. 2012. *Addressing Social Vulnerability and Equity In Climate Change Adaptation Planning*. Adapting to Rising Tides White Paper. June. http://www.adaptingtorisingtides.org/wp-content/uploads/2012/06/Equity-White-Paper.pdf

11. Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA Forest Service General Technical ReportPSW-GTR-144**.**

12. Riley, et al. 2009. *Putting a Price on Riparian Corridors as Water Treatment Facilities*. The San Francisco Bay Water Quality Control Board in conjunction with the Economics Division of the Department of Water Resources. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/watershed/Riley_2009.pdf

See Attachment 8, Project 7 References

13. Riparian Habitat Joint Venture (RHJV). 2000. *The Riparian Bird Conservation Plan: A strategy for reversing the decline of riparian associated birds in California*. Version 1.0. California Partners in Flight. http://www.prbo.org/calpif/pdfs/riparian_v-2.pdf

14. San Pablo Bay Watershed Restoration Program, The. 2010. *DRAFT Watershed Management Plan*. http://www.marinwatersheds.org/documents/SPBWMngmtPlan_DRAFT_6May_2010_004.pdf

15. Seavy, N. E., et al. 2009. *Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research*. *Ecological Restoration* 27:330–338. http://er.uwpress.org/content/27/3/330.full.pdf+html

16. Songbird Response to Riparian Restoration on Marin County Ranches, PRBO Conservation Science Unpublished Data.

17. Sonoma County Permit and Resource Management Department. 2008. *Sonoma County General Plan 2020: Open Space and Resource Conservation Element*.

18. Solano Resource Conservation District and The Community Alliance with Family Famers. 2005. *Solano Conservation and Restoration Manual*. http://caff.org/wp-content/uploads/2010/07/SolanoConservationManual.pdf

19. State Water Resources Control Board. 2001. Standard Operating Procedure (SOP) 4.2.1.4. Stream Photo Documentation Procedure.

20. Tomales Bay Watershed Council. 2007. *Integrated Coastal Watershed management Plan* (ICWMP). September. http://www.tomalesbaywatershed.org/informationreports.html

21. University of California Cooperative Extension (UCCE), County of Sonoma. 2007. *Riparian Revegetation Evaluation on California's North Coast Ranches*. June. http://cesonoma.ucanr.edu/files/27406.pdf

22. USDA Natural Resources Conservation Service. *Field Office Technical Guide*. #342 Critical Area Planting and #580 Streambank Protection.

Bayfront Canal and South Bay Salt Ponds S5/R5

Flood Mitigation Feasibility Study

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1. INTRODUCTION

1.1 BACKGROUND

The Bayfront Canal is located in the City of Redwood City (City), and runs from west to east adjacent to the former Cargill Redwood City Salt Ponds and just north of Highway 101. The Bayfront Canal merges with the Atherton Channel near Marsh Road and then outlets into Flood Slough through a tide control structure. The project location is illustrated in Figure 1-1. The properties adjacent to the Bayfront Canal currently experience flooding from larger rain events that coincide with higher tide elevations in Flood Slough. A previous study completed by the City in 2011 concluded that upgrading the pump station in the Bayshore area would not have a significant impact on flooding. The study also showed only mixed results for constructing walls to raise the banks of the Bayfront Canal and Atherton Channel.

The City requested that M&N perform a feasibility study to analyze the potential for routing flood flows from the Bayfront Canal and Atherton Channel into the managed ponds that are now part of the South Bay Salt Ponds Restoration project. Ponds S5, R5, R4, and R3 currently are managed ponds adjacent to Bayfront Park and Flood Slough, and flood flows from the Canal could be bypassed around the Flood Slough tide gate and routed into these ponds to possibly facilitate the development of a seasonal wetlands habit and help mitigate the flooding problem.

1.2 PURPOSE

The City requested that M&N perform a feasibility study to analyze the potential for routing flood flows from the Bayfront Canal and Atherton Channel into the managed ponds that are part of the South Bay Salt Ponds Restoration project. Ponds S5, R5, R4 and R3 currently are managed ponds adjacent to Bayfront Park and Flood Slough, and flood flows from the Canal could be bypassed around the Flood Slough tide gate and routed into these ponds to possibly facilitate the development of a seasonal wetlands habit and help mitigate the flooding problem.

1.3 SCOPE OF WORK

Our approach was to review the existing studies and numerical models of the Bayfront area that have already been prepared for the City and utilize the information to analyze flood mitigation alternatives for this feasibility study. The LIDAR survey data already collected by the City was reviewed and utilized in the development of stage-storage curves for the three managed ponds that could be used to receive flood flows from the Bayfront Canal.

Our scope of work was as follows:

TASK 1: REVIEW DATA AND REPORTS

The following engineering reports and data that have been generated from the study of flooding in the Bayfront area and potential mitigations were reviewed:

- Topographic LIDAR survey and as-built drawings of the Flood Slough tide gate;
- Winzler and Kelly Hydraulic study (2003);
- WRECO Hydraulic study (2011);
- Schaaf and Wheeler Hydrology study (2002).

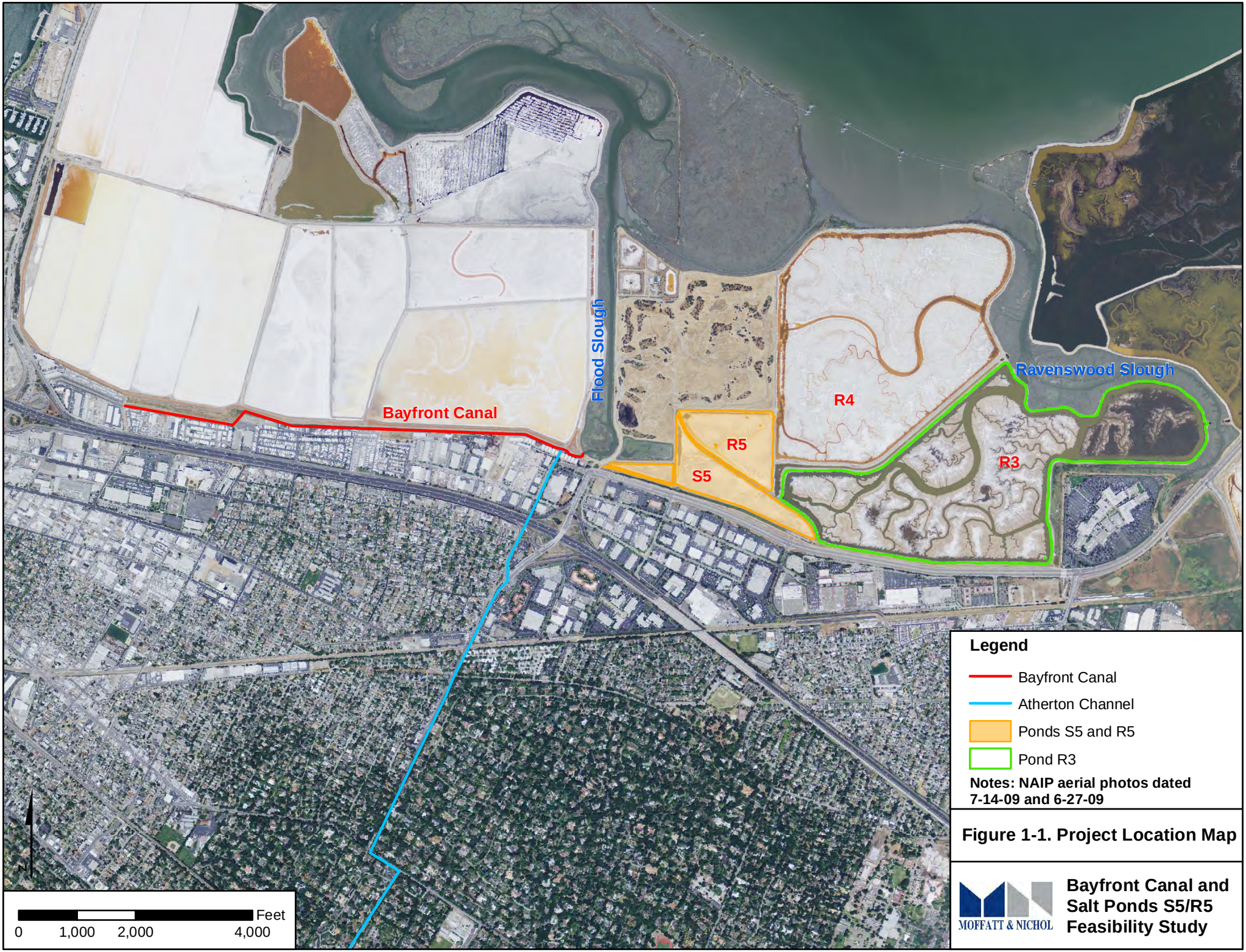

Figure 1-1. Project Location Map

TASK 2: FEASIBILITY ANALYSIS

1. Develop stage-storage relationships for the managed ponds from the available LIDAR data.
2. Perform hydraulic analyses to determine the hydraulic grade lines from the Bayfront Canal, through the managed ponds, and then out to the Bay. Potential locations for tide-gates and culverts to route flows back into Flood Slough were considered. Grading of the managed ponds to facilitate the project were also considered.
3. Perform statistical analysis to determine the frequency of occurrence for various combinations of rainfall and high tide events, which were used to estimate stage and capacity of the ponds and resulting reduction in flood stage in Bayfront Canal. Flood flows and stages associated with lower frequency precipitation events were derived from the existing hydraulic and hydrologic studies. The recurrence-interval of tide levels in Flood Slough were derived from existing studies and from available tide data in the Bay.
4. Conduct water quality sampling to document background levels of contaminants in Bayfront Canal; performed by Kinnetic Laboratories.
5. Document approach and results.

2. BACKGROUND DATA

2.1 TIDES

M&N previously completed an analysis of tides in the vicinity of the project location as part of the Redwood Shores Levee System Coastal Engineering Assessment (M&N, 2009). The following section presents the results of that analysis

2.1.1 Tidal and Geodetic Datums

Data were collected and reviewed for four tide gauges operated by the National Oceanographic and Atmospheric Administration (NOAA) in the vicinity of the Redwood City levee system.

- Gauge number 9414501: Redwood Creek, Channel Marker No. 8, San Francisco Bay, California, is the gauge closest to Redwood City levee system. However, this gauge only operated for 27 months in the mid-1970s, and NOAA has not updated the tidal datums for this location for the most recent (1983 – 2001) tidal epoch. M&N has not obtained measurements other than the tidal statistics listed in the Tables below for this station.
- Gauge number 9414523: Redwood City, Wharf 5, S.F. Bay, California, is located immediately south of Bair Island, approximately 2 miles from the Redwood City levee system. Data at Redwood City are available online (NOAA 2008) for the following periods:
  - October 10, 1974 to March 31, 1976;
  - August 15, 1983 to May 18, 1984;
  - October 1, 1997 to present.

  This period of record, including 17 winter seasons, was too short to allow the development of extreme elevations such as the 1-percent-annual-chance condition without additional information. This gauge also has the disadvantage that NOAA and the National Geodetic Survey (NGS) do not publish conversions from the tidal datum (MLLW) to geodetic datums (including NGVD29 and the City Datum) for this station.
- Gauge number 9414750: Alameda, San Francisco Bay, California, is the control station for Redwood City. M&N (2009) obtained tide data directly from NOAA for the Alameda gauge for the period August 1, 1979 to December 31, 2008. As discussed below, it is possible to convert measured data from the Alameda to the Redwood City gauge with reasonable accuracy. A combination of this synthetic data and measurements at Redwood City were used to develop extreme elevations in the M&N (2009) report.
- Gauge number 9414290: San Francisco, California, has a period of record of over 100 years. M&N (2009) obtained tide data directly from NOAA for the San Francisco gauge for the period January 1, 1945 to 2009.

Table 2-1 below shows tidal datums for the different gauges (M&N 2009).

Table 2-1. Tidal Statistics for Gauges in the Vicinity of Redwood City

Tidal Plane All elevations are in feet, MLLW	9414501 Redwood Creek	9414523 Redwood City †	9414750 Alameda	9414290 San Francisco
Period of Record *	11/74 – 3/77	1997-2009	1939-2009	1854-2009
Epoch	1960-1978	1983-2001	1983-2001	1983-2001
Highest Observed Water Level	9.63	10.86	9.65	8.66
Mean Higher High Water (MHHW)	7.96	8.22	6.60	5.84
Mean High Water (MHW)	7.35	7.59	5.97	5.23
Mean Tide Level (MTL)	4.27	4.39	3.55	3.18
Mean Sea Level (MSL)	N/A ‡	4.41	3.45	3.12
NGVD 29	3.91	N/A ‡	2.92	2.63
Mean Low Water (MLW)	1.19	1.20	1.13	1.14
Mean Lower Low Water (MLLW)	0.00	0.00	0.00	0.00
Lowest Observed Water Level	-2.13	-2.58	-2.55	-2.88

* *Period for which the gauge has generally operated continuously. M&N has obtained data for different periods as described above.*

† *NOAA also installed short-term gauges at this site in the 1970s and 1980s.*

‡ *Value not provided by NOAA or NGS.*

The City of Redwood City uses a local datum which is set at 100.0 feet below the NGVD 29 datum. Consequently, it is necessary to convert the tidal elevations shown above to NGVD 29, and then to the City datum, for use in floodplain mapping. Table 2-2 shows the tidal elevations for Redwood City based on the Redwood City gauge. This report generally uses the NAVD datum for analysis of water levels.

Table 2-2. Tidal Statistics for Redwood City Gauge with Datum Conversions

Tidal Plane All elevations are in feet	MLLW	NAVD88	NGVD29	City Datum
Highest Observed Water Level	10.9	9.7	7.0	107.0
Mean Higher High Water (MHHW)	8.2	7.0	4.3	104.3
Mean High Water (MHW)	7.6	6.4	3.7	103.7
Mean Tide Level (MTL)	4.4	3.2	0.5	100.5
Mean Sea Level (MSL)	4.4	3.2	0.5	100.5
NGVD 29 *	3.9	2.7	0.0	100.0
NAVD 88 †	1.2	0.0	-2.7	97.3
Mean Low Water (MLW)	1.2	0.0	-2.7	97.3
Mean Lower Low Water (MLLW)	0.0	-1.2	-3.9	96.1
Lowest Observed Water Level	-2.6	-3.8	-6.5	93.5

* *The conversion from MLLW to NGVD 29 is based on the Redwood Creek gauge. Coincidentally, corrections to the 1983-2001 epoch and for the different tidal ranges at the Redwood Creek and Redwood City gauges cancel out.*

† *The conversion from NGVD29 to NAVD 88 was based on the NGS Vertcon program (NGS 1999).*

2.1.2 Statistical Extreme Stillwater Elevations

M&N previously had prepared a synthetic hourly time series of stillwater elevations (tidal elevations) for Redwood City for the periods October 1, 1974 through September 30, 2008 (M&N, 2009). Table 2-3 gives the resulting extreme values for the tidal elevation at Redwood City, relative to the MLLW, NAVD88, NGVD29, and City Datum. This table also shows the more typical tidal elevations (Mean Higher High Water, Mean High Water) for comparison.

Table 2-3. Extreme and Typical Tidal Elevations for Redwood City based on various datums

All elevations are in feet	MLLW	NAVD88	NGVD29	City Datum
Return Period Events:				
0.2% annual chance (500-year)	11.6	10.3	7.6	107.7
1% annual chance (100-year)	11.0	9.8	7.1	107.1
4% annual chance (25-year)	10.6	9.4	6.7	106.7
10% annual chance (10-year)	10.3	9.1	6.4	106.4
20% annual chance (5-year)	10.1	8.9	6.2	106.2
50% annual chance (2-year)	9.8	8.6	5.9	105.9
100% annual chance (1-year)	9.2	8.0	5.3	105.3
Tidal Planes:				
Mean Higher High Water (MHHW)	8.2	7.0	4.3	104.3
Mean High Water (MHW)	7.6	6.4	3.7	103.7

2.2 TOPOGRAPHIC DATA REVIEW

This section presents results of a topographic analysis of the storage area available in the existing South Bay Salt Ponds, which are adjacent to Flood Slough and the Bayfront Canal tide gates. The three managed ponds that could potentially be used to receive flood flows from the Bayfront Canal are S5, R5, and the larger R3 pond (see Figure 1). Pond R4 is proposed to be a tidal marsh and was therefore assumed to be the “Bay”.

The LIDAR survey data already collected by the City was provided to M&N in GIS format as 1-foot interval contour data for the project location. The elevation data was based on the NAVD88 vertical datum. This contour data was then used to create a digital elevation surface in ArcMap with 1-ft horizontal resolution. A cut/fill analysis was performed for a series of assumed water surface elevations in the ponds to develop stage-storage curves. The S5 and R5 ponds were grouped together in the analysis because of their smaller size and their alignments relative to the project.

Pond R3 has existing low-flow channels which provide capacity down below Mean Tide Level (3.2’ NAVD), whereas the majority of the S5/R5 surface area is above elevation 4.0’ NAVD. The stage-storage analysis stopped at a high elevation of 6-ft NAVD due to a number of low spots on the existing salt pond berms at or near this elevation. The existing berms could potentially be raised as part of the proposed project.

The results of the cut/fill analysis are presented for ponds S5/R5 and R3 in Table 2-4 and Table 2-5, respectively. The stages-storage curves are also illustrated in Figure 2-1, below.

Table 2-4. Stage Storage Relationship for Ponds S5/R5

Elevation (ft NGVD)	Elevation (ft NAVD)	Surface Area (acres)	Storage Volume (ac-ft)	Average Depth (ft)
0	2.7	-	-	-
0.3	3.0	1.5	0.0	-
0.8	3.5	3.1	1.2	0.4
1.3	4.0	5.0	3.2	0.6
1.8	4.5	25.6	14.1	0.6
2.3	5.0	33.8	28.9	0.9
2.8	5.5	63.7	60.1	0.9
3.3	6.0	66.4	92.6	1.4

Table 2-5. Stage Storage Relationship for Pond R3

Elevation (ft NGVD)	Elevation (ft NAVD)	Surface Area (acres)	Storage Volume (ac-ft)	Average Depth (ft)
0	2.7	17.7	4.1	0.2
0.3	3.0	33.2	11.2	0.3
0.8	3.5	61.9	36.6	0.6
1.3	4.0	77.5	70.9	0.9
1.8	4.5	147.7	124.3	0.8
2.3	5.0	242.6	222.6	0.9
2.8	5.5	276.8	355.5	1.3
3.3	6.0	279.4	494.6	1.8

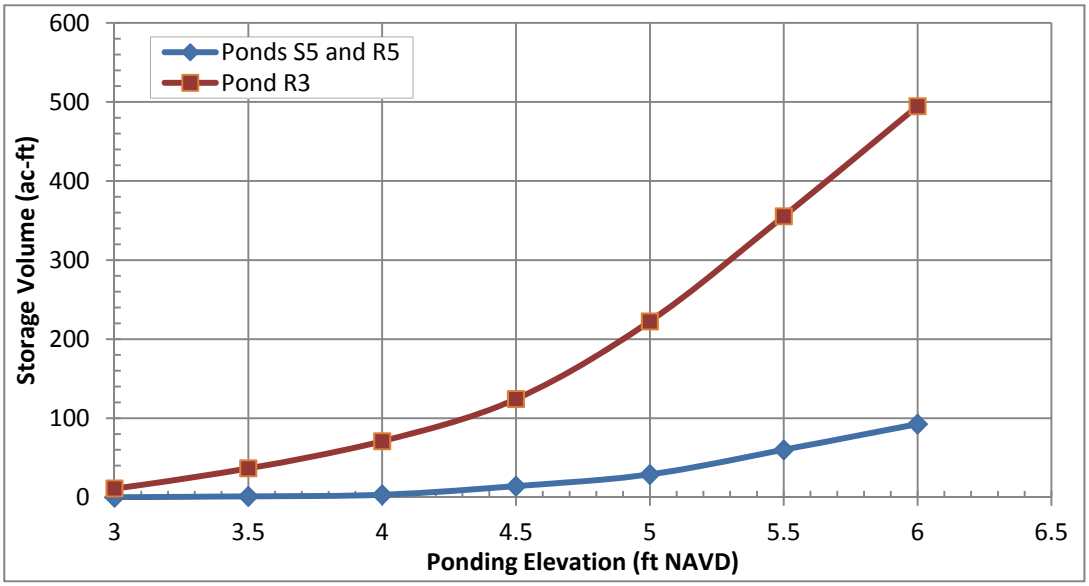

Figure 2-1. Stage Storage Relationship for Ponds S5/R5 and R3

2.3 HYDROLOGIC AND HYDRAULIC DATA REVIEW

Three hydrologic and hydraulic reports previously prepared for the City were reviewed for this study:

- WRECO Hydraulic study (2011);
- Winzler and Kelly Hydraulic study (2003);
- Schaaf and Wheeler Hydrology study (2002).

The information in these reports provided the basis for the inputs into the hydraulic modeling performed as part of this feasibility study; the pertinent data is summarized in this section.

2.3.1 Rainfall Events

The NOAA Atlas 14 precipitation frequency estimates for Redwood City are presented in Table 2-6. The 24-hour cumulative precipitation depths are shown because the runoff hydrographs presented in the Schaaf and Wheeler study and the Winzler and Kelly study both were based on a 24-hour design event.

Table 2-6. Precipitation Frequency Depths

Design Storm Event	24-hour Precipitation Depth* (in)
1% annual chance (100-year)	5.0
4% annual chance (25-year)	3.8
10% annual chance (10-year)	3.2
20% annual chance (5-year)	2.7
50% annual chance (2-year)	2.1
100% annual chance (1-year)	1.6

** Source: (NOAA, 2011)*

2.3.2 Runoff Hydrographs

The Schaaf and Wheeler study presented a set of 10-yr and 100-yr runoff hydrographs for Bayfront Canal, Atherton Channel, and their combined hydrograph at the tide gates. The peak flow from Bayfront Canal occurred roughly 30-minutes before the peak in Atherton Channel, due to a slight difference in their hydrologic time of concentration. The shape of these hydrographs was verified using the Army Corps of Engineers HEC-HMS hydrologic modeling program; they matched the shape of a 24-hour SCS Type-I storm distribution, which is applicable to the project location (NRCS 1986).

The peak discharges in Bayfront Canal are affected by the capacity of three pump-stations within the watershed, which all pass runoff from south of Hwy-101 into the Canal. The Schaaf and Wheeler study presented peak discharges for the Bayfront Canal watershed before the hydraulic impact of the pump-stations. These values were used to develop runoff hydrographs with the peak flowrates shown below in Table 2-7.

Table 2-7. Design Storm Peak Flow Rates, upstream of Pump-Stations

Flow Location	1-yr Peak Q (cfs)	2-yr Peak Q (cfs)	5-yr Peak Q (cfs)	10-yr Peak Q (cfs)	25-yr Peak Q (cfs)	100-yr Peak Q (cfs)
Broadway PS Drainage Area	34	39	51	65	78	101
Douglas PS Drainage Area	96	109	143	182	219	282
Fifth Ave PS Drainage Area	51	59	77	98	117	151
East Bayshore	29	33	43	55	66	86
Bayfront Canal - Upstream Total	211	240	315	400	480	620
Atherton Channel	294	335	440	560	680	910

The Broadway and Douglas pump stations both outlet into the most upstream extent of the Bayfront Canal; both of these pump stations each have a maximum pump rate of 72-cfs. The Fifth Avenue pump station currently has a maximum pump rate of 30-cfs. This station has been studied by the City for a possible upgrade to a 270-cfs capacity; however, based on the limited capacity of the Bayfront Canal itself, this pump station upgrade has been put on hold. For the purposes of this feasibility study, the 30-cfs capacity was used.

The peak discharges shown in Table 2-8 reflect the effects of these three pump stations on peak flowrates in the Bayfront Canal.

Table 2-8. Design Storm Peak Flow Rates, limited by Existing Pump-Station Capacities

Flow Location	1-yr Peak Q (cfs)	2-yr Peak Q (cfs)	5-yr Peak Q (cfs)	10-yr Peak Q (cfs)	25-yr Peak Q (cfs)	100-yr Peak Q (cfs)
Broadway Pump Station	34	39	51	65	72	72
Douglas Pump Station	72	72	72	72	72	72
Fifth Ave Pump Station	30	30	30	30	30	30
East Bayshore	29	33	43	55	66	86
Bayfront Canal - Upstream Total	165	174	197	222	240	260
Atherton Channel	294	335	440	560	680	910
Bayfront Canal - Downstream Total (Tide Gate)	459	509	636	782	920	1,170

Where pump-capacity limited the flowrate into the Canal, the runoff hydrographs were drawn out at the maximum pump rate to reflect the runoff volume backed up in the system.

The runoff hydrographs used in this study, which were scaled from the Schaaf and Wheeler curves and adjusted to reflect the pump capacity limitations in the watershed, are shown below in Figures 2-2 through 2-4 for the 25-year, 5-year, and 1-year design storm events, respectively.

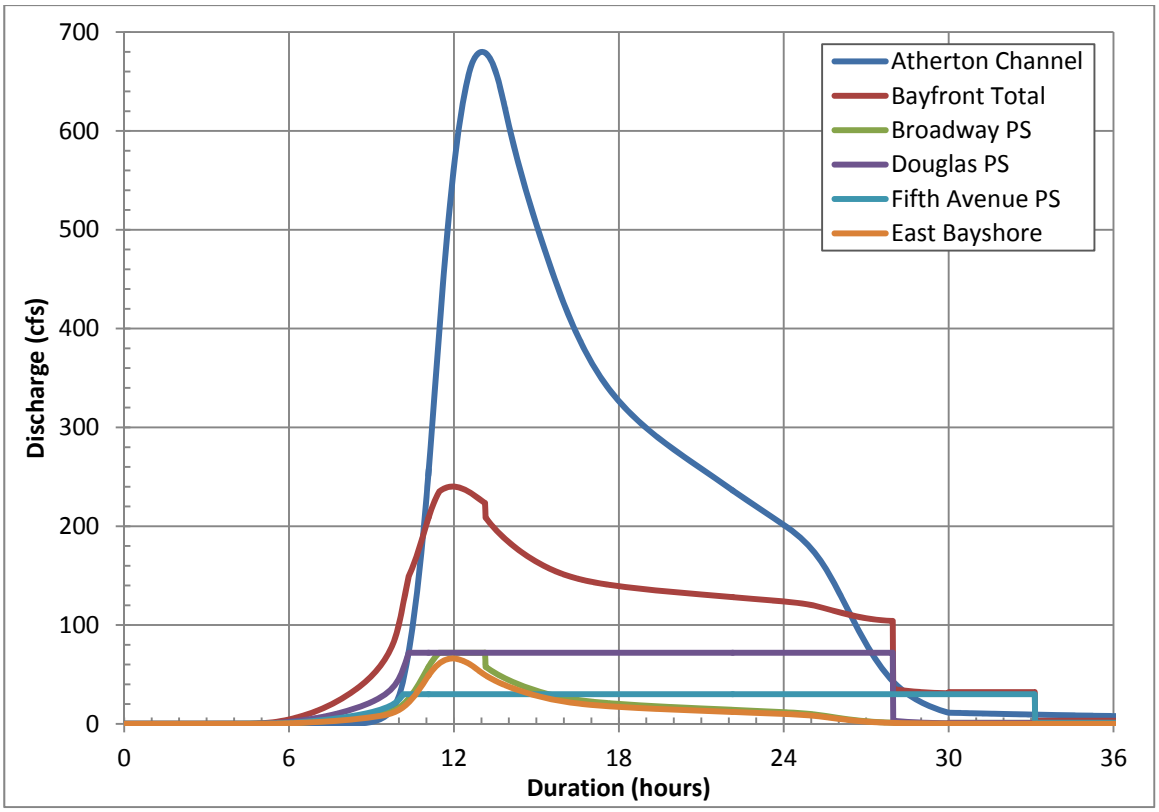

Figure 2-2. Runoff Hydrographs for 25-yr Design Storm Event

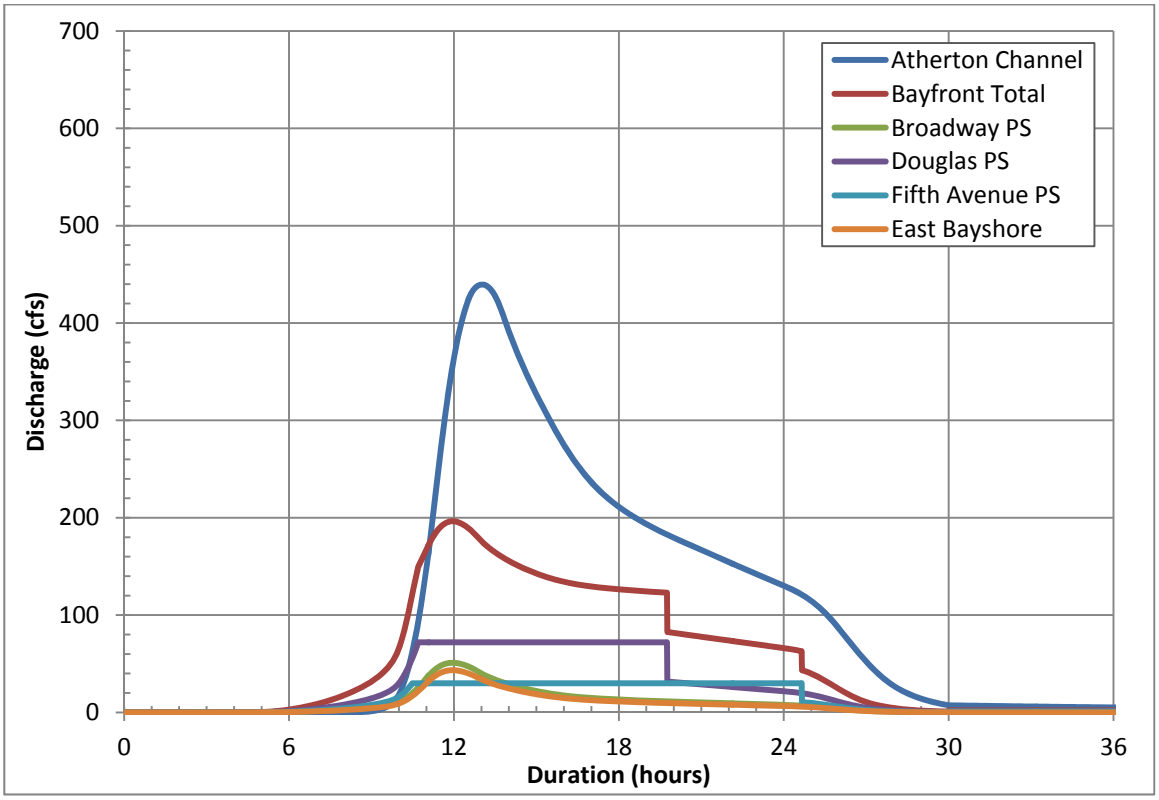

Figure 2-3. Runoff Hydrographs for 5-yr Design Storm Event

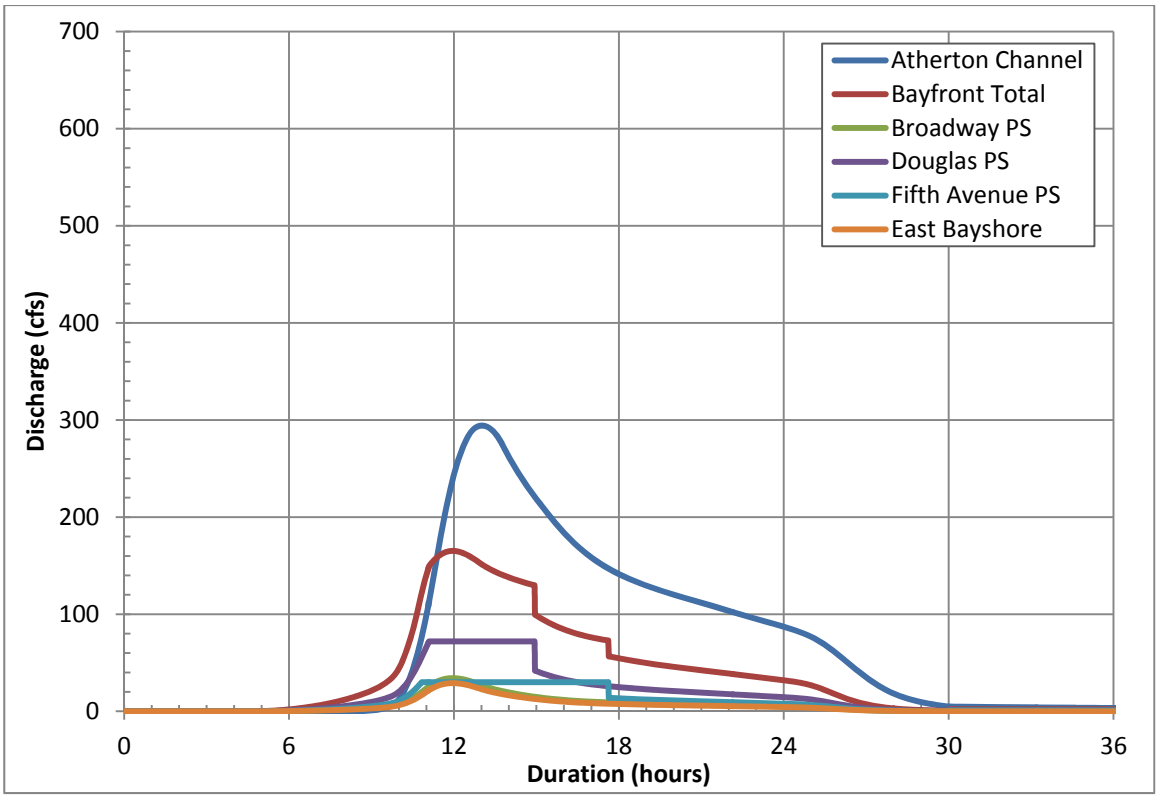

Figure 2-4. Runoff Hydrographs for 1-yr Design Storm Event

Both Winzler and Kelly and WRECO identified low points in the channel banks on the upstream reach of the Bayfront Canal, above the junction with Atherton Channel. It is these low spots in the channel banks, particularly on the south bank, that result in overbank flooding of the properties in the East Bayshore area, adjacent to the Canal. The WRECO report included stage-discharge curves representing overbank flows leaving the Canal on the right bank (north) and left bank (south). These curves were used in this study to quantify the flood volumes leaving the Bayfront Canal and flowing into the adjacent properties during the various modeling scenarios, and are shown in Figure 2-5 below.

The WRECO report also identified that for larger flood events (25-yr event used in the study), the north bank of the Bayfront Canal is overtopped and that there is hydraulic interchange between the Canal and the flooded Cargill Salt Ponds immediately north of the channel. This study did not attempt to account for flood waters entering the Canal from over the north bank and assumed that the Salt Pond levees were of sufficient height to keep out extreme high tides.

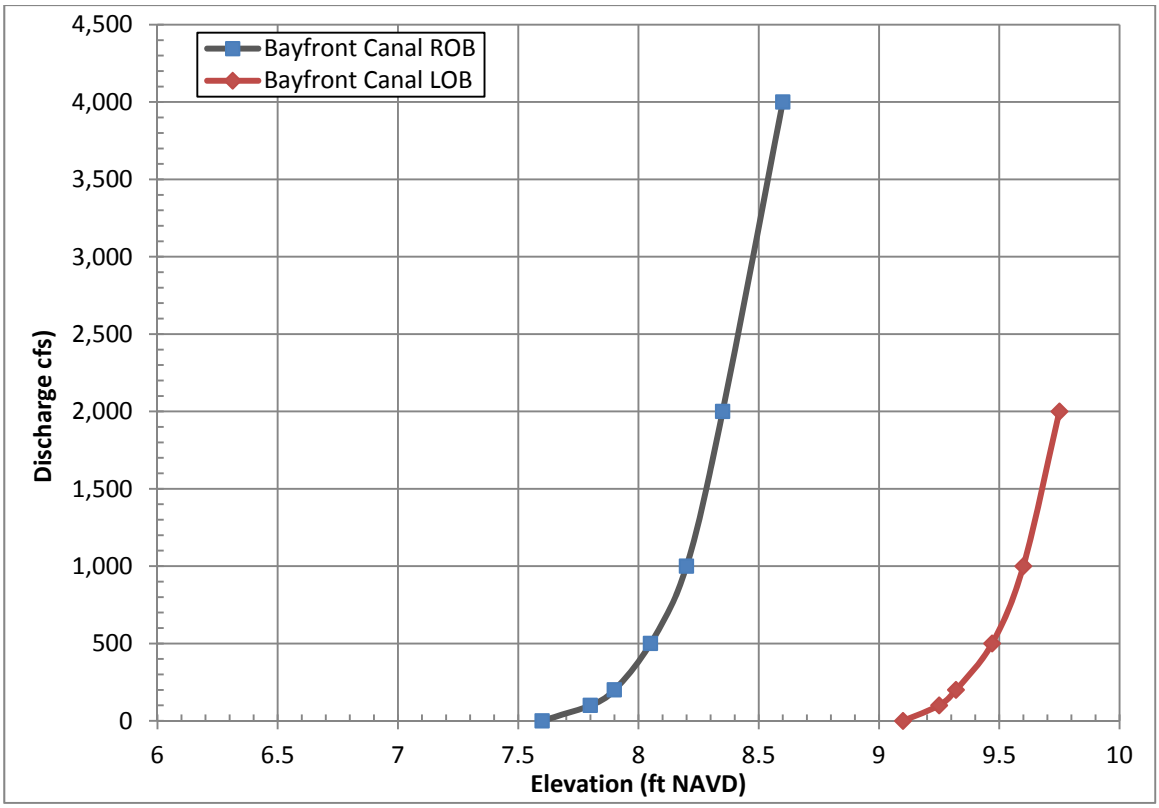

Figure 2-5. Stage-discharge Curves for the Bayfront Canal Overbanks (WRECO, 2011)

3. FLOOD MITIGATION FEASIBILITY ANALYSIS

The following sections present the various aspects of this feasibility study. The hydraulics of the existing Canal and tide gates, along with the routing of flood flows into the adjacent ponds were analyzed. The frequency and duration of fresh water flows entering the ponds was analyzed. The proposed pipe alignment and any potential clearance issues with existing buried pipes was also reviewed, along with water-quality sampling of the existing Bayfront Canal flows that are proposed to be routed into the managed ponds of the South Bay Salt Pond Restoration Project.

3.1 HYDRAULIC MODELING

3.1.1 Existing Conditions

The numerical hydraulic modeling for this study was performed using the Army Corps of Engineers HEC-RAS model. An existing conditions HEC-RAS model (from prior studies) of Bayfront Canal and Atherton Channel was provided to M&N by the City. This existing conditions model included the Bayfront Canal tide gates that outlet to Flood Slough. This structure is a set of five 4'x4' boxes with flap gates (see Figure 3-1).

Figure 3-1. Bayfront Canal Tide Gate Structure

The model from the previous studies was set up to run as a steady-state simulation, and the flap-gates themselves were not incorporated into the model. For this present study, the structure was changed in the HEC-RAS model from culverts to inline gates to allow for the representation of the tide gates' prevention of backflow during an entire tide-cycle. The logic dictating the tide gate rules are part of the boundary condition file to run an unsteady simulation in HEC-RAS.

The previous existing conditions model also did not include overbank flow losses in the upper reach of Bayfront Canal. Therefore, for this present study, two lateral structures were added to the model to represent the overbank flow losses over the north and south banks. The diversion rating curves for these lateral structures was based on the data shown above in

Figure 2-5. The volume of overbank flow that left the channel was tracked in the modeling, but this study did not attempt to route these overbank flood volumes back into the channel.

The downstream boundary condition of the HEC-RAS modeling used tidal time-series developed from the peak tide values presented in Section 2.1.2. Figure 3-2 presents four time series representing 24 hours of the MHHW, 1-yr, 5-yr, and 25-yr recurrence internal tides. The tidal-peaks were set to align with the runoff hydrograph peaks, which occurred roughly 13 hours into the simulation. The unsteady simulations were run for a total of 72 hours; the tidal time-series shown below were repeated three times to represent a 72 hour period. The low-tides were truncated at 2.7' NAVD to improve the numerical stability of the model. The outlet invert of the tide gates is at 3.5' NAVD, so this adjustment would not affect the results of the model.

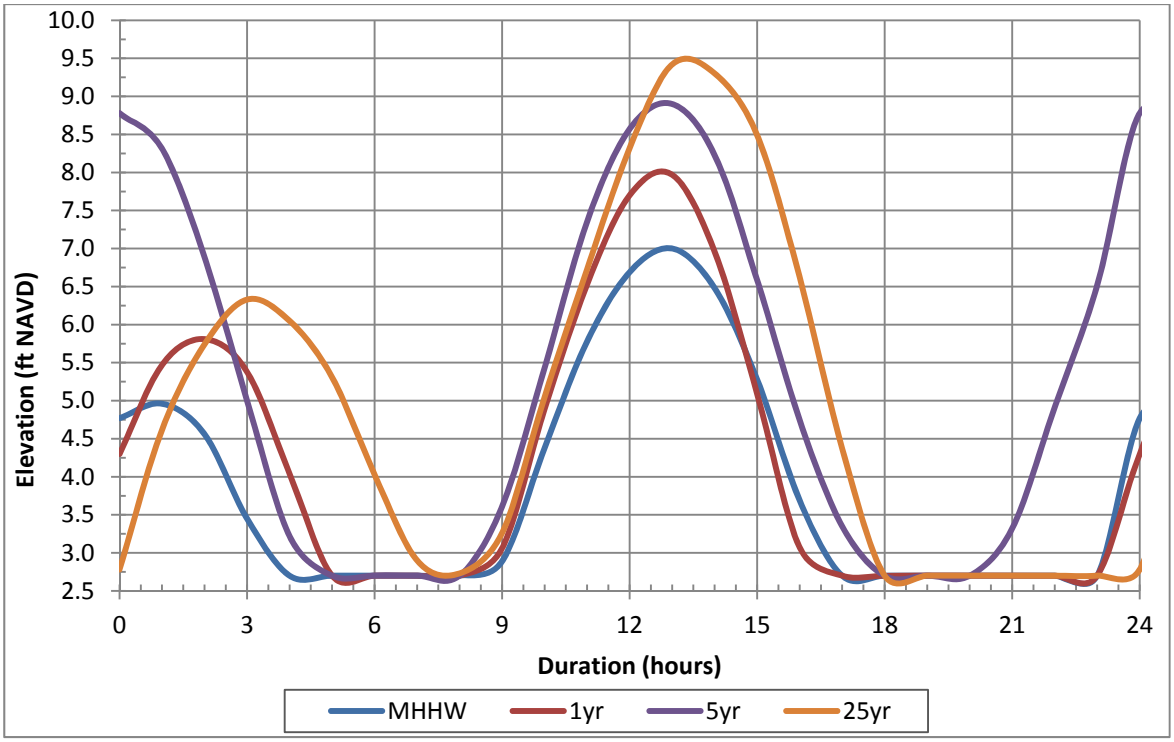

Figure 3-2. Tidal Boundary Conditions

3.1.2 Proposed Alternatives

The proposed project was modeled in HEC-RAS as a lateral structure, located 20-ft upstream of the existing tide gates. There is only roughly 30-feet of available space on the right bank to place a structure in this location, due to a bend in the channel in that area and other pipes in the vicinity. Since one of the goals of the project was to route the flows to the ponds in a buried pipe, a weir structure was not extensively analyzed. A 30-ft long weir does not provide for much overflow capacity, and then the headwater required to overcome inlet losses when routing this overflow into pipes would then occur outside of the Canal. This structure was modeled as a 30-ft long lateral headwall, with various size culverts routing the flow to the ponds.

The ponds were modeled as storage areas, connected upstream to the lateral structure on the Canal and downstream to the Bay through a second tide gate structure as part of the project. A schematic of this HEC-RAS model is illustrated in Figure 3-3.

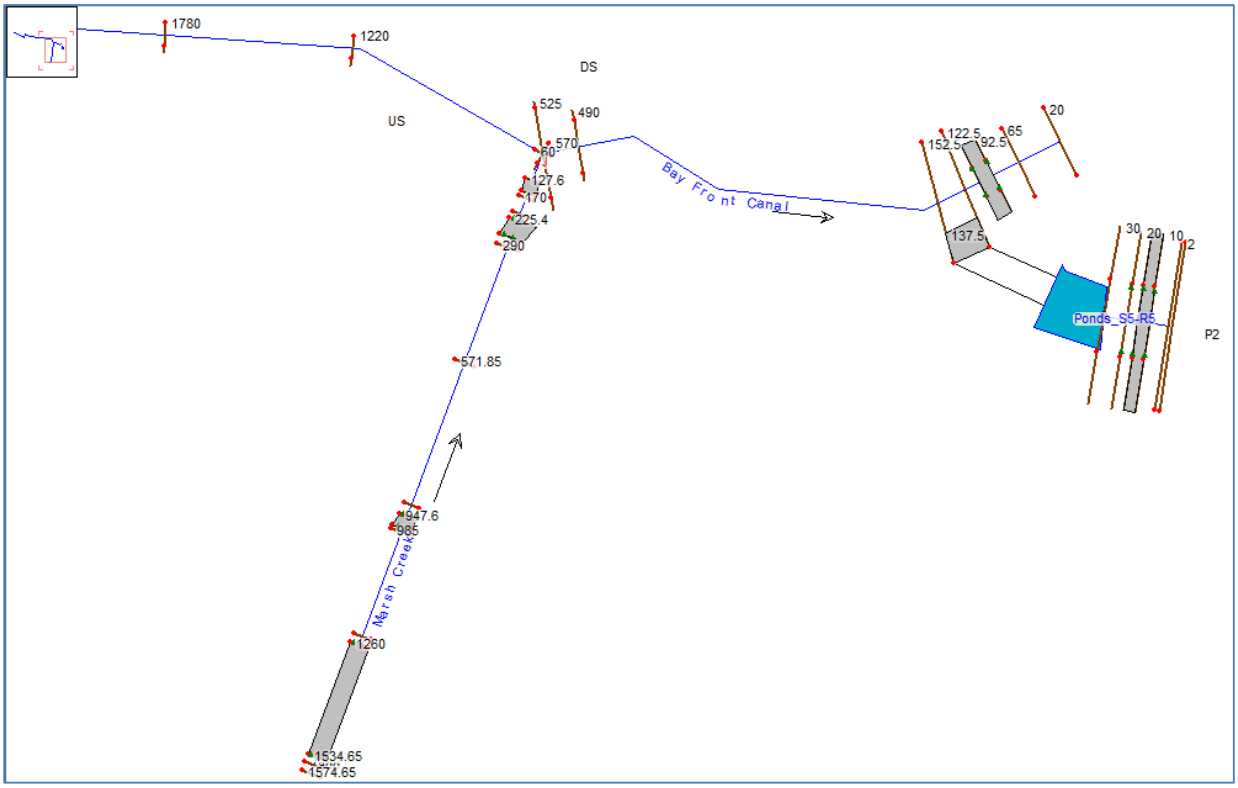

Figure 3-3. HEC-RAS Model Schematic of Proposed Project

The ponds were assumed to start the unsteady simulation with a water surface elevation matching the direct rainfall volume (ie rainfall onto the ponds) associated with the particular flood event being modeled. These starting elevation boundary conditions, based on the stage-storage relationship for the ponds (see Table 2-4) are summarized in Table 3-1.

Table 3-1. Starting-Elevation Boundary Conditions for Ponds S5/R5

Design Storm Event	24-hr Rainfall (in)	Direct Storm Volume (ac-ft)	Starting Pond Ele (ft NGVD)	Starting Pond Ele (ft NAVD)
1-yr	1.62	9.0	1.57	4.27
2-yr	2.06	11.4	1.69	4.39
5-yr	2.65	14.7	1.82	4.52
10-yr	3.15	17.4	1.94	4.64
25-yr	3.84	21.2	2.09	4.79
100-yr	4.96	27.4	2.27	4.97

Based on a series of optimization simulations, the invert elevation for the lateral culvert structure leaving the Canal was set at 3.95-ft NAVD. The invert of the existing tide gate boxes on the Canal are 3.5-ft NAVD, therefore the proposed structure would capture flow from nearly all Canal flowrates. Similarly, for the proposed tide gate structure connecting the ponds to the Bay, the invert elevation of the structure was set at 1.7-ft NAVD.

Incorporating the larger Pond R3 into the project was analyzed as part of the optimization simulations, as was the option of excavating the bottom of Ponds S5/R5 to add storage volume. Neither of these additions to the proposed project provided any benefit towards reducing flood stages in Bayfront Canal. The controlling factor affecting the ability of the project to reduce flood stages in the Canal is (1) the capacity of the culverts to pass flow at the relatively flat slopes in the project area and (2) the cross-sectional area and the hydraulic inlet losses of the inlet structure. Therefore, adding storage volume to the project did not affect the hydraulic-grade line in the analyses. Considering the cost and complications associated with adding Pond R3 or performing large scale grading, these design features were not included in the proposed alternatives reviewed as part of this feasibility study. Pond R4 was included as the "Bay" as is proposed in the South Bay Salt Pond project.

The three alternatives presented for review are:

- Alternative 1 has one 4'x8' box culvert connecting the Canal with Ponds S5/R5. The outlet tide gate structure connecting Pond R5 to Pond R4 (the Bay) has two 4'x4' boxes with flap-gates.
- Alternative 2 has two 4'x8' box culverts connecting the Canal with Ponds S5/R5. The outlet tide gate structure connecting Pond R5 to Pond R4 (the Bay) has two 4'x4' boxes with flap-gates.
- Alternative 3 has three 4'x8' box culverts connecting the Canal with Ponds S5/R5. The outlet tide gate structure connecting Pond R5 to Pond R4 (the Bay) has two 4'x4' boxes with flap-gates.

A more detailed map of the project location is illustrated in Figure 3-4.

3.1.3 HEC-RAS Results

The HEC-RAS results of the three proposed alternatives and existing condition are compared for six combinations of flood runoff and tidal events. These combinations are:

- 25-yr Rainfall event occuring during a 25-yr Tide (see results in Table 3-2)
- 25-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-3)
- 5-yr Rainfall event occuring during a 5-yr Tide (see results in Table 3-4)
- 5-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-5)
- 1-yr Rainfall event occuring during a 1-yr Tide (see results in Table 3-6)
- 1-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-7)

The ability of the three proposed alternatives to reduce overbank volumes and flood stages in Bayfront Canal is compared to existing condition over this set of potential flood events ranging from more likely to occur (1-yr rainfall and MHHW tide) to much less likely to occur (25-yr rainfall and 25-yr tide level). For Alternative 1, the reduction in overbank volumes in the Canal for these events range from 15% to 100%. For Alternative 2, the reduction in overbank volumes in the Canal for these events range from 55% to 100%. For Alternative 3, the reduction in overbank volumes in the Canal for these events range from 70% to 100%.

The results for these two flood cases are also presented graphically for each of the alternatives below. The water surface elevations in Ponds S5/R5 and the inflow hydrographs entering S5/R5 from the Canal are presented for Alternative 1 in Figures 3-5 and 3-6. Alternative 2 results are illustrated in Figures 3-7 and 3-8. Alternative 3 results are illustrated

in Figures 3-9 and 3-10. The stage for the 25-yr flood with 25-yr tide event exceeds the lowest elevation of the existing pond berms for some of these simulations; however, that can be mitigated by either raising the low spots of the berms and/or increasing the size of the flap-gated culverts which drain to Pond R4. It should also be recognized that the event itself (25-yr flood + 25-yr tide) is a very low probability event (much less frequent than a 100-yr event), given that astronomical tide and precipitation are not correlated.

Figure 3-4. Project Details Map

Table 3-2. HEC-RAS Results for 25yr Storm, 25yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	13.5	13.4	13.4	13.2
Upper Atherton	985	11.8	11.6	11.5	11.4
Middle Atherton	290	10.6	10.4	10.2	10.1
Lower Atherton	170	8.9	8.4	8.1	7.9
Upper Bayfront Canal	8210	8.6	8.6	8.6	8.5
Upper Bayfront Canal	3660	8.1	8.1	8.1	8.0
Lower Bayfront Canal	107.5	9.0	8.5	8.3	8.0
Pond S5/R5 Peak Ele		-	5.8	6.6	7.2
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	263.9	172.4	119.1	80.0
Overbank Vol. Reduction		-	**35%**	**55%**	**70%**

Table 3-3. HEC-RAS Results for 25yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	13.2	13.2	13.2	13.2
Upper Atherton	985	11.3	11.4	11.3	11.3
Middle Atherton	290	9.9	10.0	9.9	9.9
Lower Atherton	170	7.7	7.7	7.6	7.5
Upper Bayfront Canal	8210	8.5	8.5	8.4	8.4
Upper Bayfront Canal	3660	8.0	8.0	7.9	7.8
Lower Bayfront Canal	107.5	7.9	7.7	7.6	7.4
Pond S5/R5 Peak Ele		-	5.4	6.0	6.4
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	108.4	56.9	29.0	12.8
Overbank Vol. Reduction		-	**48%**	**73%**	**88%**

Table 3-4. HEC-RAS Results for 5yr Storm, 5yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	11.8	11.8	11.8	11.8
Upper Atherton	985	9.7	9.6	9.4	9.4
Middle Atherton	290	9.1	8.8	8.6	8.5
Lower Atherton	170	8.4	8.1	7.9	7.8
Upper Bayfront Canal	8210	8.4	8.4	8.3	8.2
Upper Bayfront Canal	3660	8.1	8.0	8.0	7.9
Lower Bayfront Canal	107.5	8.4	8.2	8.0	7.8
Pond S5/R5 Peak Ele		-	5.7	6.3	6.7
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	167.3	90.2	50.7	21.6
Overbank Vol. Reduction		-	**46%**	**70%**	**87%**

Table 3-5. HEC-RAS Results for 5yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	11.8	11.8	11.8	11.8
Upper Atherton	985	9.3	9.3	9.2	9.1
Middle Atherton	290	8.4	8.4	8.2	8.0
Lower Atherton	170	7.7	7.6	7.3	7.2
Upper Bayfront Canal	8210	8.3	8.2	8.0	7.9
Upper Bayfront Canal	3660	7.9	7.7	7.5	7.4
Lower Bayfront Canal	107.5	7.7	7.5	7.2	2.7
Pond S5/R5 Peak Ele		-	5.3	5.7	6.0
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	31.5	7.1	0.0	0.0
Overbank Vol. Reduction		-	**78%**	**100%**	**100%**

Table 3-6. HEC-RAS Results for 1yr Storm, 1yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	10.8	10.8	10.8	10.8
Upper Atherton	985	8.8	8.8	8.7	8.4
Middle Atherton	290	8.2	8.2	8.1	7.8
Lower Atherton	170	7.9	8.0	7.8	7.5
Upper Bayfront Canal	8210	8.2	8.2	8.2	8.0
Upper Bayfront Canal	3660	8.0	8.0	7.9	7.6
Lower Bayfront Canal	107.5	8.0	8.0	7.8	7.5
Pond S5/R5 Peak Ele		-	5.3	5.8	6.0
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	31.3	26.6	9.7	0.0
Overbank Vol. Reduction		-	**15%**	**69%**	**100%**

Table 3-7. HEC-RAS Results for 1yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1 (ft NAVD)	Alternative 2 (ft NAVD)	Alternative 3 (ft NAVD)
Atherton US of Hwy-101	1554.7	10.8	10.8	10.8	10.8
Upper Atherton	985	8.5	8.3	8.3	8.2
Middle Atherton	290	7.9	7.6	7.5	7.4
Lower Atherton	170	7.6	7.3	7.1	7.1
Upper Bayfront Canal	8210	8.0	7.8	7.7	7.6
Upper Bayfront Canal	3660	7.7	7.4	7.2	7.2
Lower Bayfront Canal	107.5	7.5	7.2	7.1	7.0
Pond S5/R5 Peak Ele		-	5.1	5.6	5.9
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	3.4	0.0	0.0	0.0
Overbank Vol. Reduction		-	**100%**	**100%**	**100%**

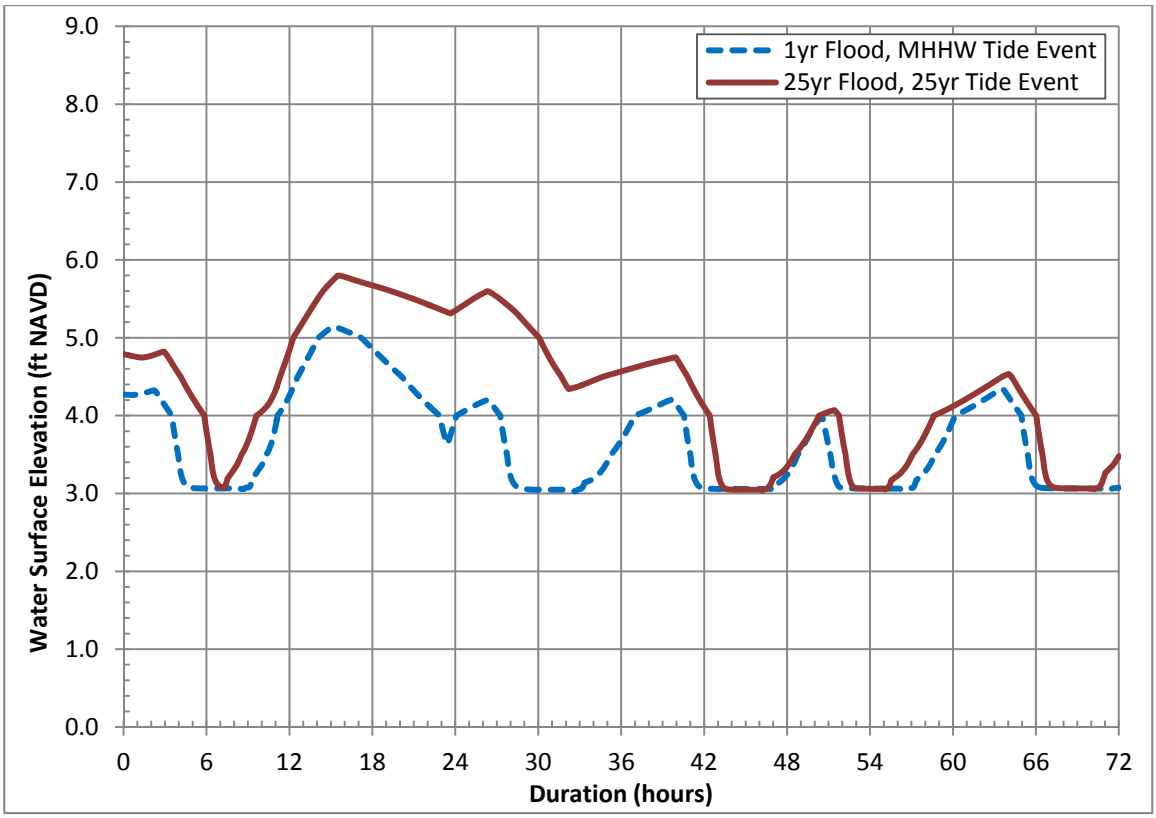

Figure 3-5. Pond S5/R5 Stages with Alternative 1 (One 4'x8' box)

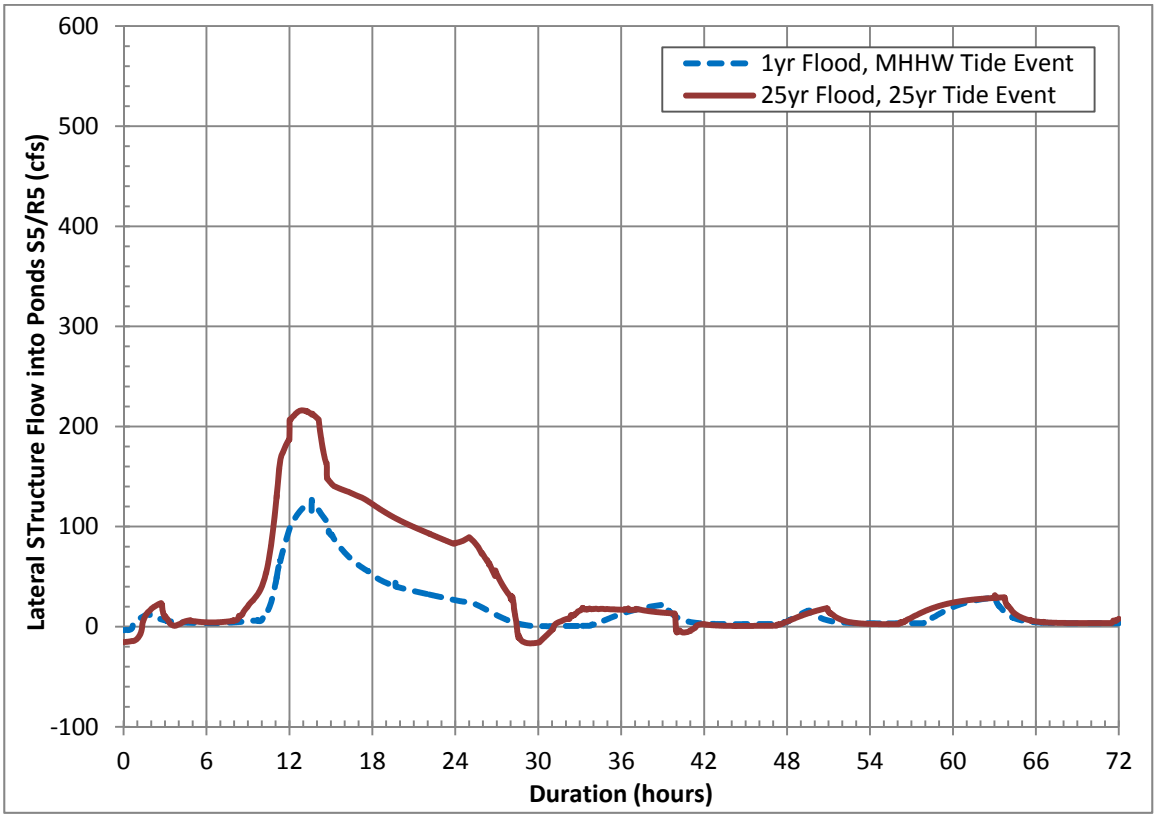

Figure 3-6. Pond S5/R5 Inflows with Alternative 1 (One 4'x8' box)

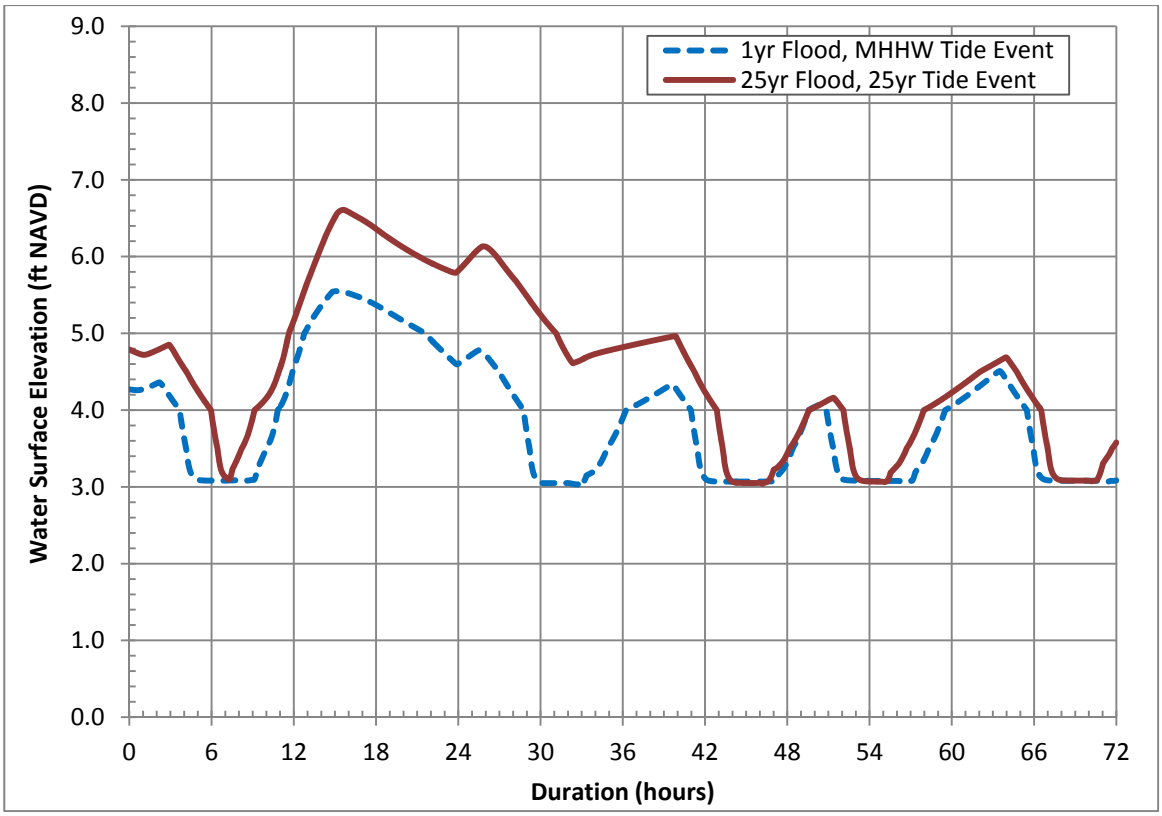

Figure 3-7. Pond S5/R5 Stages with Alternative 2 (Two 4'x8' boxes)

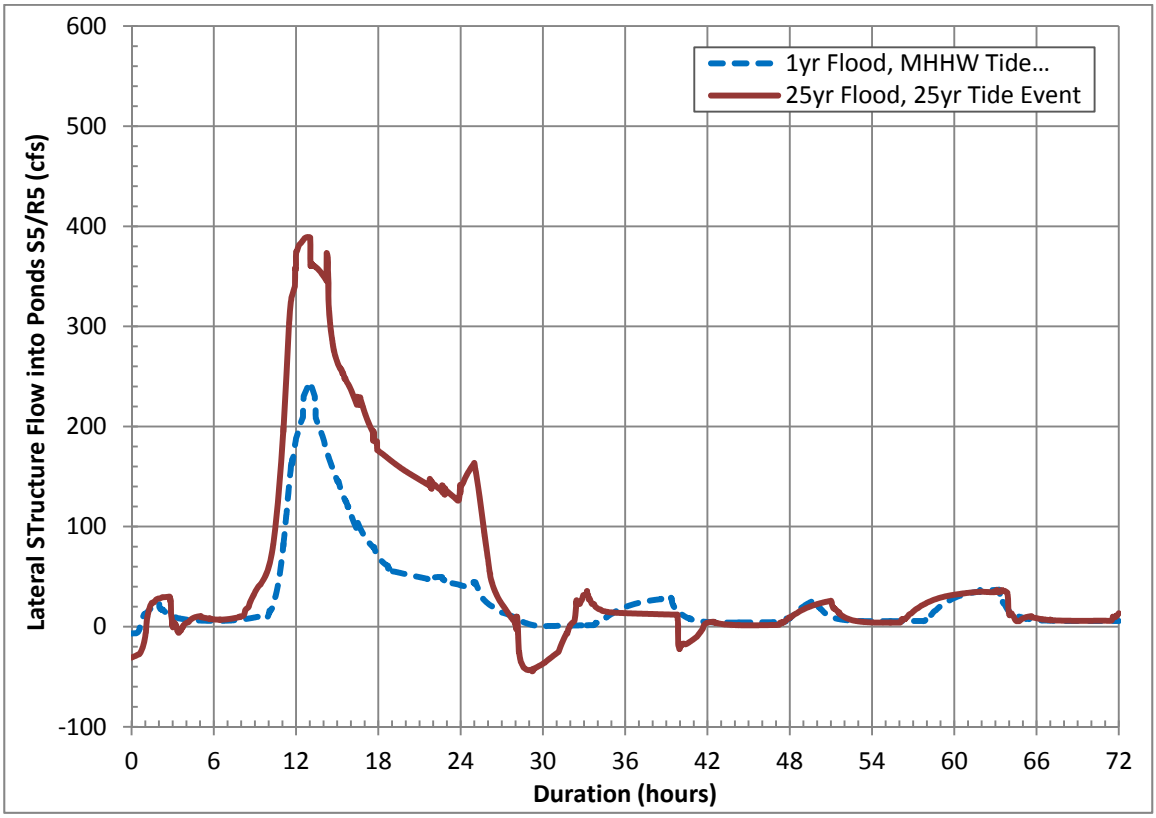

Figure 3-8. Pond S5/R5 Inflows with Alternative 2 (Two 4'x8' boxes)

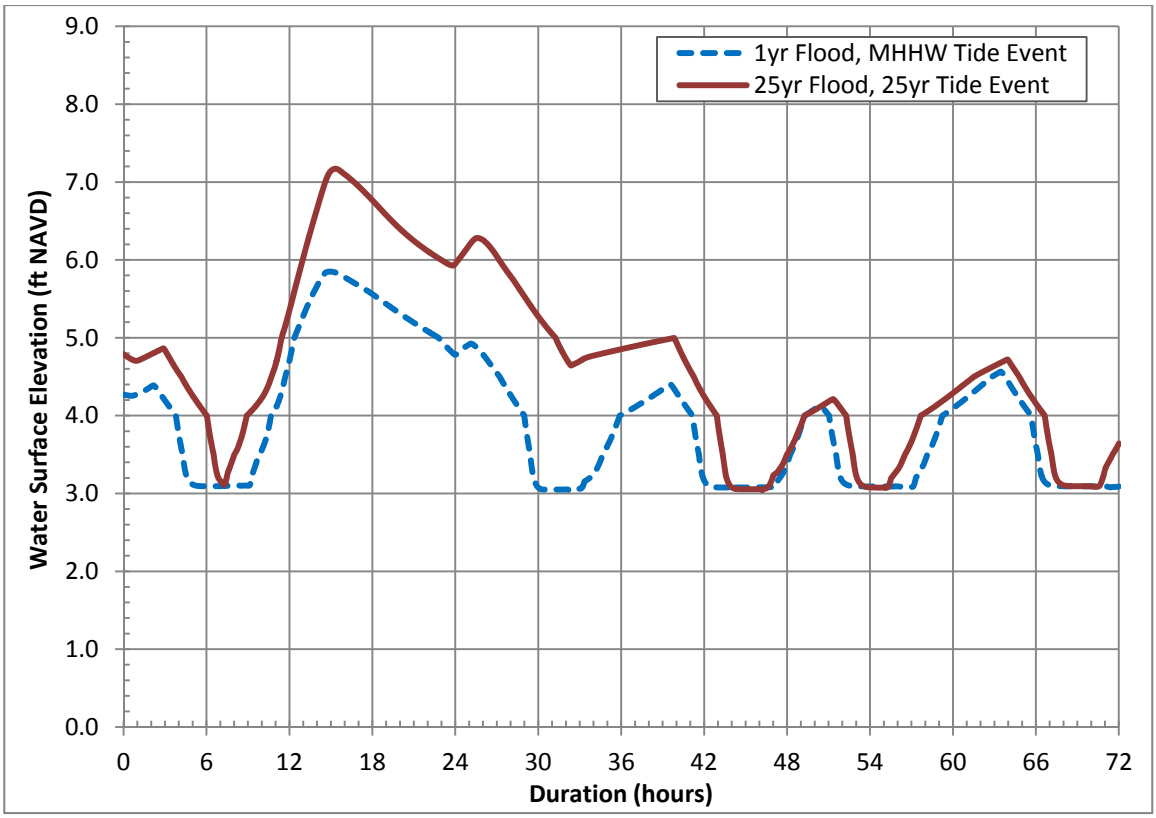

Figure 3-9. Pond S5/R5 Stages with Alternative 3 (Three 4'x8' boxes)

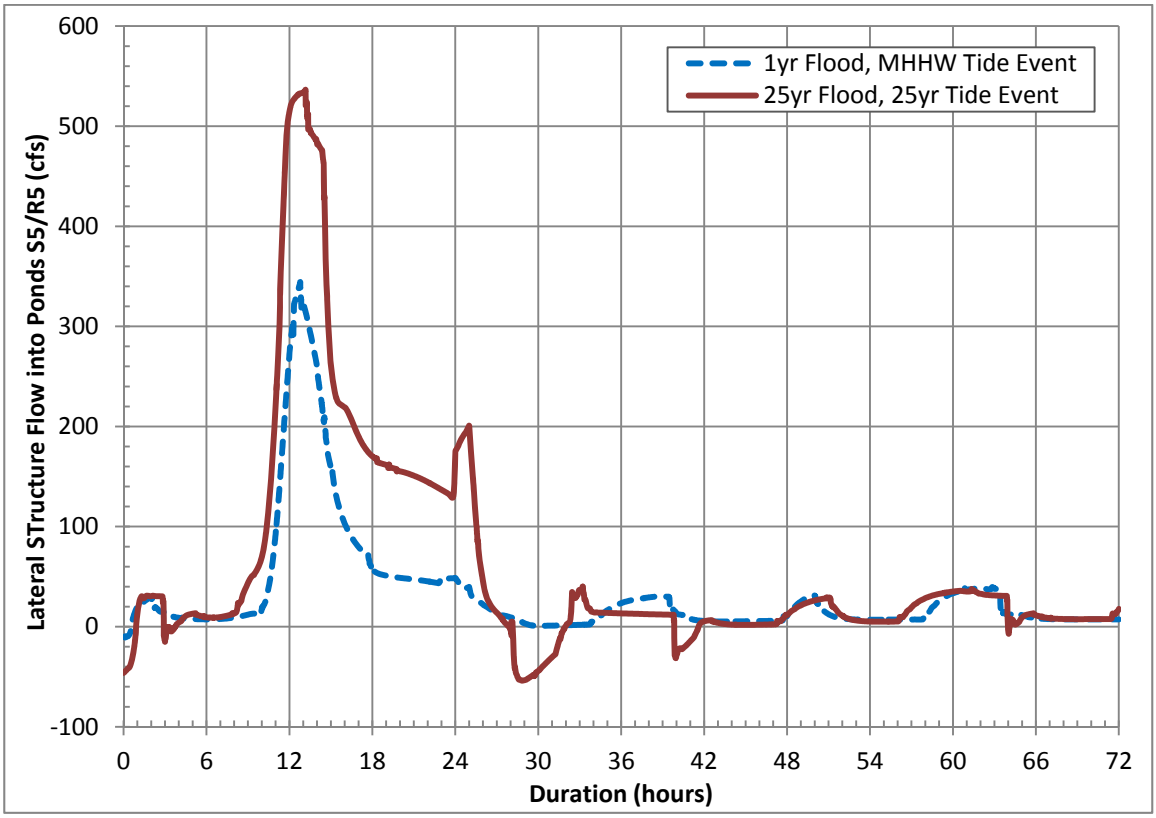

Figure 3-10. Pond S5/R5 Inflows with Alternative 3 (Three 4'x8' boxes)

3.2 FREQUENCY AND DURATION OF PONDING

Based on the modeling results, the invert elevation for the lateral culvert structure leaving the Canal was set at 3.95-ft NAVD. The invert of the existing tide gate boxes on the Canal are 3.5-ft NAVD, therefore the proposed structure would capture flow from nearly all Canal flowrates. With an invert elevation of 1.7-ft NAVD for the proposed tide gate structure connecting the ponds to the Bay, relative to the existing bottom elevation of the ponds at ~3.0-ft NAVD, the ponds will drain within one to two tide cycles. The figures showing the pond water surface elevations in the HEC-RAS simulations bear this out, with the pond draining over a period of 18-36 hours.

A coincident frequency analysis performed by the U.S. Army Corps of Engineers for San Francisquito Creek, which is immediately south of the project site, concluded that while the tidal surges and riverine peaks were slightly correlated, the R values were small enough to justify an assumption of independence between the two events (USACE 2011). The assumption of independence between tidal surge and riverine peaks implies that design-event combinations, such as the 25-yr rainfall event aligning exactly with a 25-yr tidal surge, represent an extremely infrequent event.

3.3 ADDITIONAL HYDRAULIC ANALYSES

The City requested that supplementary hydraulic analyses be performed to assess the effects of three additional design features on peak water levels in the Canal.

The first design feature analyzed was to raise the Canal's south bank elevation at select areas to increase the water levels in the Canal during high flow events. There are in general two areas of the Canal's south bank that are relatively low: at the upstream end of the Canal (RC and Le Mar Mobile Home Park), and after Harbor Village (at Trailer Villa & Bayshore Villa). The south bank elevations along those two areas were raised a foot in the HEC-RAS model to compare the impact versus the other two supplemental alternatives.

The second design feature added to the hydraulic analysis was to excavate the smaller forebay region of Pond S5, nearest to Marsh Road, down by 2-feet to allow for a lower culvert outlet elevation.

The third feature added to the hydraulic analysis was to connect the flow-bypass to the Canal via an open-channel, utilizing the footprint of the existing ditches located between the Canal and Marsh Road that were previously used by Cargill.

Based on a series of simulations incorporating various combinations of these three design features, the findings were:

- Adding sheet-pile to raise the bank-elevation in the two low-spots on the south bank of the Canal to +8.7' NAVD only raised the flood stages in the Canal and increased the likelihood that floodwater would leave the Canal in other locations. Based on the Canal topography provided by the City (MASTTOPO.dwg), there are multiple locations where the bank elevations are in the +8.7' to +9.7' NAVD range, where flows could also leave the Canal. Therefore, the sheet-pile option did not provide enough flood-mitigation benefit to justify the potential problems this alternative could create due to elevated flood-stages in the Canal.
- Lowering the pipe-outlet invert without changing the pipe inlet elevation did not affect the results. However, lowering the pipe-inlet elevation along with deepening the S5 forebay by 2-feet (from +3' NAVD down to +1' NAVD) did improve the flood-mitigation results.
- Open-Channel connection – see discussion in the subsequent section

3.3.1 Supplemental Alternatives

As a result of the above findings, three additional alternatives were created based on a combination of the open-channel design feature along with deepening the S5 forebay by 2-feet. The open-channel portion of the bypass was created by deepening the existing ditches adjacent to the Canal into a trapezoidal channel. Side-slopes of 2:1 (h:v) were used in the channel in an effort to fit this channel into the existing footprint of the ditches. The open-channel section ended at Marsh Road, where flows would have to pass underneath the road in a culvert or in a bridge section. Figure 3-11 illustrates this supplemental alignment, along with the original culvert alignment previously discussed.

From the headwall located at the upstream side of Marsh Road, the same box-culvert alternatives were then applied as the previous study. Alternative 1b uses one 4'x8' box, Alt 2b has two 4'x8' boxes, and Alt 3b has three 4'x8' boxes. These box-culverts would span from the upstream side of Marsh Road to the outlet location in the S5 forebay. This results in a 280-ft long culvert, instead of the 480-ft length from the previous alternatives. The invert elevation at the Marsh Road headwall was set at +1.6' NAVD and the outlet elevation into the S5 forebay was +1.0' NAVD. This culvert alignment used the same 0.002 slope as the previous alternatives, but this allowed the headwater elevations to be lowered upstream of the culverts, which had the greatest impact on flood-stages in the Canal.

Figure 3-12, below, compares the proposed open-channel cross-sections with the existing ditch sections at the upstream connection with the Canal. Figure 3-13, below, compares the proposed open-channel cross-sections with the existing ditch sections at the headwall on the upstream side of Marsh Road. These sections show how the proposed channel is deepened by more than 4-feet relative to the existing ditch at Marsh Road. This deepening of the culvert's inlet invert helps to mitigate the head-losses and lowers the water surface profile in the open-channel and in the Canal.

3.3.2 HEC-RAS Results

The HEC-RAS results of the three supplemental alternatives and existing condition are compared for six combinations of flood runoff and tidal events. These combinations are:

- 25-yr Rainfall event occuring during a 25-yr Tide (see results in Table 3-8)
- 25-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-9)
- 5-yr Rainfall event occuring during a 5-yr Tide (see results in Table 3-10)
- 5-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-11)
- 1-yr Rainfall event occuring during a 1-yr Tide (see results in Table 3-12)
- 1-yr Rainfall event occuring during a MHHW Tide (see results in Table 3-13)

For Alternative 1b, the reduction in overbank volumes in the Canal for these events range from 47% to 100%. For Alternative 2b, the reduction in overbank volumes in the Canal for these events range from 67% to 100%. For Alternative 3b, the reduction in overbank volumes in the Canal for these events range from 77% to 100%. The results for the 1-yr rainfall, MHHW tide event and the 25-yr rainfall, 25-yr tide event are also presented graphically for Alternative 2b below. The water surface elevations in Ponds S5/R5 and the inflow hydrographs entering S5/R5 from the Canal are presented for Alternative 2b in Figures 3-14 and 3-15.

The HEC-RAS channel profile of the open-channel and culvert from the Bayfront Canal to the S5/R5 Forebay is shown in Figure 3-16, below. The Bayfront Canal connection is shown at Station-500 in the profile and the culvert outlet into the S5/R5 forebay is at Station-0. The

open-channel connects to the Canal at an elevation of +3.7' NAVD, and the culvert outlets into the S5/R5 forebay at an elevation of +1' NAVD. For reference, the invert of the Bayfront Canal tide-gates is at +3.5' NAVD, and the existing bottom of Pond S5 ranges from +3' to +4' NAVD.

The HEC-RAS cross-section of the headwall and culverts at Marsh Road for Alternative 2b is shown in Figure 3-17, below. This section shows the entrance to the double 4'x8' box culverts.

The HEC-RAS channel profile of the tide-gates connecting Pond R5 to Pond R4 and the Bay is shown below in Figure 3-18, with the bottom elevation of Pond R5 represented by Station-30. The cross-section of the headwall and tide-gates is shown on Figure 3-19. In all of the proposed alternatives, this outlet structure utilized two 4'x4' box culverts, with an inlet invert elevation of +1.7' NAVD.

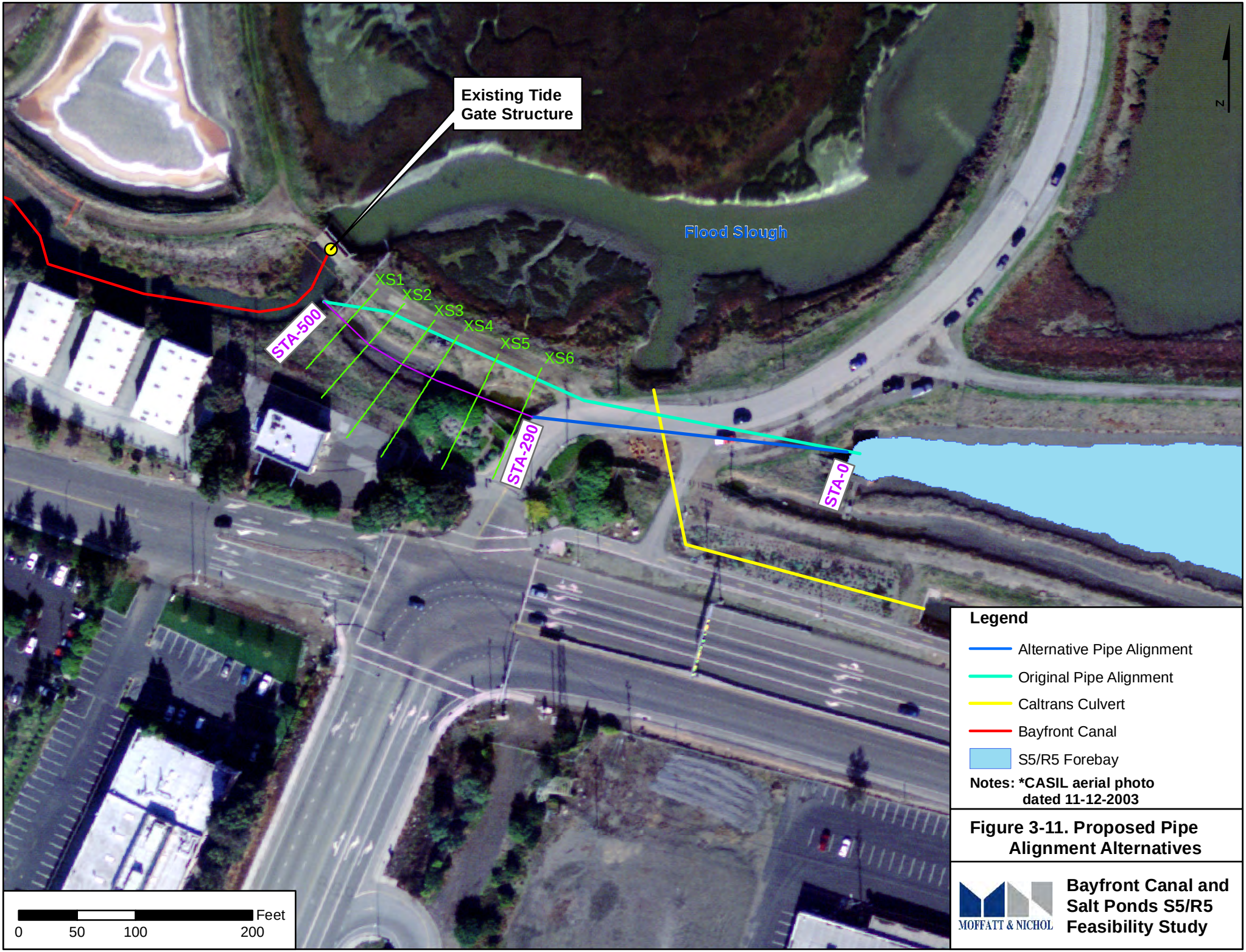

Figure 3-11. Proposed Pipe Alignment Alternatives

Bayfront Canal and Salt Ponds S5/R5 Feasibility Study

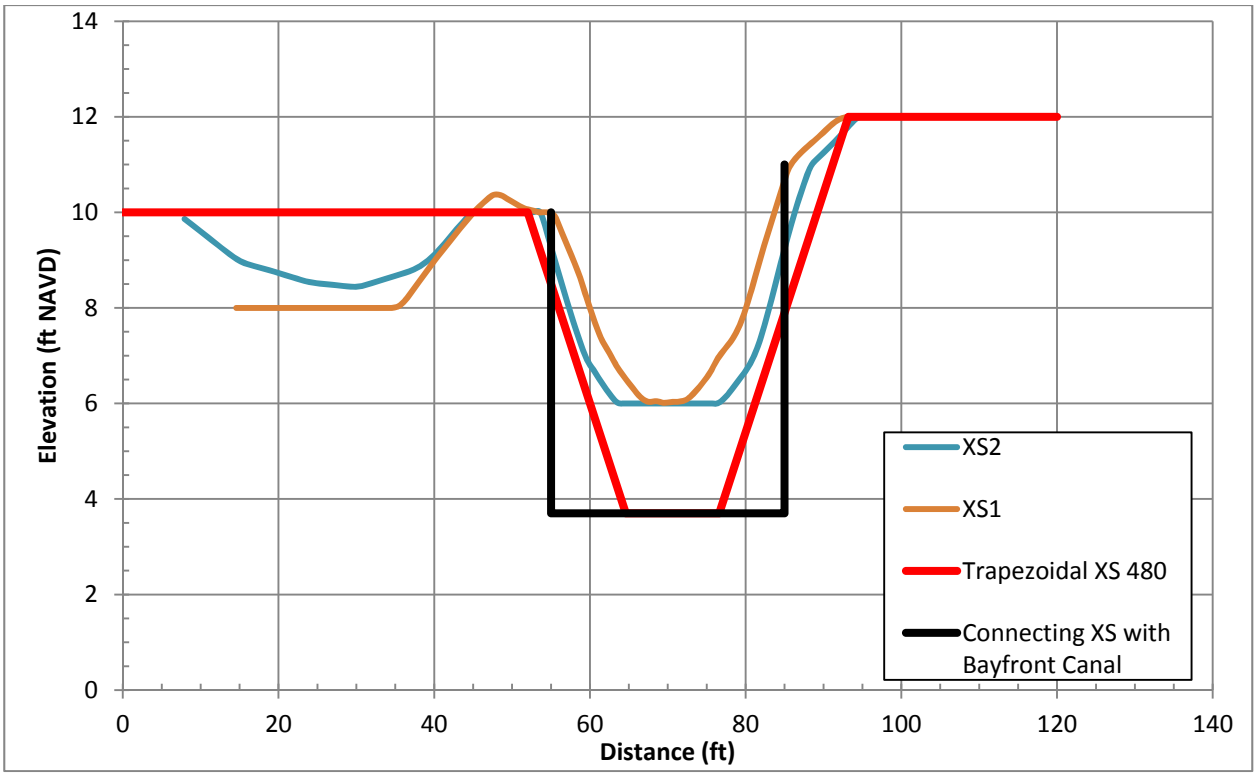

Figure 3-12. Cross-Sections for Proposed Open-Channel at Bayfront Canal

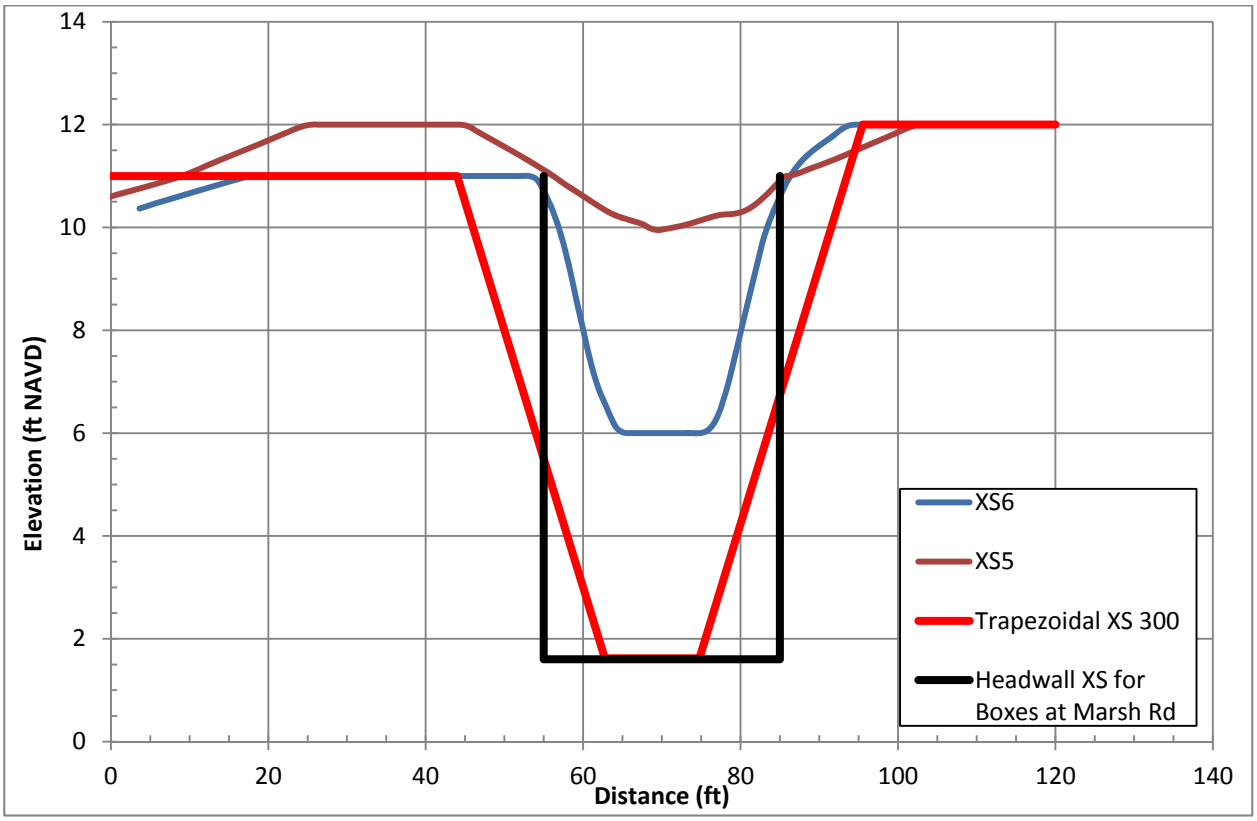

Figure 3-13. Cross-Sections for Proposed Open-Channel and Headwall at Marsh Road

Table 3-8. Supplementary HEC-RAS Results for 25yr Storm, 25yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	13.5	13.4	13.2	13.2
Upper Atherton	985	11.8	11.6	11.5	11.4
Middle Atherton	290	10.6	10.3	10.1	10.0
Lower Atherton	170	8.9	8.2	7.9	7.8
Upper Bayfront Canal	8210	8.6	8.6	8.5	8.5
Upper Bayfront Canal	3660	8.1	8.1	8.0	8.0
Lower Bayfront Canal	107.5	9.0	8.4	8.0	7.9
Pond S5/R5 Peak Ele		-	6.2	6.9	7.2
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	263.9	139.2	87.3	60.6
Overbank Vol. Reduction		-	**47%**	**67%**	**77%**

Table 3-9. Supplementary HEC-RAS Results for 25yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	13.2	13.2	13.2	13.2
Upper Atherton	985	11.3	11.4	11.3	11.3
Middle Atherton	290	9.9	9.9	9.9	9.8
Lower Atherton	170	7.7	7.7	7.5	7.4
Upper Bayfront Canal	8210	8.5	8.4	8.4	8.3
Upper Bayfront Canal	3660	8.0	7.9	7.8	7.8
Lower Bayfront Canal	107.5	7.9	7.6	7.3	7.2
Pond S5/R5 Peak Ele		-	5.8	6.4	6.6
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	108.4	39.4	15.8	8.9
Overbank Vol. Reduction		-	**64%**	**85%**	**92%**

Table 3-10. Supplementary HEC-RAS Results for 5yr Storm, 5yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	11.8	11.8	11.8	11.8
Upper Atherton	985	9.7	9.5	9.4	9.2
Middle Atherton	290	9.1	8.7	8.5	8.2
Lower Atherton	170	8.4	8.0	7.8	7.6
Upper Bayfront Canal	8210	8.4	8.3	8.2	8.0
Upper Bayfront Canal	3660	8.1	8.0	7.9	7.7
Lower Bayfront Canal	107.5	8.4	8.0	7.8	7.6
Pond S5/R5 Peak Ele		-	6.2	6.5	6.8
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	167.3	60.6	19.5	3.4
Overbank Vol. Reduction		-	**64%**	**88%**	**98%**

Table 3-11. Supplementary HEC-RAS Results for 5yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	11.8	11.8	11.8	11.8
Upper Atherton	985	9.3	9.2	9.1	9.1
Middle Atherton	290	8.4	8.2	8.1	8.1
Lower Atherton	170	7.7	7.5	7.2	7.3
Upper Bayfront Canal	8210	8.3	8.0	7.9	7.9
Upper Bayfront Canal	3660	7.9	7.6	7.4	7.4
Lower Bayfront Canal	107.5	7.7	7.2	7.1	7.2
Pond S5/R5 Peak Ele		-	5.7	6.1	6.3
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	31.5	0.3	0.0	0.0
Overbank Vol. Reduction		-	**99%**	**100%**	**100%**

Table 3-12. Supplementary HEC-RAS Results for 1yr Storm, 1yr Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	10.8	10.8	10.8	10.8
Upper Atherton	985	8.8	8.7	8.2	8.0
Middle Atherton	290	8.2	8.1	7.5	7.1
Lower Atherton	170	7.9	7.8	7.2	6.8
Upper Bayfront Canal	8210	8.2	8.2	7.7	7.3
Upper Bayfront Canal	3660	8.0	7.9	7.3	6.9
Lower Bayfront Canal	107.5	8.0	7.9	7.2	6.7
Pond S5/R5 Peak Ele		-	5.6	5.9	6.0
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	31.3	9.1	0.0	0.0
Overbank Vol. Reduction		-	**71%**	**100%**	**100%**

Table 3-13. Supplementary HEC-RAS Results for 1yr Storm, MHHW Tide Event

LOCATION	River Station	Existing Condition (ft NAVD)	Alternative 1b (ft NAVD)	Alternative 2b (ft NAVD)	Alternative 3b (ft NAVD)
Atherton US of Hwy-101	1554.7	10.8	10.8	10.8	10.8
Upper Atherton	985	8.5	8.3	8.2	8.0
Middle Atherton	290	7.9	7.5	7.4	7.1
Lower Atherton	170	7.6	7.2	7.0	6.8
Upper Bayfront Canal	8210	8.0	7.7	7.5	7.3
Upper Bayfront Canal	3660	7.7	7.3	7.1	6.9
Lower Bayfront Canal	107.5	7.5	7.1	7.0	6.7
Pond S5/R5 Peak Ele		-	5.5	5.9	6.0
		(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Bayfront Left OB Volume	7550	0.0	0.0	0.0	0.0
Bayfront Right OB Volume	3820	3.4	0.0	0.0	0.0
Overbank Vol. Reduction		-	**100%**	**100%**	**100%**

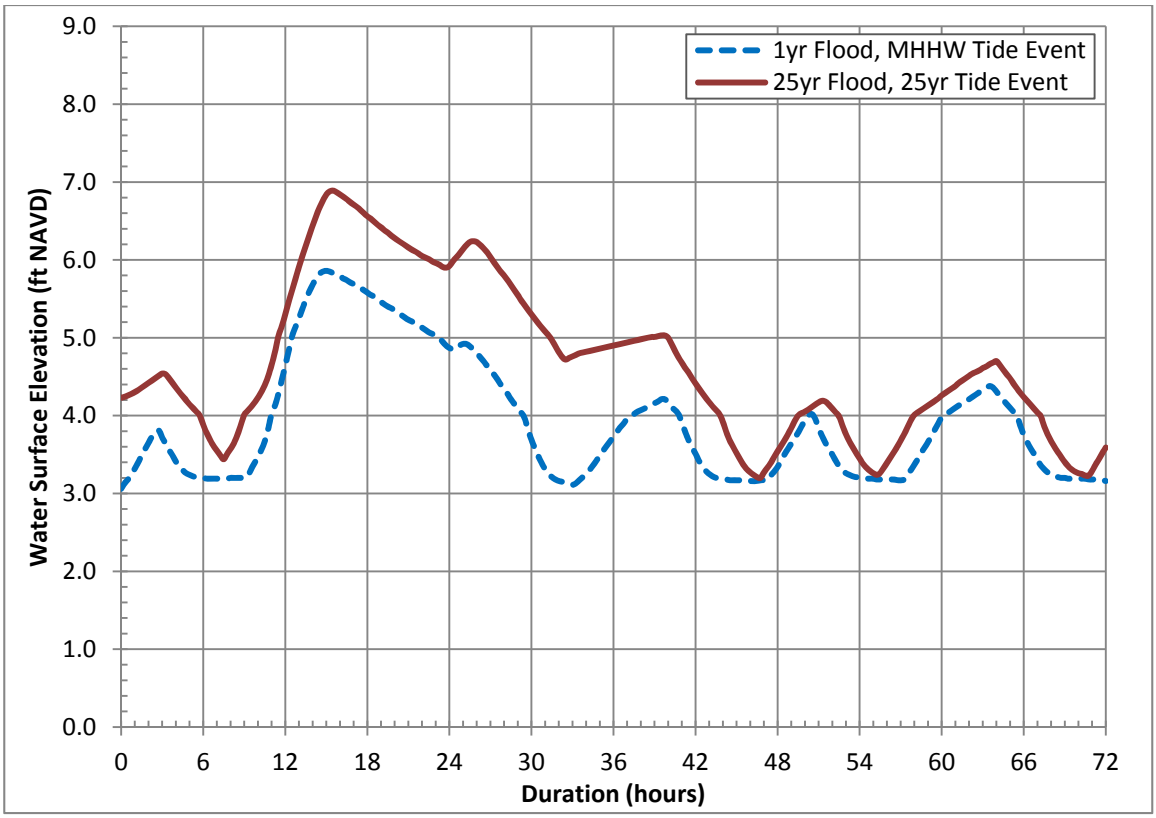

Figure 3-14. Pond S5/R5 Stages with Alternative 2b (Two 4'x8' boxes)

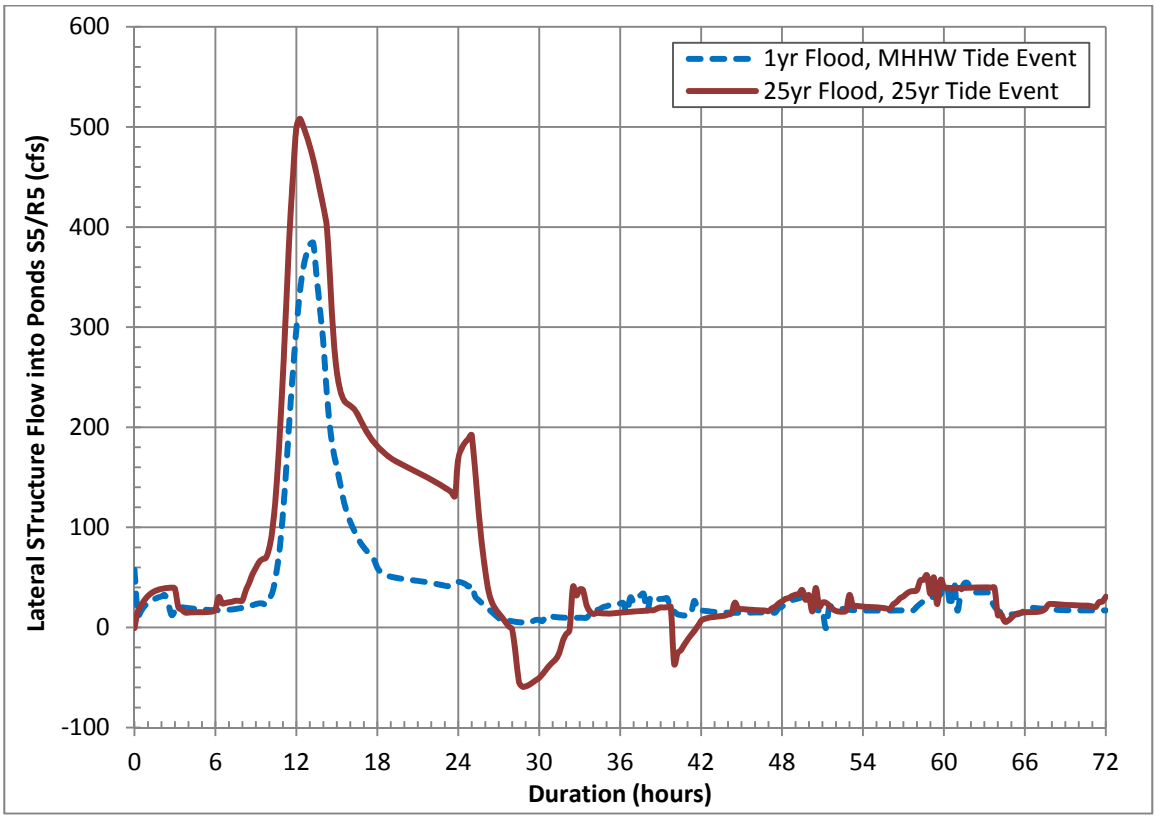

Figure 3-15. Pond S5/R5 Inflows with Alternative 2b (Two 4'x8' boxes)

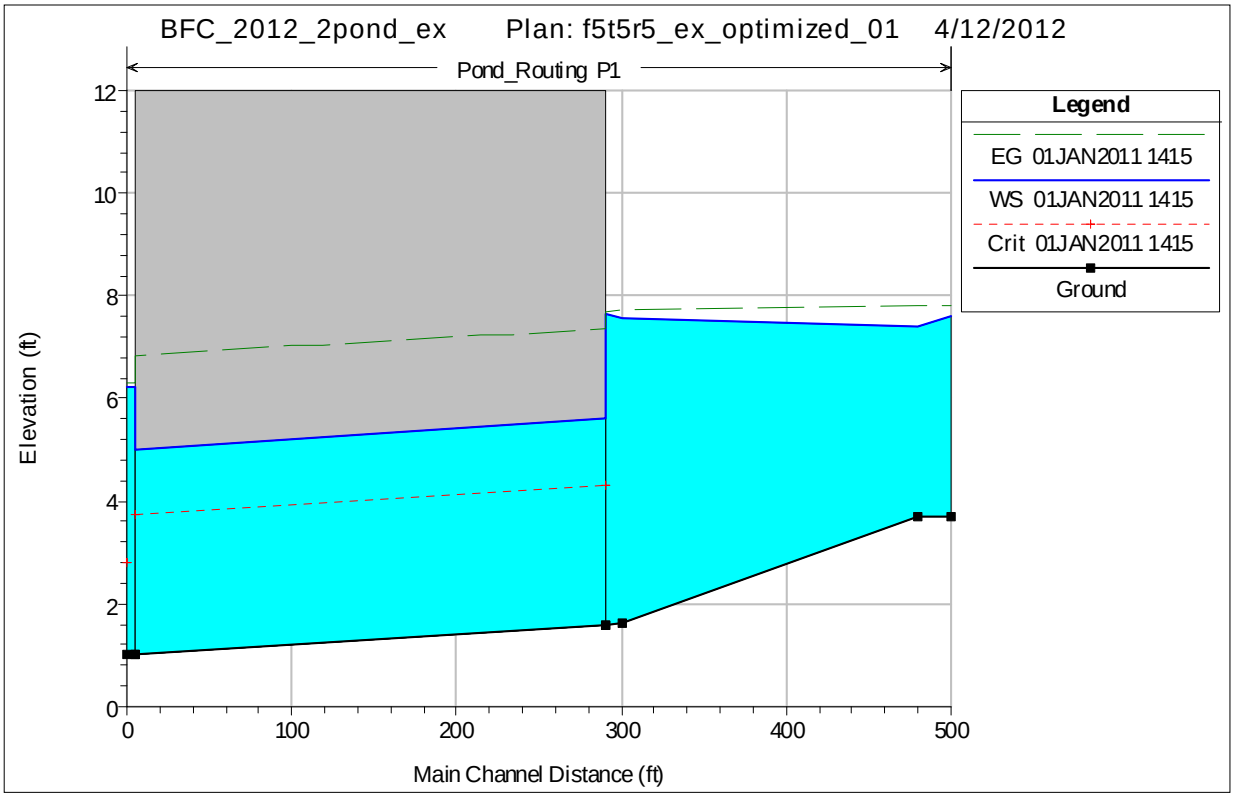

Figure 3-16. HEC-RAS Channel Profile of Open Channel and Culvert from Bayfront Canal to S5/R5 Forebay

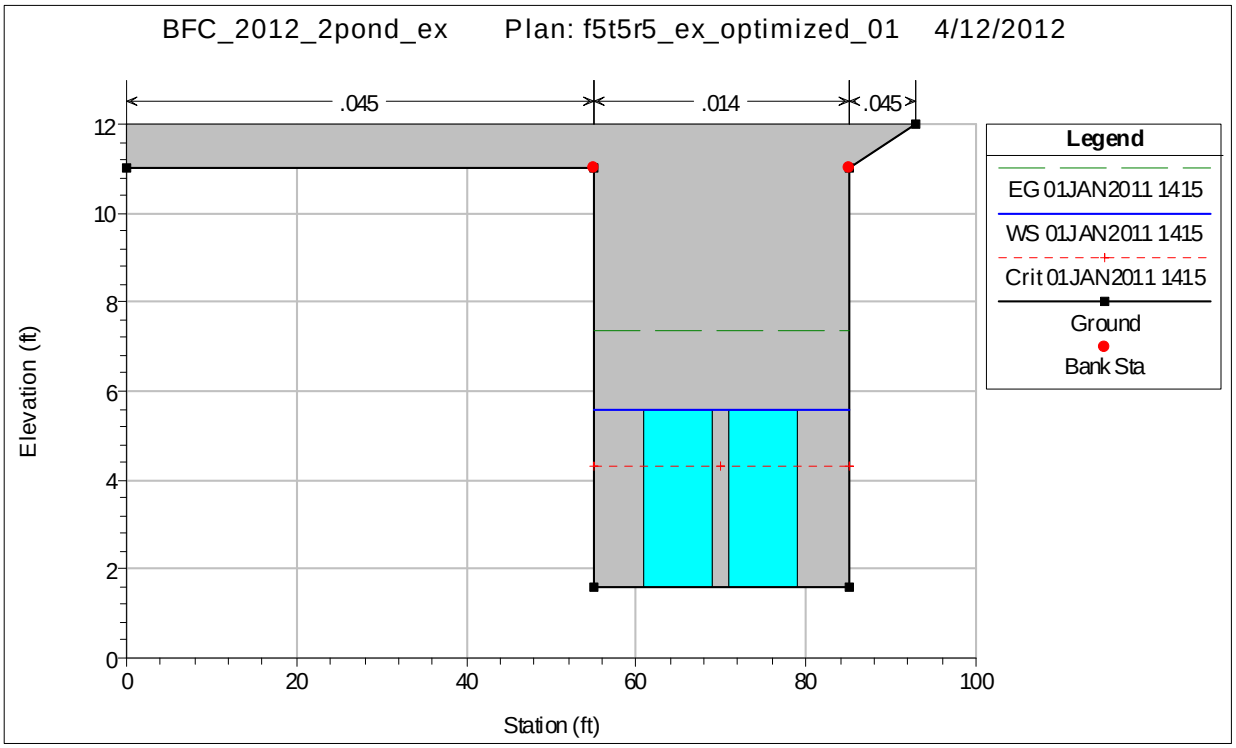

Figure 3-17. HEC-RAS Cross-Section of Headwall and Culverts at Marsh Road

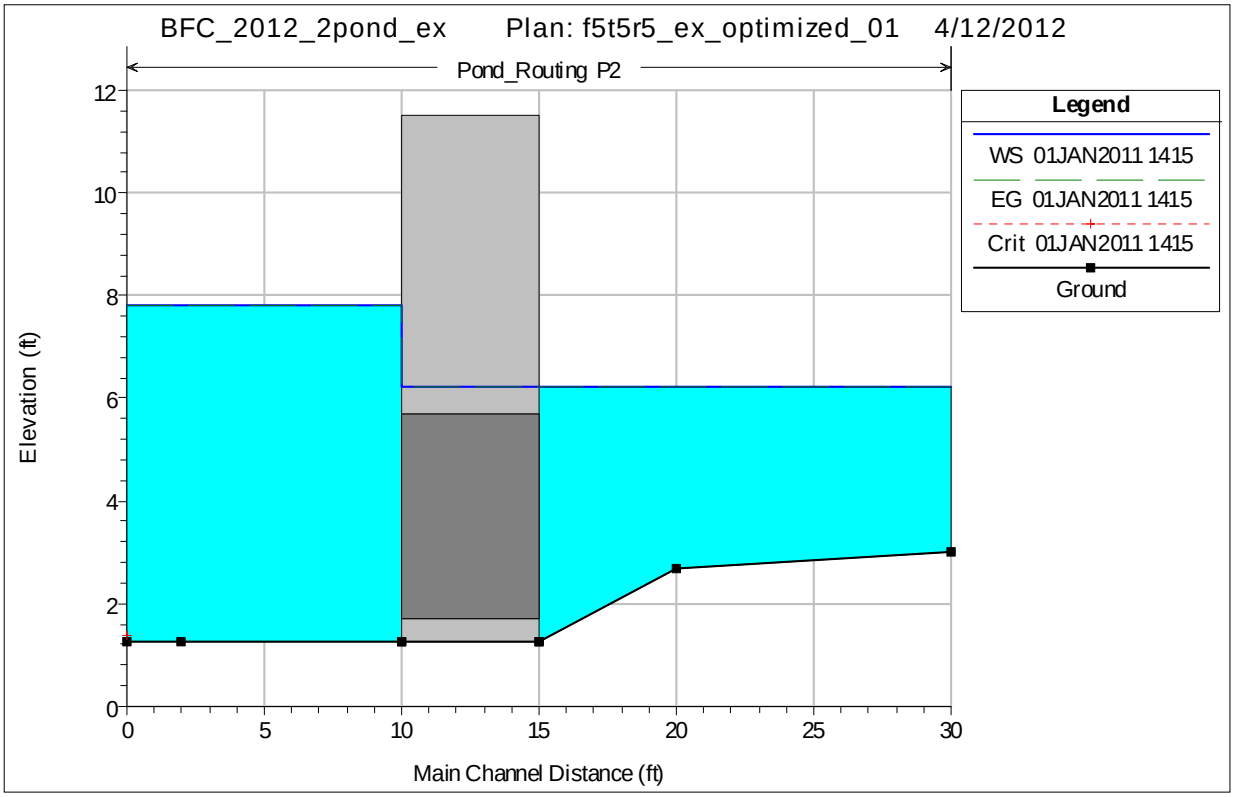

Figure 3-18. **HEC-RAS Channel Profile of Tide-Gates Connecting Pond R5 to Pond R4**

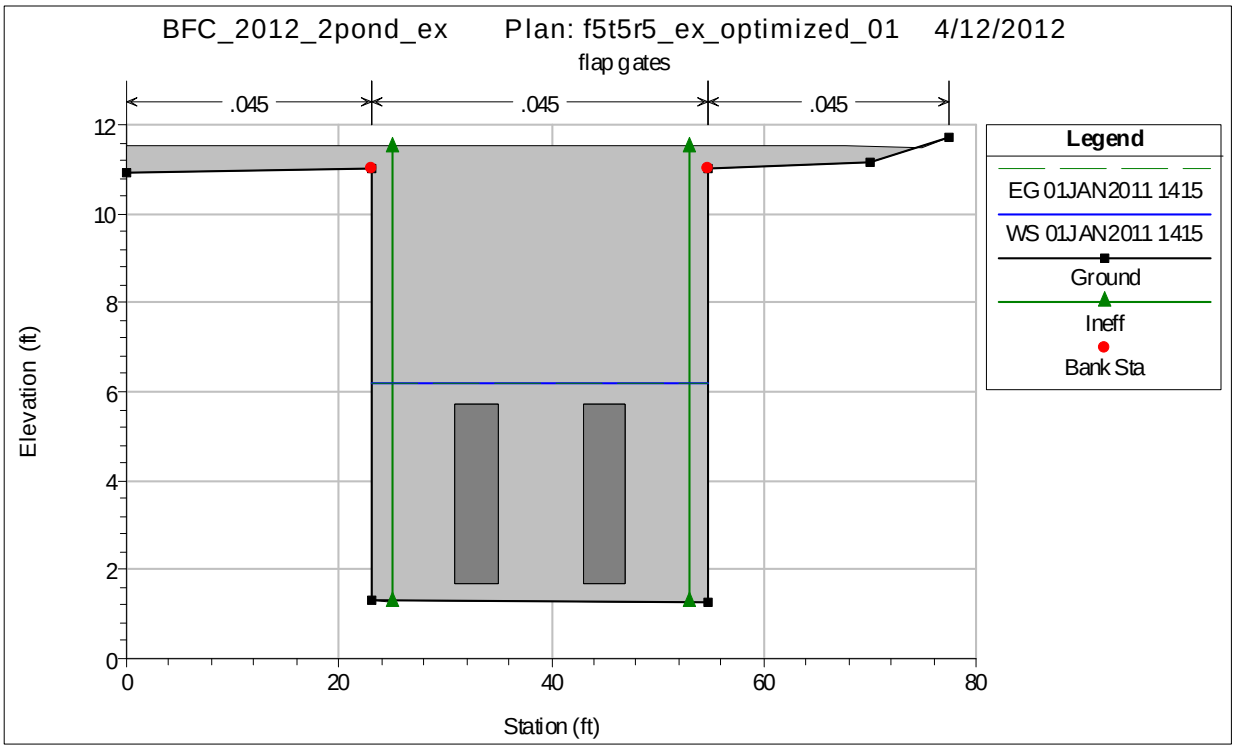

Figure 3-19. **HEC-RAS Cross-Section of Tide-Gates Connecting Pond R5 to Pond R4**

3.4 PIPE ALIGNMENT AND CLEARANCE

The proposed culvert alignment spans roughly 480-feet from Bayfront Canal to Ponds S5/R5, adjacent to the Cargill pump station that remains at the site (red shack). Based on the elevations in the ponds and at the Canal, the culvert slope that was used in the analysis was approximately 0.2%.

Both the original and supplemental proposed alignments must cross the alignment of an existing Caltrans storm-drain culvert. Figure 3-11, above, illustrates these proposed alignments. The Caltrans culvert passes flows from a roadside ditch adjacent to Hwy-101 into Flood Slough through a double flap-gate structure (see Figure 3-20). The photo shown in Figure 3-21 shows a manhole where it is assumed that the storm-drain changes directions from the roadside ditch towards the double flap gate structure.

The City received as-built drawing from Caltrans for this storm-drain culvert. The storm-drain consists of double 48-inch RCPs; the plan and profile drawings are shown below in Figures 3-22 and 3-23, respectively. The Caltrans culvert in the vicinity of our crossing has a flow-line elevation between +0.3' to +0.4' NAVD and a crown elevation between 4.3' to 4.4' NAVD.

Based on the inverts and design slope of the previously proposed 4’x8’ box culverts, the flowline of the box at the crossing would be approximately 3.35-ft NAVD with the crown at an elevation of 7.35-ft NAVD. The existing ground surface elevation at the location of this crossing is between 13-ft and 14-ft NAVD.

Based on our new alternatives, the proposed box culverts would have a bottom elevation of approximately 1.34' NAVD with a crown elevation of 5.34' NAVD.

Either alignment interferes with the Caltrans culvert. The proposed culverts could either be routed above the Caltrans culverts, or routed beneath them using a siphon.

Figure 3-20. Tide gate Structure for Caltrans Stormdrain

Figure 3-21. Manhole Location for Caltrans Stormdrain

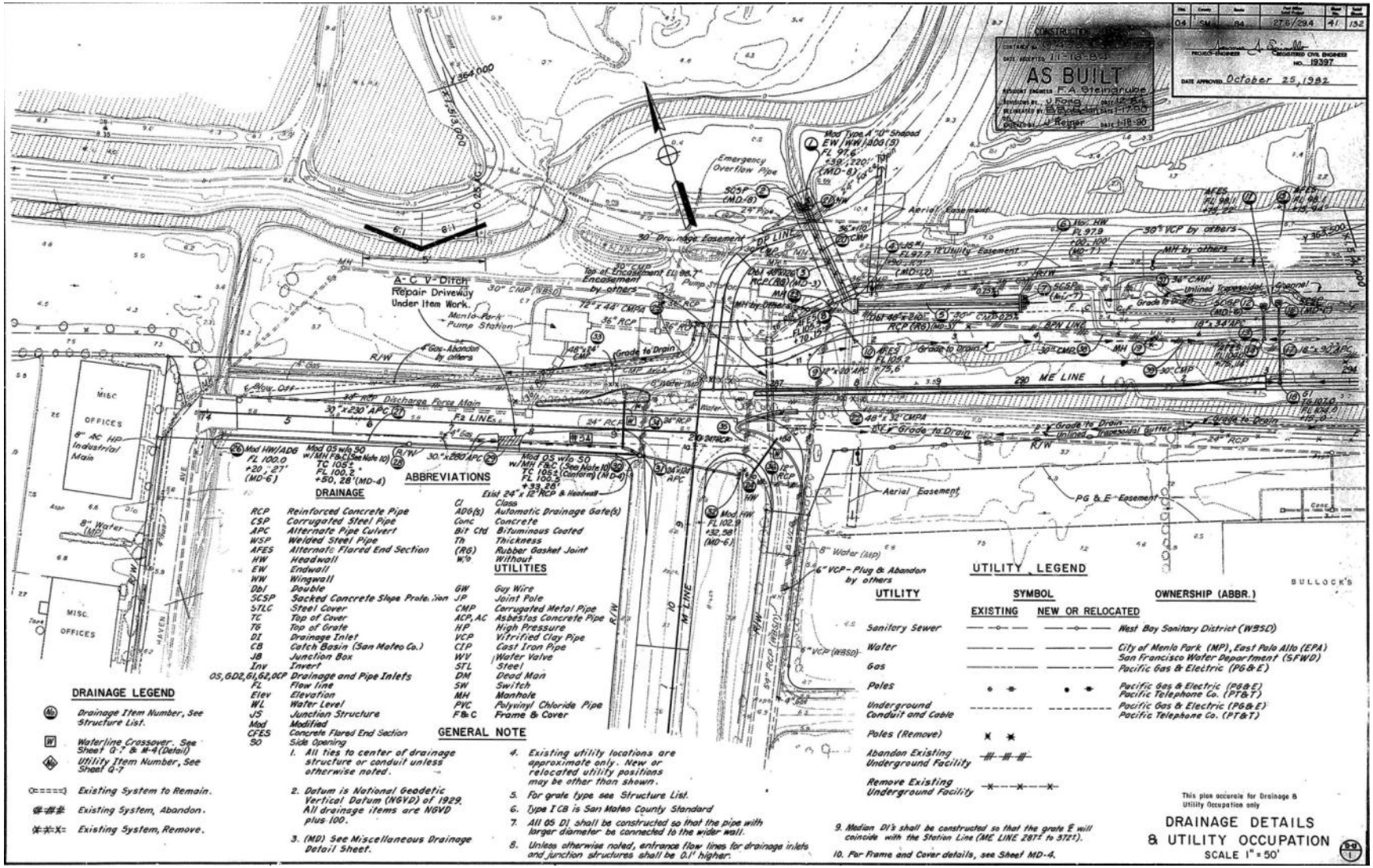

Figure 3-22. **Caltrans As-Builts for Storm-Drain in Project Vicinity, Plan-view**

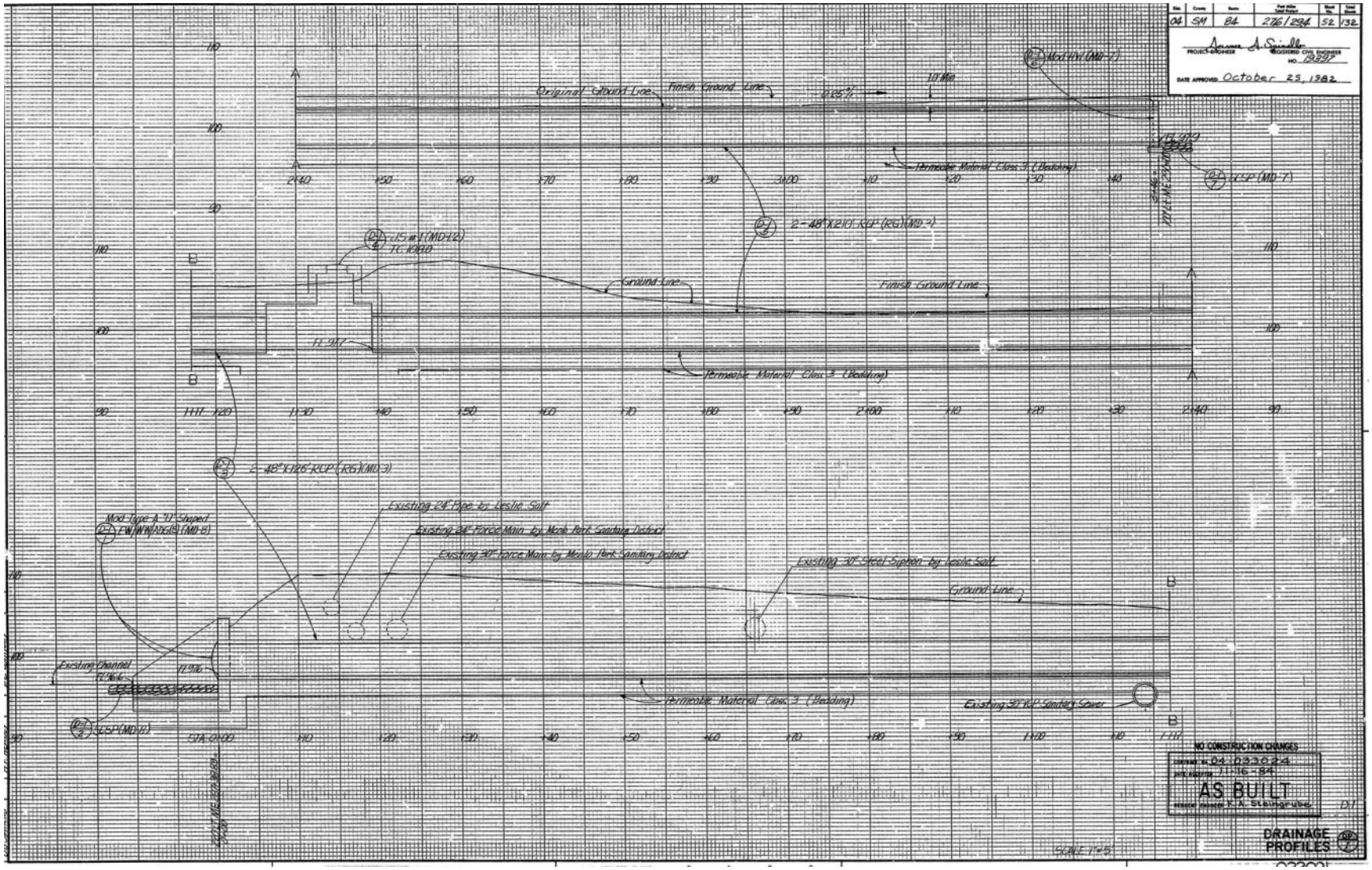

Figure 3-23. **Caltrans As-Builts for Storm-Drain in Project Vicinity, Profile**

3.5 WATER QUALITY SAMPLING

Water quality samples were collected from Atherton Channel and Bayfront Canal during two separate rainfall events over the past month by Kinnetic Laboratories, Inc. The first set of samples was collected on March 1st; and the second set was collected on March 14th. The analyses were conducted by Soil Control Laboratory and Caltest Analytical Laboratory.

The results of the analyses from March 1st are attached as Appendix A. The results of the analyses from March 14th are attached as Appendix B.

4. SUMMARY

- Stage-storage relationships were developed for the three managed ponds from the available LIDAR data. Pond R3 has existing low-flow channels which provide capacity down below Mean Tide Level (3.2' NAVD), whereas the majority of the S5/R5 surface area is above elevation 4.0' NAVD. The stage-storage analysis stopped at a high elevation of 6-ft NAVD due to a number of low spots on the existing salt pond berms at or near this elevation. The existing berms could potentially be raised as part of the proposed project.
- Incorporating the larger Pond R3 into the project was analyzed as part of the optimization simulations, as was the option of excavating the bottom of Ponds S5/R5 to add storage volume. Neither of these additions to the proposed project provided any benefit towards reducing flood stages in Bayfront Canal. The controlling factor affecting the ability of the project to reduce flood stages in the Canal is (1) the capacity of the culverts to pass flow at the relatively flat slopes in the project area and (2) the cross-sectional area and the hydraulic inlet losses of the inlet structure. Therefore, adding storage volume to the project did not affect the hydraulic-grade line in the analyses. Considering the cost and complications associated with adding Pond R3 or performing large scale grading, these design features were not included in the proposed alternatives reviewed as part of this feasibility study.
- The ability of the three proposed alternatives to reduce overbank volumes and flood stages in Bayfront Canal was compared to existing condition over a set of potential flood events ranging from more likely to occur (1-yr rainfall and MHHW tide) to much less likely to occur (25-yr rainfall and 25-yr tide level). For Alternative 1, the reduction in overbank volumes in the Canal for these events range from 15% to 100%. For Alternative 2, the reduction in overbank volumes in the Canal for these events range from 55% to 100%. For Alternative 3, the reduction in overbank volumes in the Canal for these events range from 70% to 100%.
- The stage for the 25-yr flood with 25-yr tide event exceeds the lowest elevation of the pond berms for some of these simulations; however, that can be mitigated by either raising the low spots of the berms and/or increasing the size of the flap-gated culverts which drain Pond R4. It should also be recognized that the event itself (25-yr flood + 25-yr tide) is a very low probability event (much less frequent than a 100-yr event), given that astronomical tide and precipitation are not correlated.
- Based on the invert elevation for the lateral culvert structure leaving the Canal, the proposed structure would capture flow from nearly all Canal flow rates. The ponds will drain within one to two tide cycles, over a period of 18-36 hours.
- Lowering the pipe-outlet invert without changing the pipe inlet elevation did not affect the results. Lowering the pipe-inlet elevation along with deepening the S5 forebay by 2-feet (from +3' NAVD down to +1' NAVD) did improve the flood-mitigation results.
- Adding sheet-pile to raise the bank-elevation in the two low-spots on the south bank to +8.7' NAVD only raised the flood stages in the Canal and increased the likelihood that floodwater would leave the Canal in other locations. Based on the Canal topography provided by the City (MASTTOPO.dwg), there are multiple locations where the bank elevations are in the +8.7' to +9.7' NAVD range, where flows could also leave the Canal. Therefore, the sheet-pile option did not provide enough flood-mitigation benefit to justify the potential problems this alternative could create due to elevated flood-stages in the Canal.

- The ability of the three supplemental alternatives to reduce overbank volumes and flood stages in Bayfront Canal was compared to existing condition over the same set of potential flood events. For Alternative 1b, the reduction in overbank volumes in the Canal for these events range from 47% to 100%. For Alternative 2b, the reduction in overbank volumes in the Canal for these events range from 67% to 100%. For Alternative 3b, the reduction in overbank volumes in the Canal for these events range from 77% to 100%.
- The proposed alignment must cross the alignment of an existing Caltrans storm-drain culvert. The Caltrans culvert passes flows from a roadside ditch adjacent to Hwy-101 into Flood Slough through a double flap-gate structure. The City received as-builts for this storm-drain structure from Caltrans. The Caltrans culvert in the vicinity of our crossing has a flow-line elevation between +0.3' to +0.4' NAVD and a crown elevation for the double 48" RCPs between 4.3' to 4.4' NAVD. Either of the proposed culvert alignments interferes with the Caltrans culvert. The proposed culverts could either be routed above the Caltrans culverts, or routed beneath them using a siphon.
- Water quality samples were collected from Atherton Channel and Bayfront Canal during two separate rainfall events over the past month by Kinnetic Laboratories, Inc. The first set of samples was collected on March 1st; and the second set was collected on March 14th. The analyses were conducted by Soil Control Laboratory and Caltest Analytical Laboratory.
- If one of the proposed alternatives presented in this feasibility study is selected by the City for further study, it is recommended that a more detailed hydrodynamic model be created to determine the movement of flood waters through Ponds S5 and R5. Both the MIKE and XP-SWMM software packages have modules that can simulate 1D storm drain systems that surcharge into 2D hydrodynamic systems.

REFERENCES

Moffatt and Nichol (M&N). 2009. Redwood Shores Levee System, Coastal Engineering Assessment. Submitted to City of Redwood City on November 6, 2009.

National Geodetic Survey (NGS). 1999. National Geodetic Survey Height Conversion Methodology. Viewed online at <http://www.ngs.noaa.gov/TOOLS/Vertcon/vert_method.html> on January 15, 2009. Dated May 12, 1999.

National Oceanographic and Atmospheric Administration (NOAA). 2008. NOAA Tides & Currents: Center for Operational Oceanographic Products and Services. Viewed online at <http://tidesandcurrents.noaa.gov/index.shtml> on December 19, 2008.

National Oceanographic and Atmospheric Administration (NOAA). 2011. NOAA Atlas 14, Volume 6, Version 2.0, “Precipitation-Frequency Atlas of the United States: California”.

Schaaf and Wheeler. 2002. Draft Hydrology Study, Atherton Creek at Haven Court. Submitted to City of Redwood City on July 8, 2002.

U.S. Army Corps of Engineers, San Francisco District. 2011. Without Project Conditions Coincident Frequency Analysis, San Francisquito Creek, San Mateo and Santa Clara Counties, California. January 2011.

Winzler and Kelly. 2003. Design Development Alternatives Analysis Report, Bayfront Canal Improvement Project. Submitted to City of Redwood City in December 2003.

WRECO. 2011. Draft Hydrology and Hydraulics Report, Bayfront Canal Improvement Project. Submitted to City of Redwood City in September 2011.

R E P O R T

OPPORTUNITIES AND CONSTRAINTS FOR RAVENSWOOD POND COMPLEX

SOUTH BAY SALT PONDS RESTORATION, PHASE II

Prepared for

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June 28, 2012

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Acronyms and Abbreviations

AMP	Adaptive Management Plan
BA	Biological Assessment
Bayfront Park	Bedwell Bayfront Park
BCDC	(San Francisco) Bay Conservation and Development Commission
BO	Biological Opinion
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
Conservancy	California State Coastal Conservancy
EFH	Essential Fish Habitat
EIS/EIR	Environmental Impact Statement
ESA	Endangered Species Act
HMMP	Habitat Mitigation and Monitoring Plan
LEDPA	Least Environmentally Damaging Practicable Alternative
ISP	Initial Stewardship Plan
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI/NOP	Notice of Intent/Notice of Preparation
PMT	Project Management Team
project	South Bay Salt Ponds Restoration Project
PWA	Philip Williams and Associates
refuge	Don Edwards National Wildlife Refuge
ROD	Record of Decision
ROW	right of way
SBSP	South Bay Salt Ponds (Restoration Project)

Shoreline Study	South San Francisco Bay Shoreline Feasibility Study
SR	State Route
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

The South Bay Salt Pond (SBSP) Restoration Project (project) encompasses approximately 15,100 acres of former salt ponds located on the perimeter of San Francisco Bay, including the 1,600 acre Ravenswood Pond Complex at the western end of Dumbarton Bridge (Figure 1). The project also includes the Eden Landing Pond Complex and the Alviso Pond Complex. The Ravenswood and Alviso Pond Complexes are part of the U.S. Fish and Wildlife Service's (USFWS) Don Edwards National Wildlife Refuge (refuge). The Eden Landing Pond Complex is under the California Department of Fish and Game's (CDFG) Eden Landing Ecological Reserve.

The project has three main goals: habitat restoration, flood management, and improved public access. Each of these is briefly described below.

The purpose of this memorandum is to

- Develop a set of proposed Phase II project actions for the Ravenswood Pond Complex
- Evaluate the ability of those actions to achieve project goals and objectives
- Make an initial assessment of the opportunities and constraints of those actions,
- Outline a strategy for environmental clearance and permitting.

This memorandum was written for the California State Coastal Conservancy (Conservancy) and the Project Management Team (PMT) of key stakeholder representatives. As such, it assumes that the reader is familiar with the overall project, the setting, and the actions undertaken under the Initial Stewardship Plan (ISP) and Phase I.

1.1 HABITAT RESTORATION

Habitat restoration is the project's primary goal, to be achieved while incorporating flood management and public access as corollary goals. The actual configuration of each Ravenswood Pond Complex Phase 2 restoration activity will be guided by the Adaptive Management Plan (AMP; FEIS/R App. D 2007) – a strategy that is continuously adjusted based on each site's response to previous restoration activities observed through strategic monitoring and data evaluation – and furthered by this initial analysis of opportunities and constraints. The habitat restoration goals are linked to numerous species – including those listed under the Federal or California Endangered Species Acts (ESA), California species of special concern, migratory birds, and others – that depend upon these habitats for all or part of their life cycles.

Restored habitat should be of sufficient size, function, and appropriate structure to promote restoration of special status species, support current migratory bird species that utilize existing salt ponds and associated structures, and increase abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components (EDAW et al. 2007).

1.2 FLOOD MANAGEMENT

In order to address sea level rise and public safety, one of the project's main purposes is flood management. The specific objective listed in the EIR is to maintain or improve existing levels of flood protection in the South Bay Area (EDAW et al. 2007). Flooding in the project area can potentially be caused by high tides, El Niño effects, sea level rise, and fluvial flood hazards (rainwater runoff). Congress authorized the Corps of Engineers to conduct the South San Francisco Bay Shoreline Feasibility Study (Shoreline Study), together with the Santa Clara

Valley Water District and State Coastal Conservancy, to identify and recommend projects that simultaneously address flood damage reduction, ecosystem restoration, and public access. The initial focus of the Shoreline Study is on projects in the Alviso Complex of the Don Edwards NWR.

1.3 PUBLIC ACCESS

A key component of the pond complex design goals is to provide wildlife-compatible public access and recreational opportunities. Public access activities may include hiking, hunting, fishing, wildlife viewing, and other recreational activities. Facilities for public access may include walkways and trails, as well as interpretive signage and elevated viewing platforms. These public access and recreation features will be integrated with the Bay Trail and other existing regional and local plans for trails. Evaluating and addressing possible conflicts between recreation and restoration goals will be a key part of this project.

1.4 RESTORATION APPROACH

The basic restoration approach is to restore tidal marsh and managed pond habitat with an ultimate ratio somewhere between 50/50 and 90/10 for tidal marsh/managed pond. Initially, restoration design will aim to meet the 50/50 level goal, and will later aim to increase the percentage of tidal marsh restoration to as much as 90 percent. The actual configuration of each restoration activity will be guided by the AMP. Regular monitoring and evaluation of the data is a vital component of a successfully administered AMP. The PMT will direct URS to maintain or improve upon what has been a successful AMP. This approach is a valuable and necessary strategy for projects with a complex set of interrelated variables. In addition, the precise impacts of climate change and associated sea-level rise or changes in amounts or intensity of rainfall are unknown. Yet, they are likely to affect flood control management and tidal marsh restoration and must also be adaptively managed.

This section provides a summary list of reports and other documents reviewed as part of the background research on this project.

Ackerman, Josh, U.S. Geological Survey (USGS); Mark Marvin-DiPasquale, USGS; Darrell Slotton, UC Davis; Collin Eagles-Smith, USGS. 2010. Memo to Laura Valoppi (USGS), Ann Buell, State Coastal Conservancy, Meghan Hertel, Resources Legacy Fund; Quarterly Report for RLF Grant #2009-0421. The Effects of Wetland Restoration on Mercury Bioaccumulation in the South Bay Salt Pond Restoration Project: Using the Biosentinel Toolbox to Monitor Changes across Multiple Habitats and Spatial Scales. April.

Fulfrost, Brian, Brian Fulfrost Associates. 2011. *Annual Report (Year Two) on the Habitat Evolution Mapping Project for the South Bay Salt Pond Restoration Project*. July 6.

Brown and Caldwell in association with PWA, EDAW, Harvey and Assoc. 2008. South Bay Salt Pond Restoration Project, Attachment to the Application for 401 Water Quality Certification Operations and Maintenance and Phase 1 Actions. May.

Foxgrover, Amy; David Finlayson, Bruce Jaffe. 2011. 2010 Bathymetry and Digital Elevation Model of Coyote Creek and Alviso Slough, San Francisco Bay, California; USGS Survey Open File Report 2011-1315.

Harvey and Assoc. 2008. *South Bay Salt Pond Restoration Project, Phase 1 Monitoring Plan*. October.

Philip Williams and Associates (PWA), EDAW, Harvey and Assoc., Brown and Caldwell. 2006. *South Bay Salt Pond Restoration Project, Final Alternatives Report*. January.

PWA, EDAW, Harvey and Assoc., Brown and Caldwell, and Geomatrix. 2007. *South Bay Salt Pond Restoration Project, Final EIS/R*. December.

Santa Clara Valley Water District. Not Dated. *Relationship between Groundwater Elevations and Local Subsidence in Santa Clara County*.

Stacey, Mark. 2010. *The Interactions of Island Pond Restoration and Coyote Creek Final Report to Legacy Fund*, Grant #2009-0105; UC Berkeley; 6/2011. South Bay Salt Pond Restoration Project; Annual Report, 2011; 2/2012. South Bay Salt Pond Restoration Project, Project Status Report, 8/2009. South Bay Salt Pond Restoration Project, Table of Key Uncertainties and Phase 1 Studies. August.

SBSP (South Bay Salt Pond) Project Management Team. 2010. South Bay Salt Pond Restoration Project, Phase 2: Preliminary Options for Future Actions. September.

SBSP (South Bay Salt Pond) Project Management Team. 2009. *South Bay Salt Pond Restoration Project Status Report*. August.

Takekawa, J., Arriana Brand, Isa Woo, Stacy Moskal. 2011. Effects of regional wetland restoration on the Alviso Shoals of the South San Francisco Bay: migratory bird ecology, food webs, and sediment supply. February.

United States Fish and Wildlife Service (USFWS) and United States Geological Survey (USGS). 2012. *South Bay Salt Pond Restoration Project, 2011 Annual Self-Monitoring Report*. March.

United States Fish and Wildlife Service (USFWS). 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*). In 2 volumes. Sacramento, California. xiv + 751 pages.

This section first provides an overview of Ravenswood Pond Complex Phase II actions. Three of ponds in the complex are involved in Phase II: R4, R5, and S5. Specific actions under consideration are:

- Restore tidal action at Pond R4
- Enhance habitat value at Pond R5 and Pond S5

This section evaluates the proposed actions and the opportunities and constraints for the design elements that may be used to implement the two main actions. Table 1 summarizes actions, alternative approaches or components, and the opportunities and constraints associated with them. Opportunities are essentially alternatives for how particular actions could be achieved. Constraints are technical, legal, financial, temporal, or political/social barriers to successful implementation. They are included to assist the PMT in considering cost, ease of permitting, and consistency with any of the three goals of habitat restoration, flood control, and public access/recreation.

3.1 RESTORE TIDAL ACTION AT POND R4

As part of the Phase II action to restore tidal action to R4, the following design elements may be included:

- Breaching, lowering or altering levee to restore tidal action
- Constructing upland habitat transition zone
- Creating western snowy plover (*Charadrius alexandrinus*) habitat
- Enhancing the levee between R3 and R4 for sediment storage and flood protection
- Developing recreational trails, facilities and signage

In order to meet the Phase II objective of restoring tidal action in R4, some of these design elements (e.g., levee breach or lowering) will be required. Many of these elements, however, are design options that are not required, but if implemented could advance the project goals of habitat restoration, recreation, and flood control. Potential options for the design elements are shown on Figure 2. The opportunities and constraints of each of these design alternatives are described below.

3.1.1 Breaching, lowering, or altering levee to restore tidal action at R4

In order to restore tidal action to R4, the exterior levee separating the former salt pond from the bay must be lowered or breached to allow tidal water to enter the pond. Design options to be considered include the depth and width of the breach and the location of the breach. Two breach locations have been proposed: at the eastern side of R4 between the remnant R4 slough channel and Ravenswood Slough and/or at the northwestern corner of R4 between the outer borrow channel and Greco Slough (Figure 2). The location and cross-sectional area or dimensions of the breach would be determined based on the results of calculations or models to estimate the flow volume and velocity of water entering R4 after the breach and evaluation of potential scour or erosion. The breach location and design will aim to provide tidal action without resulting in significant undesirable scour, rapid salinity changes, flooding risk, or rapid erosion of other constructed elements (e.g., upland habitat transition zones, trails).

Opportunities

The two breach location options are expected to provide similar opportunities. Both levee breach options would reintroduce tidal action into R4, promoting the growth of wetland vegetation. By retaining some portions of the existing levee, it is expected that some sediment deposition will occur within the pond, slowly increasing the bottom elevation. The sedimentation would help to establish marsh vegetation. Continued sedimentation may allow the marsh plain to transition with sea level rise.

Another opportunity is to keep open the possibility of implementing multiple breaches in R4 levees. This could isolate the bay-front levee and may provide refugia free of predator corridors.

In addition, the tidal marsh habitat and channel network could provide protected nursery habitat for fish. R4's proximity to Greco Island strengthens habitat connectivity, allowing genetic exchange and increased habitat area for neighboring populations. This increased habitat may ultimately increase populations and recreational opportunities for fishing and birding.

Constraints

The primary constraint is that introduction of tidal action could result in flooding unless additional flood protection is provided. Thus, in order to introduce tidal action to R4, additional flood protection must be provided. This could be achieved by retaining the external levee around R4 and/or enhancing the levee between R3 and R4 as described below.

Pond R4 currently serves as habitat for nesting western snowy plover; restoring tidal action to Pond R4 would eliminate this habitat. This is a significant constraint because the USFWS is requiring the SBSP Restoration Project to provide 500 nesting pairs of this species. Eliminating existing snowy plover habitat is only possible if it can be replaced and increased elsewhere. Otherwise, the project is likely to experience increased difficulty in receiving permits. Potential replacement locations for snowy plover habitat are described further below.

Restoring tidal action in R4 will undoubtedly affect how Ponds R5, S5, and R3 could be restored and managed. The determination as to whether and how to connect these ponds to each other will be affected by restoring tidal action in R4. The restoration timing/schedule should be developed in consideration of the other restoration actions proposed.

A constraint of the breach design may be in the erosion and scour that could result because of the breach. A breach at the Greco Slough location is likely to increase the tidal prism on both sides of this opening, scouring larger channels and potentially eroding part of Greco Island. Alternatively, a breach on the eastern side of R4 would also result in scour. Overall, scour would occur until the channel dimensions adjust to the new volume. If this is increase in scour is problematic, then the breach would need to be hardened to halt channel enlargement.

The breach at Greco Island may also be incompatible with upland habitat transition plans if the borrow channel along the western edge of R4 is needed to provide hydrologic connectivity.

3.1.2 Constructing upland habitat transition zone

To enhance the habitat value associated with the restored tidal wetlands of Pond R4, provide resiliency for sea level rise, and to protect the landfill at Bedwell Bayfront Park (Bayfront Park), the creation of an upland transition zone around Bayfront Park is proposed (Figure 2). The size, slope and shape of the upland transition zone will be further evaluated in the conceptual design.

The design will consider the amount of available fill material, sea level rise scenarios, public access benefits, species benefits, and permitting constraints. The transition area may wrap around Bayfront Park to extend into R5/S5 or only include a portion of the western edge of R4.

Opportunities

The primary purpose of the upland transition zone is to provide habitat complexity and refugia for tidal marsh wildlife species during high tides. However, there are additional opportunities. The upland transition area provides resiliency to sea level rise by having a transitional area that can slowly be converted to tidal marsh habitat with sea level rise. In addition, the fill material around the edge of Bayfront Park provides an extra buffer to protect the toe of the landfill. If the habitat transition zone is wide enough, a trail may be able to be included in the design. This trail could attach to the existing trail along the edge of Bayfront Park to create a small loop trail through diverse habitats. If dredged or upland fill material is plentiful, the upland transition area provides a location for reuse.

Constraints

Construction of the upland transition area will likely require a large volume of fill, depending on the final design. If dredged material is abundant, this could serve as an opportunity. If dredged material is scarce, it would be a significant constraint to the creation of the upland transition area. During construction there would be a short-term impact to recreational users of Bayfront Park as the exterior recreation trail would be the most efficient way to transport the material to R4. The larger the transition zone, the longer the construction and the more trail access would be affected.

In addition, constructing the upland transition area around Bayfront Park would require fill of the borrow channel around the interior side of the western and southern R4 levees. This channel currently increases connectivity to the marsh plain. If filled, additional channels may need to be dug within R4 to maintain connectivity. Filling of this borrow channel may also affect permitting. This would result in a larger amount of fill placed in USACE jurisdictional waters of the U.S. Due to the restoration focus of this project, this is not expected to be a significant problem for permitting.

3.1.3 Creating western snowy plover habitat

Western snowy plover habitat currently in R4 will be lost when the pond is opened to tidal action. *The Recovery Plan for the Pacific Coast Population of the Western Snowy Plover* directs a recovery criterion of 500 breeding pairs of western snowy plover in San Francisco Bay (USFWS 2007). In order to be compatible with this plan, snowy plover habitat within the area needs to be maintained or enhanced. In 2010, 74 western snowy plover nests were observed throughout the Ravenswood complex; 37 nests were observed in 2011. The loss of potential nesting habitat in R4 needs to be compensated by providing or enhancing habitat within R4 or elsewhere in the Ravenswood complex or other sites within the SBSP. Proposed potential locations for western snowy plover habitat creation or preservation are shown on Figure 2.

A number of design options have been proposed, listed here in no particular order:

- Create snowy plover islands out of segments of existing levee (e.g., R3/R4 or exterior R4 levees).

- Create salt mogul fields in isolated pockets around the corners of ponds by creating a cutoff levee (e.g., northeast corner of R4, E end of R3, southwest corner of R4).
- Create supplemental habitat by adding shells/salt along existing levees (e.g., north side of R4)
- Do not design western snowy plover habitat at this location
- Build islands within the marsh plain (e.g., in R4) out of dredged material
- Build floating habitat islands that would rise and fall with tidal exchange.

Opportunities

Building habitat islands is a potential opportunity for the reuse of dredged or upland material. In contrast, creating snowy plover habitat on existing levee structures may be a way to provide habitat without the need for additional fill provided minimum elevations are met. Building interior/cutoff levees to create fields of salt moguls (small mounds of dirt, salt deposits, and other materials) would allow the preservation of existing habitat that is already known to support snowy plover. Snowy plover may be more likely to use this preserved habitat than artificially made habitat structures.

Providing shelter/screens, such as tall vegetation or other visual barriers, around bird nesting locations may allow public access closer to nesting sites without significant disturbance of the birds. This would not work for snowy plover, however, which generally use open and vegetation-free sites for nesting.

Constraints

Maintaining existing snowy plover habitat in R4 is incompatible with restoration to tidal marsh. Building snowy plover habitat has the potential to be costly both for construction and maintenance.

Artificial habitat construction should consider the existing surface substrate, making an effort to conserve material that is suitable for snowy plover habitat (e.g., salt or shells). If substrate is not maintained, plants may colonize the area, reducing the suitability for plover nesting. Also, floating islands surrounded by water may present a problem for perinatal chicks.

Western snowy plover may be disturbed by the presence of people and dogs. In the past, nesting has been unsuccessful at S5, which is both small and ringed by a public access trail. At SF2 – a salt pond in this complex recently restored to managed pond habitat – buffer distances of 300 feet from trails and 600 feet from viewing platforms were implemented. The location of public access trails and viewing platforms will limit where snowy plover nesting could be sited.

The construction of snowy plover habitat will need to consider project timing. For example, if existing habitat is to be preserved in place, it would need to be isolated from tidal inundation by, for example, adding or raising levees. This would need to occur prior to breaching R4 so that salt substrate is not lost during tidal introduction.

In contrast, if existing levees are to be enhanced for snowy plover habitat, it may be more ecologically advantageous (though likely more difficult to permit) to wait until after tidal action

has established a dominant flow path through the pond before depositing new substrate. Alternatively, the desired flow path could be established during design and permitted in advance.

Permitting conditions will be a major constraint associated with the provision of snowy plover habitat. Regulatory agencies may dictate the amount of habitat to be conserved or constructed or the type of habitat to be provided.

3.1.4 Enhancing levee between R3 and R4 for sediment storage and flood protection

One way to reduce the risk of flooding associated with restoring tidal action to R4 would be to enhance the levee between R3 and R4. This is actually a dual levee with a small channel called the All-American Canal running between them. In this option, fill material would be placed in the All-American Canal channel between R3 and R4 to create a single, higher levee. This could incorporate reuse material, as described elsewhere. Design of the R3/R4 levee will depend on availability of suitable fill material as well as the designs for adjacent ponds (R3, R4, S5, and R5).

Opportunities

As an alternative to filling the All-American Canal, the levee enhancement could occur on one of the levees and extend into one of the ponds. This would leave the canal open and could reduce the total fill volume needed.

In addition to providing flood protection, this raised levee could also serve as a storage location for fill until R3 restoration is feasible. Once restoration at R3 is an option, material stored in this levee could be removed and used to raise, strengthen, or complete the levee south of R3 along State Route (SR) 84.

An improved levee between R3 and R4 could serve as a location for a public access trail, creating a loop trail with the existing trail along SR 84 (Figure 2). Alternatively, the levee could be left isolated for use as snowy plover habitat or developed into ecotone and upland refugia.

Constraints

Increasing the height of the levee between R3 and R4 may limit the future restoration opportunities at R3. If a trail is constructed on this levee, it may be difficult to get the public support needed to remove or modify the trail, levee, and fill during the restoration of R3.

Enhancing this levee may require significant volume of fill material. This is a constraint if material is not available. Construction would also require hauling of material on public access roads which could limit recreational use in the area for a short time.

3.1.5 Developing recreational trails

There are several options for providing public access around R4 that are compatible with restoring R4 to tidal marsh. Any breach in the exterior levee of R4 would limit the potential for a recreational trail on the exterior levee; however, bridges could be installed over the breach points in order to provide access. Alternatively, trails could be developed on existing interior levees, particularly if they were to be improved to provide flood control. Restoration actions at R4 provide the following trail location options as shown in Figure 2.

1. On exterior levee surrounding R4: this would require bridge over breach and maintenance of exterior levee, or the trail would end at the breach.
2. On interior levee between R3 and R4: this levee will likely require additional fill placement to build up levee for flood protection. Incorporation of a trail may require construction of additional levee segments or raising an existing levee to connect to existing trails that run along SR 84 and Bayfront Park. This connection point could use the existing levee between R4 and R5 or between R5 and S5.
3. New trail on the surface of the proposed upland transition area: this would require that sufficient dredged material be available to create a transition area wide enough to support a trail.
4. A spur trail off the northwest corner of Bayfront Park extending to a viewing area on the exterior levee between R4 and the Bay. Similar overlooks are also possible at breach locations.

Opportunities

Providing public access is a priority goal of the project. In addition, signage along trails and at viewing platforms provides an opportunity to raise public awareness about restoration activities, the ecosystem and its inhabitants, and what individuals can do to help the environment. Specific opportunities provided by the potential trail options at R4 include:

- Location for the reuse of dredged material in the levee between R3 and R4.
- Potential location for a viewing platform at the end of the spur trail on the northeast corner of R4. This location provides opportunity to view multiple ecosystems for a single vantage point: restored tidal marsh (Greco Island), restoring tidal marsh (R4), San Francisco Bay, and upland (Bayfront Park).
- A trail on the upland habitat transition area would provide a loop trail option, potentially reducing the need to provide loop trails at other locations that might conflict with restoration goals.
- Trail on the upland transition area would allow users to view transition habitat, which is uncommon in the bay area.
- An exterior levee trail would provide a large loop for users who want longer trail options.
- Trails into the Ravenswood Pond Complex provide an opportunity to place interpretive signage about the refuge itself.
- Trails also provide locations for notices and/or barriers to educate public about the no-dog policy on USFWS lands.

Constraints

While recreation use is compatible with restoring tidal action to R4, there are some constraints:

- Trails may require that levees be raised, strengthened, resurfaced, and/or maintained. The natural erosive forces of tidal areas may increase the difficulties associated with maintaining trails over the long-term.

- Signage or barriers may be required to exclude dogs from USFWS lands.
- Recreational use is not always compatible with wildlife use. Studies have shown that snowy plover nesting at S5 has been unsuccessful, potentially due to the high recreational use in the area. If trails go near nesting habitat, visual screens may be needed to reduce impacts on nesting birds.
- If levee between R3 and R4 is raised and a trail is constructed there, the public may resist proposals to remove or modify the trail during the restoration of R3. This may limit restoration options for R3.
- The location of such a trail may also be constrained by the desire to connect with the Bay Trail.

3.2 ENHANCE HABITAT VALUE AT POND R5 AND S5

The restoration objective for R5/S5 is to enhance habitat value. While originally proposed as a managed pond to benefit birds, other restoration approaches that enhance habitat are being considered: the ponds can be restored as one unit or restored separately; the ponds could be further subdivided, each portion being restored differently. This area may provide significant opportunity to alleviate flooding concerns and improve runoff water quality from nearby neighborhoods and has potential to support additional recreational trails. The specific design elements discussed here are:

- Enhancing habitat value
- Providing flood retention and the potential for water quality improvement
- Installing water control structures
- Creating snowy plover habitat
- Developing recreational trails

3.2.1 Enhancing habitat value

There are several design options for habitat enhancement at Ponds R5 and S5:

- Both R5 and S5 could be converted to managed ponds
- Both R5 and S5 could be restored to tidal action
- A portion of both R5 and S5 could be restored to tidal and a portion could be converted to managed pond
- S5 could be converted to managed pond while R5 could be restored to tidal action
- R5 and/or S5 could be converted to a willow glen, which is typically a rare riparian habitat with ecological and scenic values of its own, despite not being habitat that is specifically useful for snowy plover or other listed species

Historically, both ponds R5 and S5 were tidal, however, once converted to salt production ponds, the suite of species using the ponds shifted. The former salt ponds and now managed ponds provide habitat for nesting, migration, and foraging for shorebirds and ducks. Conversion of the

ponds to tidal habitat potentially reduces habitat for some shorebirds and ducks, but increases habitat value for tidal marsh species.

In order to create habitat diversity and provide flood storage, it is recommended that at least one of the two ponds be converted to a managed pond. Due to its location further from R4, which is slated to be restored to tidal marsh, and its proximity to neighborhoods in need of flood water storage, S5 has been proposed for conversion to a managed pond that would provide both habitat values and flood control (Figure 2). Alternatively, R5/S5 could be restored into a willow glen with a large bioswale in its center. Further evaluation of R5/S5 would be necessary to determine whether it is better suited for tidal marsh, managed pond, upland transition, or some other habitat type. Opportunities and constraints are summarized below.

Opportunities

The R5/S5 managed ponds option provides opportunities for providing waterfowl habitat and possible foraging habitat for western snowy plover. Creating a managed pond at R5 would provide similar habitat to that provided by S5. It could provide additional flood storage capacity and simultaneously provide waterfowl habitat. Likewise, conversion to tidal habitat would provide similar habitat values as restoring pond R4 to tidal action. Connecting R4 and R5 allows for greater tidal exchange. It would also allow more connectivity of the upland transition area to Bayfront Park uplands. The upland transition area within R5 would serve to protect Bayfront Park from erosion.

The willow glen option, if successful, would provide habitat to passerine birds and increase habitat diversity. Willow glens were always a rare habitat around SF Bay, but development has further reduced them. Restoring even a small patch of this unique habitat would be an interesting and valuable contribution from this project.

Constraints

There are constraints placed on the species and habitats that could successfully use ponds S5 and R5, depending on the habitat restoration approach taken. Managed ponds would require active management and maintenance which could be costly and time consuming.

The development of a willow glen at S5 is potentially limited by the existing soil and hydrology conditions at the site. Soils would need to be tested for salts and metals to see whether they could support willows. In addition, the conceptual design would need to provide an appropriate water source appropriate for growing willows.

3.2.2 Providing flood retention

In conjunction with making S5 a managed pond, S5 could be connected to Flood Slough or the surrounding drainage network to serve as flood storage to relieve adjacent communities. Options for this connection include installing culverts, overflow weirs, one-way or two-way gate structures between Flood Slough and the southwest corner of S5 (Figure 2).

Opportunities

Creating a managed pond at S5 provides opportunity for flood storage to help relieve flooding in the neighboring communities of Menlo Park and Redwood City. While currently disconnected from the surrounding drainage systems, S5 could be connected to Flood Slough or other existing

drainages through the installation of culverts with water control structures. During periods of high rainfall, water could be released into S5 to reduce flooding in the neighborhoods. A water control structure installed at the north or east side of S5 could allow flood water to be discharged into R3 or R4.

Flood flows from the nearby neighborhood likely contain elevated concentrations of constituents common to urban and suburban runoff, including suspended sediments, metals, nutrients, bacteria, and pesticides. Temporary storage of flood flows in Pond S5 would provide coincidental water quality improvement through a number of mechanisms: suspended solids are removed by settling in quiescent areas and filtering through vegetation; and dissolved constituents are removed through chemical or biological mechanisms mediated by the soils, vegetation, and microbial fauna. The resulting discharges to San Francisco Bay may be improved over current conditions.

There is an opportunity to create localized estuarine conditions by facilitating the mixing of fluvial outflow with bay tides. These salinity gradients are ecologically productive.

Constraints

Managed ponds could require active management and maintenance which could be costly and time consuming. There may also be passive structures that could work. To allow discharge of flood waters, a gate structure would need to be installed between these ponds and R3 or R4. Gate structures also require on-going maintenance. Flood modeling is needed to assess the storage capacity of S5 and R5 and determine whether these ponds would be useful as storm water protection. Additional maintenance (i.e., periodic dredging) may be required to maintain capacity in the flood storage pond.

The use of R5 and S5 as flood control storage would require connecting existing flood control structures and systems (which empty into the bay via Flood Slough) to these ponds. That would require passing under the small Bedwell Park parking lot entrance road. Doing that would require working around a large number of easements for transportation and utility lines and easements.

There are more than 20 of Right of Ways (ROW), easements and utilities in the area that could serve as constraints to building water control structures. The conceptual design would need to consider ROWs owned by Caltrans, Cargill and others. These groups would need to be notified and included during the design process if construction would impact their properties, facilities, or ROWs.

3.2.3 Installing water control structures

Water control structures would need to be installed to move water between the various ponds. Water transport out of the managed ponds may be desired during times of heavy rain to reduce flooding potential or to manage water levels for nesting or foraging birds. In addition, it may be desirable to release tidal waters into the managed ponds (R5/S5) in order to control water levels for waterfowl or to control vegetation growth or pond salinity. Water control structures can consist of two-way culverts or gates or one-way gates. Potential locations for water control structures would be:

- Between Flood Slough/adjacent neighborhood into S5

- Between S5 and R5
- Between S5 into R4
- Between S5 into R3 (in preparation for next phase of action)
- Between R5 into R4

These locations are shown on Figure 2. The type of structure and location of structure needs evaluation based on studies. Historic slough traces and locations that connect with the existing, adjacent drainage system are being considered as locations for the water control structures.

Opportunities

Water control structures between the ponds allow for better pond management for maximizing waterbird habitat. Maintaining waterbird habitat may increase recreational value by providing hunting or bird opportunities. The gates also allow water management for flood control.

Constraints

Water control structures require active operation, long-term maintenance and replacement. Erosional forces, particularly in those areas with tidal action, may produce scour along the edges of the control structures. The control structures could sink, scour, or generally not remain secure if placed in a location where there is tidal action or other opportunities for erosion. Fish passage controls may also be needed.

3.2.4 Creating snowy plover habitat

The options for snowy plover habitat described for the restoration of R4 are also applicable to R5/S5 and shown on Figure 2. Specifically, the following may be options for creating snowy plover nesting habitat:

- Create snowy plover islands out of segments of existing levee (e.g., levee between R5/S5).
- Create salt mogul fields in isolated pockets around the corners of ponds by creating a cutoff levee (e.g., bottom half of R5)
- Supplement habitat by adding shells/salt along existing levees (e.g., S5/R5 levee)
- Don't plan snowy plover habitat features - reserve them for other complexes or let come in naturally
- Build islands within the marsh plain (e.g., in R5) out of dredged material
- Build floating islands.

Opportunities

The opportunities are similar to restoration of R4 with the following additional opportunities:

- Since R5/S5 are already isolated from R4, they will not be impacted through the restoration of tidal action at R4. Snowy plover enhancement activities could occur on a variety of timelines, independent of the R4 breach.

- Since habitat is more easily accessed, monitoring may be able to be done more easily, perhaps with less disturbance of the nesting area.
- If restored to managed ponds, there may be an opportunity to try floating nesting islands.

Constraints

The constraints are similar to restoration of R4 with the following additional constraints:

- Snowy plover habitat in the R5/S5 area is in closer proximity to human disturbance than R4 and likely more affected by it.
- The small size of the R5/S5 ponds limits the area that can be used as snowy plover habitat
- Restoring S5/R5 to completely managed ponds would limit the options for providing nesting habitat to anchored, floating islands or habitat on levees.

3.2.5 Developing recreational trails

Enhancement of R5/S5 may limit options for recreational trails in the area (potential options shown on Figure 2). Previously, a cutoff trail between SR 84 and Bayfront Park was proposed along the levee S5/R3 and R5/R4 levee. This trail would still be an option in the managed pond scenario. If all or part of R5 is opened to tidal action, a bridge over a breach point, or a walkway over a water intake structure would be required to complete this trail. If R5 is restored to tidal action, but S5 is left as a managed pond, the levee separating R5/S5 could be enhanced to provide a walking trail. This levee would also serve as flood protection. Using the levees as trails limits the potential for their use as snowy plover habitat.

Opportunities

Maintaining R5 and S5 as separate ponds rather than connecting them would allow a trail to be built on the levee separating the two ponds. There is also potential for a trail to be built on the levee between R4 and R5. These trails provide opportunities for recreation.

Constraints

Increasing public access in the S5/R5 area decreases the habitat value of the area. A trail on the levees between R4 and R5 or between R5 and S5 limits the use of these levees as nesting bird habitat or snowy plover enhancement areas. Building the recreational trails may limit future restoration options, including eventually restoring S5 to tidal action. To build the trails, levee improvements would be needed. This could be a limitation depending on the type and volume of material available. The levees/trails would also need to be maintained.

4.1 NEPA/CEQA STRATEGY

A Programmatic Environmental Impact Statement and Environmental Impact Report (EIS/EIR) for the entire SBSP Restoration Project was completed and signed in 2007 (PWA et al. 2007). That document also served as a project-level EIS/EIR for the Phase I actions that were to be undertaken at all 3 complexes. Under the current scope, the preparation of an EIS/EIR for Phase II projects at the Alviso and Ravenswood Pond Complexes will be tiered off of the Programmatic document and will use as much of the existing Phase I project material as possible. A similar EIS/EIR for the Eden Landing Pond Complex will be produced as part of a subsequent project task with the Conservancy.

In order to streamline the National Environmental Policy Act and California Environmental Quality Act (NEPA/CEQA) process, a single EIS/EIR will be prepared that will cover both Alviso and Ravenswood Pond Complexes. After the conceptual (10%) design alternatives have been developed, the impacts of at least three alternatives will be compared, including the 'no project' alternative. Alternatives may be in the form of the number/sequence of restoration actions (as done for the Phase 1 EIS/EIR) or could be different design alternatives for each restoration action proposed. The likely case will be a mixture of both of these interpretations of "alternatives."

Project descriptions will be written for each of the alternatives and summarized in the NOI/NOP. After the NOI/NOP is released, a public scoping meeting will be held to inform the public and agencies of the project alternatives and their potential impacts and to solicit their input regarding the environmental analysis. The EIS/EIR will then be drafted. The following sections are expected to be included in the EIS/EIR which largely follow the format of the Programmatic EIS/EIR (PWA et al. 2007):

- Hydrology, Flood Management, and Infrastructure (to include Sea-level Rise)
- Surface Water, Sediment, and Groundwater Quality
- Wetlands and Waters of the United States
- Geology, Soils, and Seismicity
- Biological Resources
- Recreation/Public Access Resources
- Cultural Resources
- Land Use
- Public Health and Vector Management
- Socioeconomics and Environmental Justice
- Traffic
- Noise
- Air Quality/Greenhouse Gas Emissions
- Public Services

- Utilities
- Visual Resources
- Cumulative Impacts

Additional field and technical studies are needed to complete the wetlands and other waters, biological resources, cultural resources, and recreation/public access sections. These studies will be conducted early during the development of the EIS/EIR and used to further inform future permitting tasks.

The Draft EIS/EIR will be released for public review. Interested parties and adjacent property owners will be notified directly. In addition, a public hearing will be conducted to receive public comments on the draft document. A Final EIS/EIR will be produced based on the public comments and a record of decision (ROD) and findings statement will be published and filed.

4.2 PERMITTING STRATEGY

Permitting preparation will begin after the 10% conceptual design for the restoration actions is completed and NEPA/CEQA document is drafted in order to increase efficiency. The permits will utilize the framework of the Phase 1 permit applications and the project description prepared for the 10% design memo. Similarly, the Phase I permit conditions and/or those proposed in the Phase I applications will be used as source material for the Phase II applications. Though the conditions will not be exactly the same, the material will be useful in developing and proposing appropriate avoidance, minimization, and mitigation measures.

The permitting for Ravenswood will be combined with the permitting for the Alviso complex (both owned by USFWS) to the extent possible. This will limit the number of applications that need to be prepared and can reduce redundancy in preparation of background material that is the same for both complexes.

The following permit documents are expected to be needed for this complex:

- Jurisdictional Wetland Delineation Report for the U.S. Army Corps of Engineers (USACE)
- Biological Assessment for the U.S. Fish and Wildlife Service (USFWS) (through USACE)
- Biological Assessment for the National Marine Fisheries Service (NMFS) (through USACE)
- Clean Water Act Section 404 permit application for U.S. Army Corps of Engineers (USACE)
- Clean Water Act Section 401 water quality certification application for the Regional Water Quality Control Board
- Clean Water Act Section 404(b)(1) Alternatives Analysis for the Environmental Protection Agency
- Consistency Determination request or Incidental Take Permit application for California Department of Fish and Game (CDFG)
- National Historic Preservation Act (NHPA) Section106 Technical Report for the State Historic Preservation Officer (through USACE)
- Native American consultation letters for NHPA compliance for USACE archaeologist

- Habitat Mitigation and Monitoring Plan for the USACE
- San Francisco Bay Conservation and Development Commission (BCDC) major permit application

Many regulatory agencies will be involved in the permitting process. To streamline the various application processes, prior to the preparation of applications, permit scoping will be a primary subject at the annual SBSP multi-agency meeting. Communication with agency staff will be on-going through the application development process to ensure that applications adequately cover all of the topics of interest. Additional strategies related to each permit application or document are provided below.

4.2.1 Jurisdictional Delineation of Waters of the United States

A delineation of jurisdictional wetlands and other waters of the U.S. will be conducted in order to quantify those wetlands and other waters that would be impacted by the restoration actions. To the extent possible, the delineation will rely on existing LiDAR data and aerial imagery to define wetland and other waters extents. These extents will be verified and/or modified in the field. A previous delineation of wetlands was done for those ponds included in the Phase I actions, but it does not cover the area impacted under the Phase II actions. The wetland delineation will be conducted as early as possible, to serve as background data for the preparation of the NEPA/CEQA document, but more importantly, will be timed to occur with the blooming period of the wetland-indicator plant species.

As early as possible, the jurisdictional delineation report will be submitted to the USACE for its review and approval or modification of the jurisdictional boundaries. This is a critical step to take in the early parts of the project because several subsequent project applications and steps depend on a verified delineation from the USACE.

4.2.2 Biological Assessments for USFWS and NMFS

The Biological Assessment (BA) documents will be prepared concurrently with the 404/401 applications and will address federally-listed species with potential to occur in the Ravenswood complex and potentially impacted by the project. These BAs will be based on those prepared for Phase I and the issued Programmatic Biological Opinion (BO) and the BO for Phase I. The species expected to be covered under the BA for USFWS are: western snowy plover, least tern, tadpole shrimp, salt marsh harvest mouse, and California clapper rail. The species expected to be covered under the BA for NMFS are Central California Coast steelhead and green sturgeon.

As part of the biological assessment, conflicts among the recovery plans will need to be identified. Restoration actions beneficial to one listed species may be detrimental to another listed species. BAs will rely primarily on desktop data to map habitats and determine the potential presence of species, but some field work to assess species occurrence may be necessary.

4.2.3 Essential Fish Habitat Consultation with NMFS

Under the Magnuson-Stevens Fishery Management and Conservation Act, consultation with NMFS about impacts to areas designed as Essential Fish Habitat (EFH) for federally managed fish species is required. NMFS must consider whether a federal or state action would adversely

affect EFH and is required to provide conservation recommendations if it is. Much of the information in the BA that will be submitted to NMFS as part of Section 7 ESA consultation can be re-used in the EFH consultation.

4.2.4 Clean Water Act 404/401 applications

The 404 and 401 applications will be developed concurrently by staff that is familiar with the requirements of both USACE and RWQCB. Much of the information in these documents is the same, so figures and text will be shared between the two documents to the extent possible.

4.2.5 404(b)(1) Alternatives Analysis

This document describes alternatives to the project and identifies the Least Environmentally Damaging Practicable Alternative (LEDPA). The Alternatives Analysis will use the alternatives and project goals as defined the EIS/EIR prepared for the Phase II actions. It will analyze impacts to wetlands and other waters as defined by the wetland delineation, and therefore, must be developed after the wetland delineation is complete and has been verified by the USACE.

4.2.6 Consistency Determination/Incidental Take Permit

Of the species potentially affected and covered under the USFSWS Biological Opinion, the California clapper rail, California least tern, and salt marsh harvest mouse are also state listed. There are two avenues for obtaining take permission from CDFG for these species: a consistency determination or an Incidental Take Permit.

A consistency determination is appropriate only for species listed under both the Federal and California Endangered Species Acts. It is a letter from CDFG indicating that it agrees with the provisions of the Biological Opinion and that the measures therein are adequate to avoid jeopardy for the species; it also allows some level of take. It is the simplest and least costly way to obtain permission to take a California ESA-listed species.

CDFG will be approached about Consistency Determinations for those species covered under the BO(s) issued by USFWS and/or NMFS. But in recent years, CDFG has not been as willing to issue them as it had been previously. Early consultation with CDFG will be initiated to determine whether Incidental Take Permit applications will be necessary for dually listed species.

For species listed only under the California ESA, Incidental Take Permits from CDFG would certainly be necessary. There are several species listed in the 2007 EIS/EIR that are state-listed, but not federally listed. If these species are to be impacted, an Incidental Take Permit would be required as these species would not be covered under the Biological Opinion. These state-listed species include American peregrine falcon, California black rail, and bank swallow. None of these species are expected to be nesting in the vicinity of the Ravenswood complex. It is assumed that they would not be impacted by the Phase II project activities, and would not trigger the need for an Incidental Take Permit.

4.2.7 Consultation in Accordance with the National Historic Preservation Act

While both Eden Landing and Alviso qualify as National Register of Historic Places eligible as cultural landscapes, Ravenswood does not. The impacts to an eligible cultural landscape would require some sort of mitigation, potentially Historic American Buildings Survey/Historic American Engineering Record documentation. This is not expected to be needed at Ravenswood.

However, since the CEQA/NEPA documentation and permitting will be combined for Ravenswood and Alviso, time required to address cultural resources at Alviso with correspondingly affect the Ravenswood project schedule.

At Ravenswood, a desktop survey and field assessment for cultural resources would be conducted as part of the evaluation for the CEQA/NEPA document. The results of these surveys would be provided in a Technical Report to be submitted to the State Historic Preservation Officer. If no eligible resources are identified, mitigation would not be required. If eligible cultural resources are identified mitigation, such as recordation and interpretive development, may be needed. In addition to the preparation of the technical report, consultation would include preparation and submittal of letters to relevant local Native American tribes associated with the landscape.

4.2.8 Habitat Mitigation and Monitoring Plan (HMMP)

This is a document required to be submitted with the 404 and 401 applications. It discusses project mitigation and post-construction monitoring and success criteria. The HMMP will comply with the AMP, will incorporate the results of the ongoing Applied Science Studies, and will be based on the approaches and measures used in the Phase 1 projects and the permits and other documents associated with it. It will include post-construction mitigation measures for fill in wetlands and other waters of the United States. The mitigation approach will be to suggest that the project is self-mitigating, and that on-site restoration activities account for any wetland and other waters lost as part of the project. No off-site mitigation is expected to be necessary or proposed as part of the project. The HMMP structure will follow the USACE outline for wetlands and other waters mitigation. In addition, mitigation requirements to enhance wildlife habitat or protect water quality that might be required under the biological opinions or other permits may also be included. This would allow a single document to be used to describe all post-construction monitoring and maintenance requirements.

4.2.9 San Francisco Bay Conservation and Development Commission Major Permit

In previous discussions the Conservancy has had with BCDC, the latter has indicated that its preference would be to amend an existing permit rather than apply for a new permit. A single permit amendment application would be prepared for Ravenswood and Alviso complex Phase II actions. Prior to acceptance of the amendment request, two hearings, one with the Design Review Board and a second with the Commission, are anticipated.

Though many regulatory agencies prefer to be the last one to issue a permit – so that they can review the others before issuing their own – BCDC generally insists on it. Therefore, this application is planned to be the last one applied for.

4.3 PERMITTING SEQUENCE

The attached Gantt chart (Figure 3) depicts a proposed permitting sequence and relative timing. While the dates may change, the sequence and relationship between different permitting elements is expected to stay the same. The conceptual design and project alternatives would be developed first, followed by development of the EIS/EIR document.

Permit application preparation would follow the completion of these two documents, though the field work, pre-application meetings with agencies, development of the strategies behind the

individual permits, and even the drafting of portions of the text (e.g., the project descriptions) will likely begin before those documents are complete.

The planned schedule for the applications will contain time for responding to agencies' requests for additional information. The maximum agency review period will be assumed to be required. We also anticipate that all regulatory agency application processing fees will be required.

4.4 RISKS

Risks to permitting the project include:

- Cultural resources: Identification of unexpected cultural resources during survey may delay permitting process by adding additional mitigation in the form of recordation and interpretation.
- Public access: Recreational users interested in using the area may be particularly interested in seeing that the design provides public access opportunities. This risk will be minimized by having frequent and early stakeholder involvement.
- Threatened and endangered species habitat: Due to differing species habitat requirements, it is impossible to create habitat that will be compatible or suitable for all species. For example, tidal marsh habitat that is suitable for salt marsh harvest mouse will be unsuitable for western snowy plover. In order to obtain permits from state and federal wildlife agencies, the designs must include a diversity of habitats that can accommodate multiple species. Early consultation with state and federal agencies during the design process will ease obtaining permits. Communication should involve both state and federal agencies, where appropriate.
- Tidal marsh versus managed ponds: In addition to threatened and endangered species, wildlife species that do not have state or federal designations also use the managed pond habitats. Many of these species are waterfowl that are popular among bird watchers and other recreational users. Public opinion will need to be considered in the decision on whether to restore to tidal marsh or managed ponds.

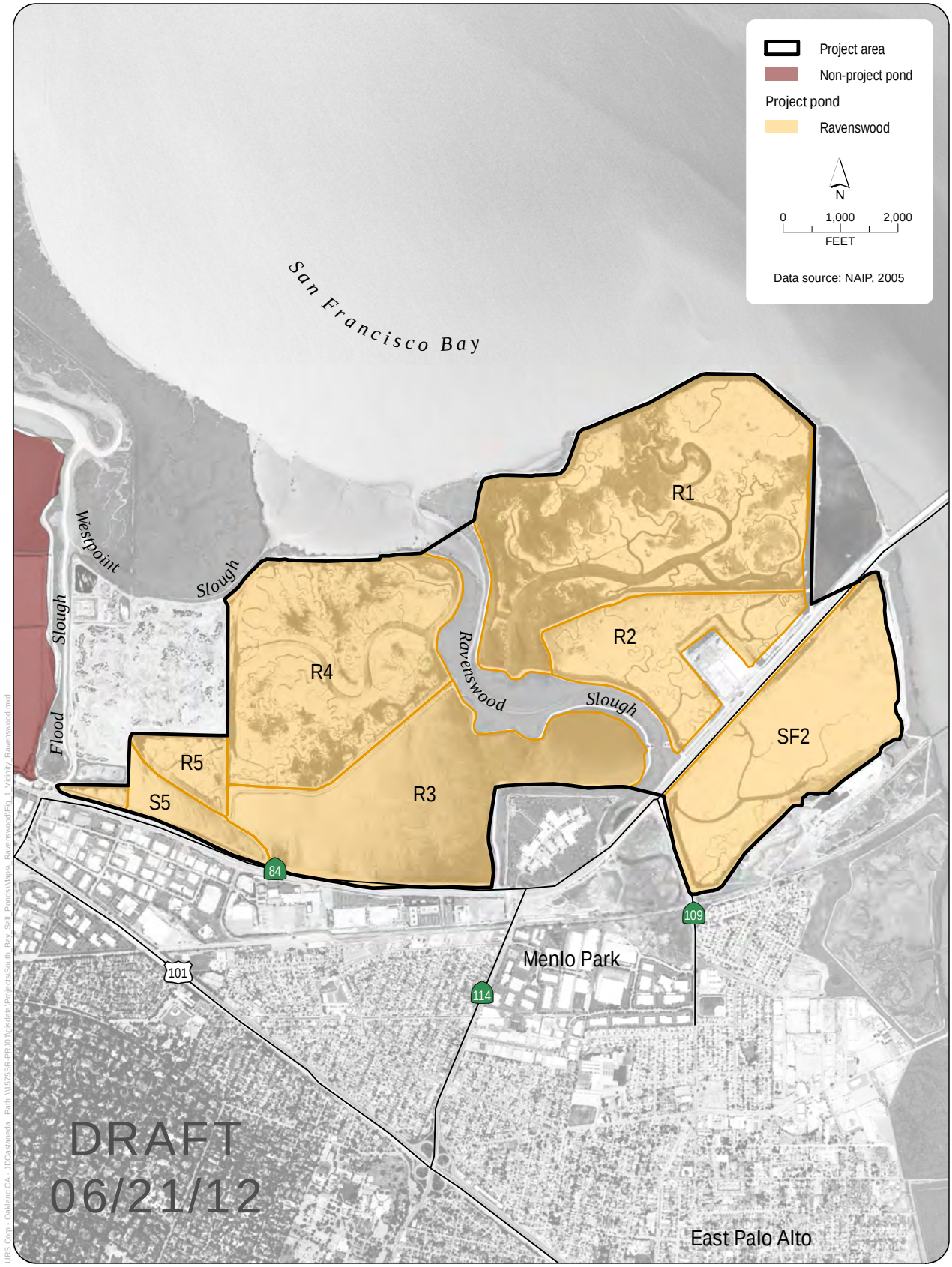
Each of these risks should be considered and addressed early in the design processes in order to minimize delays in the permitting process and limit comments on the EIS/EIR.

Existing, available data in combination with the results and reports of ongoing studies is believed to be mostly sufficient for preparing the 10% conceptual designs and NEPA/ CEQA document. However, the following information may be needed:

- Hydraulic calculations to evaluate breach locations and sizes. Because of the critical need for flood control to be incorporated into the restoration design hydrodynamic modeling will be required. Presently, it is assumed that the County will conduct the modeling as part of its flood control studies. However, because of the County emphasis on flood control rather than restoration it is imperative that there be coordination between the restoration team and flood control study team. If the county does not conduct the modeling then some analysis may be necessary for the restoration design.
- Quantities or estimates of tidal and storm surge-delivered sediment to inform understanding of likely accretion rates in breached ponds
- Information on available dredged material and upland material for reuse
- Evaluation of sea level rise study results. Although the design will not be driven by SLR concerns, a discussion of how the design may respond under future SLR conditions should be included.
- Results from ongoing or new SBSP-sponsored priority studies that may be available or become available
- Jurisdictional wetland delineation report and eventual verification by the USACE (to be done as part of this project)
- Cultural resources desktop records review and field surveys for artifacts that may need mitigation
- Reconnaissance site visits to confirm or update the most recent externally developed data on biological resources such as habitats for listed species (to be done as part of this project)
- The existing LiDAR/topography data (with 1-ft or less accuracy) needs to be reviewed and incorporated
- Geotechnical studies may be needed as the design progresses
- Quality (and quantity available) of sediment to be imported
- Specific preferences for trail corridor and interpretive center locations
- Public feedback on proposed restoration design options

Pond Number	Action	Main Restoration Goal(s)			Opportunities	Constraints	Details of Action/Action Options	Next steps
		Habitat	Flood Mgmt	Recreation / Access				
R4	Tidal marsh restoration	x			No FEMA levee needed. Could add temporary walking trail along new R3/R4 levee. May allow spur trail near Greco Island. May enable hunting/fishing. Lowering external levee may help promote natural sedimentation, gradually increasing marsh plain elevation with sea level rise. Provides habitat connectivity to Greco Island for genetic exchange. Nursery for fish.	Requires that additional flood protection be provided (currently proposed as building levee between R3/R4). Must leave rip-rapped portion of outboard levee facing bay and prevailing winds. Would reduce existing plover habitat in dry pond bottom. Where to store fill? Design could limit future restoration options at R3. Need topographic data. Work done at R4 affects what is possible at R5/S5.	Restoring tidal action to R4 would require a levee breach or lowering, currently proposed on the E side of R4 adjacent to Ravenswood Slough or on the west side adjacent to Greco Island. Existing exterior levee could be left or removed, but currently planning to be left to provide protection to R4 and promote sedimentation. Channels may need to be constructed to connect the marsh plane with the interior slough.	Look at hydrology data and topography/bathymetry data. Do hydrology analyses to determine the amount of water that will enter the area at different breach options (varying depth and width of breech). Model sedimentation rates and salt discharge rates with breach. Determine whether hydrology is sufficient to provided water to the entire marsh plane. Model flood scenarios and sealevel rise scenerios. Investigate what, if any, additional channel cuts are needed to increase circulation. Evaluate incremental difference of include R3 restoration with R4.
R4/R5	Upland Habitat Transition	x			Provide refugia for species during high tides. Allow resiliency to see level rise. Add buffer to Bayfront Park landfill waste to limit exposure to tidal action/potential erosion. May provide location for loop trail. Provides location for reuse of dredged material.	Requires a lot of fill material - if dredged material is limited, this could be problematic. If constructed from the Bayfront Park hillside area would result in disruption of public access during construction. Reduces connectivity of the marsh provided by the exterior (western) channel in R4. If built along upland transition would likely requiring filling large amount of WUS leading to bigger impacts associated with permitting and potentially mitigation.	Fill in the western channel on R4 and/or wrap upland transition south of Bayfront Park in R5/S5. Create a shallow slope going from tidal habitat to upland habitat. Width and location of upland transition in part dependant upon availability of dredged material. Trails may be able to be constructed in the transition area if space allows.	Review/model sea level rise. Investigate sources and amounts of potential dredged material. Design of upland transition will be directly related to the availablity of dredged material. Provide estimates of how much dredged material would be needed under different width/slope/location scenerios. Discuss/design public access trails/signage on upland transition habitat if appropriate.
All ponds	Creation/mainenance of snowy plover habitat	x			Creation of snowy plover island habitats - potentially by breaking up existing levee structure. May be able to provide shelter/screens from public by providing tall/dense vegetation around plover habitat.	Maintaining existing snowy plover habitat in R3/R4/R5 is incompatible with restoration to tidal marsh or managed ponds. Plover habitat needs to have a substrate that surpresses the growth of plants or must be regularly maintained (requiring access). Plover nesting success is limited by disturbance; therefore, it is best if plover nesting habitat is not close to trails (at least 300-600 ft away as done for SF2).	Options: 1) Create snowy plover islands out of segments of existing levee (e.g. levee between R5/S5). 2) Create salt mogel fields in isolated pockets around the corners of ponds by creating a cutoff levee (e.g., NE corner of R4, E end of R3, SW corner of R4, or R5/S5). 3) supplement habitat by adding shells/salt along existing levees (e.g. N side of R4) 4)Don't plan snowy plover habitat features - reserve them for other complexes or let come in naturally 5) Build islands within the marsh plane (e.g. in R4) out of dredged material	Review topography data and snowy plover nesting data to identify areas that may serve as good nesting island locations. Review literature/discuss with experts snowy plover nesting preferences. Develop 1 to several potential options to discuss with stakeholders.
R3/R4	Establish levee between R3/R4		x		Serves a storage location for fill until R3 restoration is feasible. Can provide public access trail between R3 and R4. Could also provide ecotone and refugia.	May limit restoration opportunities at R3. Would require significant amount of fill. Construction may require lots of trips on public roads.	Fill material would be brought in to fill the All American Canal between R3 and R4 and create a higher levee. Design of the R3/R4 levee will depend on available fill material as well as the designs for adjacent ponds (R3, R4, S5, R5).	Model hydrology associated with R4 restoration to determine the flood protection necessity of a levee between R3 and R4. Estimate amount of fill needed and potential fill sources. Consider options for additional levee/trail cut off on E side of R3 (potentially Phase 3 action). May need geotechnical investigation to evaluate stability requirements.
R4	R4 Spur Trail			x	Wildlife viewing that would work with many other actions.	Would need signage to inform people about dog rules and where not to go. Would need to maintain trail and levee. Potentially building platform. Would require leaving levee in place (eliminating option to remove levee).	Would require signage and potentially levee/trail reinforcements. May build viewing platform at end of spur. Trail design may be dependent on upland transition design in the area.	Priority study. Solicit public feedback. Design trail/signage.

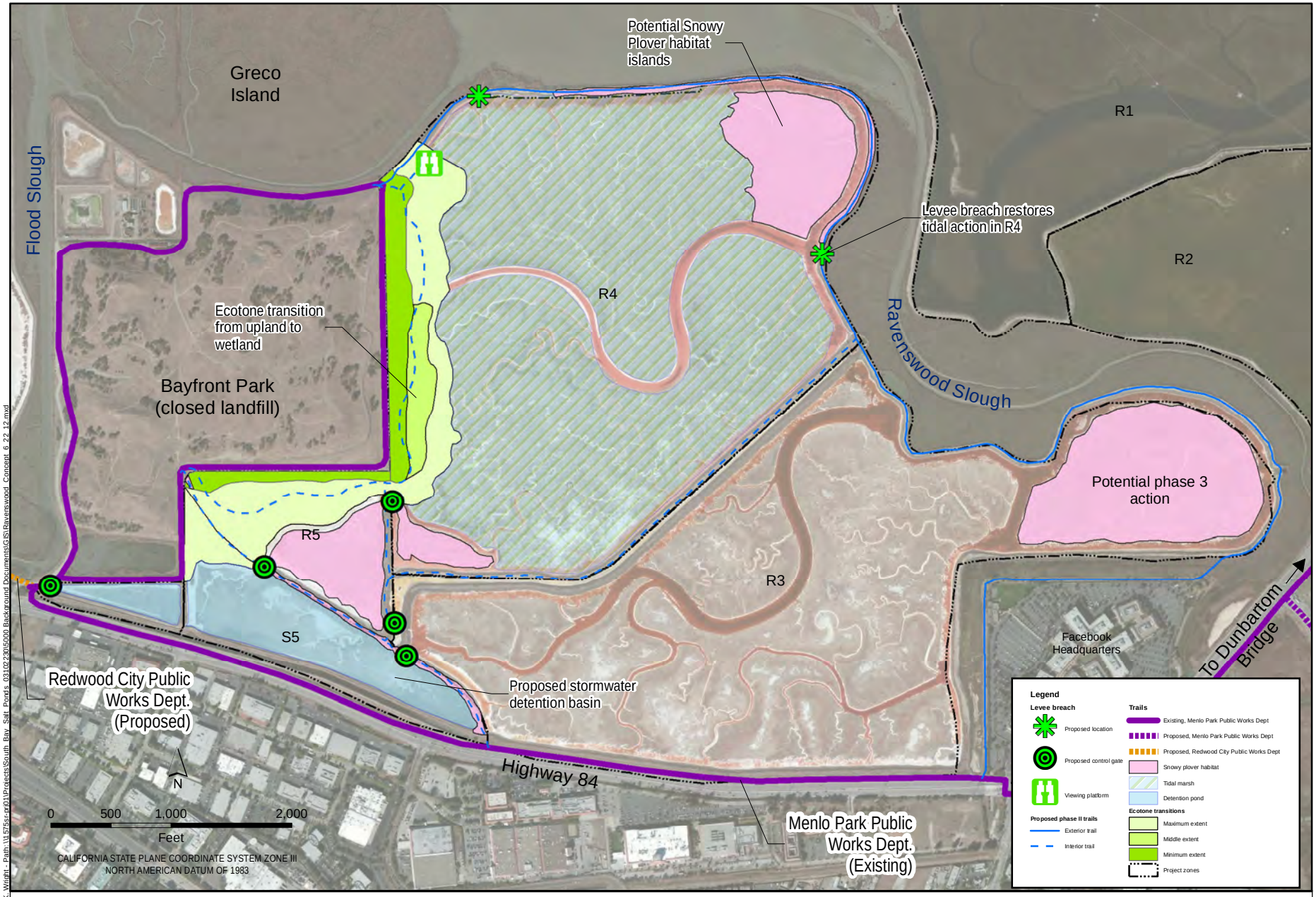
Pond Number	Action	Main Restoration Goal(s)			Opportunities	Constraints	Details of Action/Action Options	Next steps
		Habitat	Flood Mgmt	Recreation / Access				
R5/S5	Managed Ponds	x			Improves flood management. Decisions about depth and which species to manage toward habitat for. Could also link in with desire for increased flood protection from nearby Flood Slough (Menlo Park). Provides habitat for diving ducks/waterfowl. Managed ponds may provide foraging opportunity for snowy plover. Improves water management capabilities. Allows the ability to manage for multiple species by manipulating water flow/levels throughout the seasons.	Limits progress towards 90/10 scenario. Would require active management of the ponds. May require a gate structure between R5 and R4 to allow floodwater to be discharged. Gate structures have associated maintanance risks. Does not provided habitat for tidal marsh species or snowy plover. Would be good to know soil chemistry/salinity in these ponds. Could also provide habitat for plovers depending on how the ponds were managed.	Consider different pond management options for R5 and S5. This may result in recommendations to make all, part, or none of the area into managed pond. R5 may be suited for tidal action. Some of S5 may be retained as a detention basin for flood runoff. Water control structures can be installed at these ponds to allow/limit water transfer between them and R4.	Review topography data. Review drainage/flood data from neighboring properties to determine freshwater runoff input. Esitmate capacity of ponds R5 and S5 under different shape configurations and then model these under different flood scenerios. Evaluate what type and size levee would be needed to prevent flooding.
R4, R5, S5	Water control structures		x		Allows better pond management for maximizing waterbird habitat. May allow hunting.	Long-term maintenance requirement. Need protection from scour if exposed to tidal action.	Potential locations for water control structures 1)outflow of Flood Slough/neighborhood into S5 2)S5 into R5 3) S5 into R4 4) S5 into R3 (in preparation for next Phase of action) 5)R5 into R4. The type of structure and location of structure needs evaluation based on studies.	Evaluate hydrology and flooding potential in ponds S5, R5, and R4. Identify potential locations for water control structures that would alleviate flooding. Review potential types of gate structures. Perform geological studies to determine subsurface and anchoring structure. Model potential scour. Select and design gates.



URS

State Coastal Conservancy
South Bay Salt Ponds Project, Phase 2

Figure 1
Vicinity map - Ravenswood



URS

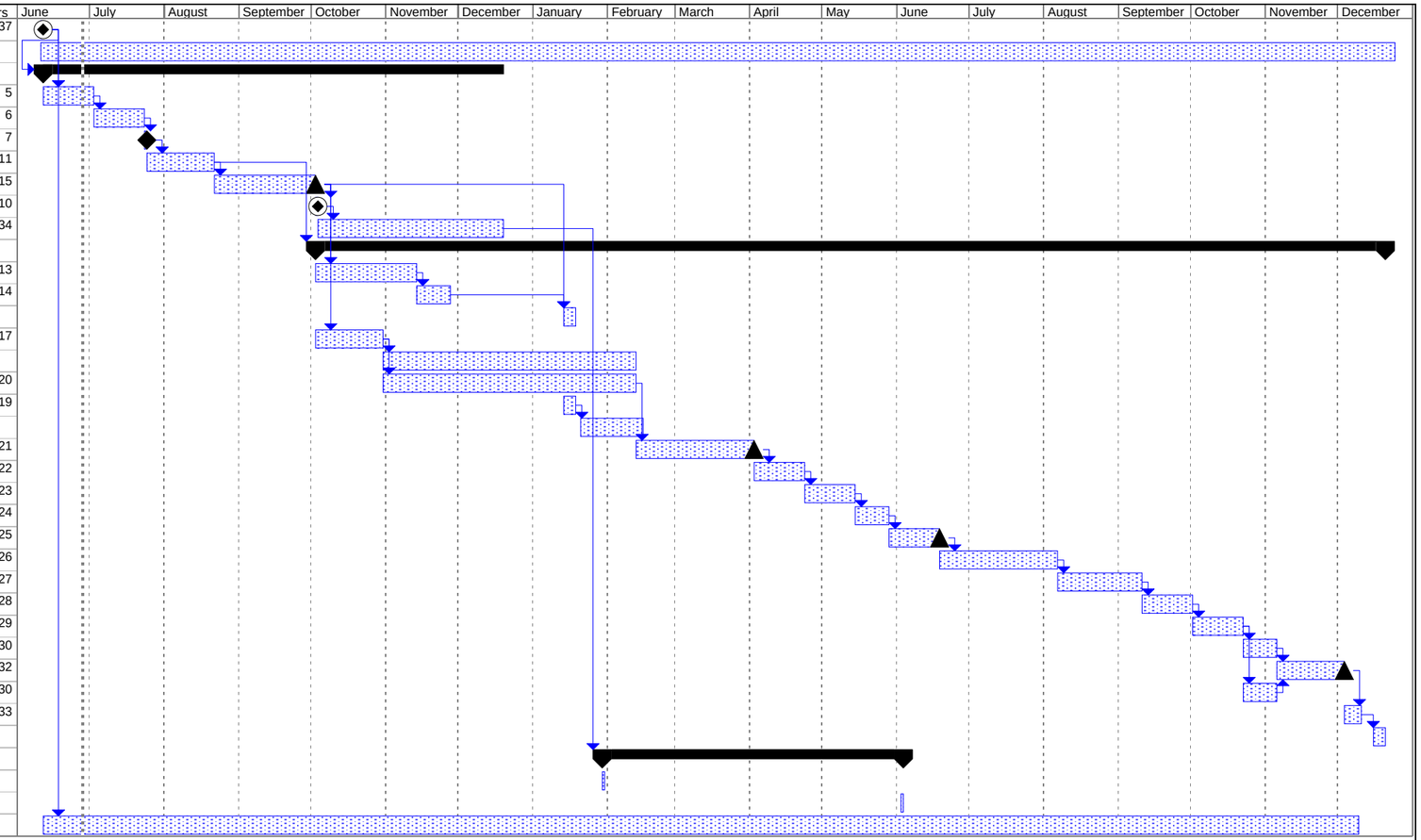
SOUTH BAY SALT PONDS
RAVENSWOOD
SAN MATEO COUNTY, CA

DATE OF PREPARATION: 6/22/2012
DRAFT, FOR INTERNAL USE ONLY
URS PROJECT NO. 26818346

FIGURE 2
ACTIONS PROPOSED FOR FULL ANALYSIS AT RAVENSWOOD POND COMPLEX

URS Oakland CA - K. Wright - Path \\ts575sv-gp01\Projects\South Bay Salt Ponds 43102230\5000 Background Documents\GIS\Ravenswood Concept 6 22 12.mxd

ID	Task Name	Duration	Start	Finish	Predecesso	Successors
1	Notice to Proceed	1 day	Mon 6/11/12	Mon 6/11/12		4,3,37
2	Project Management	402 days	Mon 6/11/12	Tue 12/24/13		
3	**Alternatives Development and Conceptual Design**	**137 days**	**Tue 6/12/12**	**Wed 12/19/12**	**1**	
4	Review Phase II projects, AMP and Phase I Applied Stu	15 days	Tue 6/12/12	Mon 7/2/12	1	5
5	Rank Project Features	15 days	Tue 7/3/12	Mon 7/23/12	4	6
6	PMT Meeting	1 day	Tue 7/24/12	Tue 7/24/12	5	7
7	Revise Preliminary Design concepts	20 days	Wed 7/25/12	Tue 8/21/12	6	8,11
8	Develop Alternatives Draft 10% Design memo	30 days	Wed 8/22/12	Tue 10/2/12	7	14,9,12,15
9	Constructability Review Workshop	1 day	Wed 10/3/12	Wed 10/3/12	8	10
10	Refine and Deliver Alternative Design Memo	55 days	Thu 10/4/12	Wed 12/19/12	9	34
11	**NEPA/CEQA Documenation (Ravenswood and Alviso)**	**318 days**	**Wed 10/3/12**	**Fri 12/20/13**	**7**	
12	Prepare Project Description / Alternatives Descriptions	30 days	Wed 10/3/12	Tue 11/13/12	8	13
13	Prepare and File NOP/NOI	10 days	Wed 11/14/12	Tue 11/27/12	12	14
14	Conduct Scoping Meetings	5 days	Mon 1/14/13	Fri 1/18/13	8,13	
15	Prepare Environmental Setting	20 days	Wed 10/3/12	Tue 10/30/12	8	16,17
16	Background and field data collection and analysis	75 days	Wed 10/31/12	Tue 2/12/13	15	
17	Prepare technical sections (impacts, mitigation measure	75 days	Wed 10/31/12	Tue 2/12/13	15	20
18	Wetland Delineation - Field Surveys	5 days	Mon 1/14/13	Fri 1/18/13		19
19	Prepare Wetland Delineation Report	20 days	Mon 1/21/13	Fri 2/15/13	18	
20	Prepare First Administrative Draft EIS/EIR	35 days	Wed 2/13/13	Tue 4/2/13	17	21
21	PMT Review	15 days	Wed 4/3/13	Tue 4/23/13	20	22
22	Prepare Second Admin Draft EIS/EIR	15 days	Wed 4/24/13	Tue 5/14/13	21	23
23	PMT Review	10 days	Wed 5/15/13	Tue 5/28/13	22	24
24	Prepare Public Draft EIS/EIR	15 days	Wed 5/29/13	Tue 6/18/13	23	25
25	Public Review	35 days	Wed 6/19/13	Tue 8/6/13	24	26
26	Prepare First Admin Final EIS/EIR	25 days	Wed 8/7/13	Tue 9/10/13	25	27
27	PMT Review	15 days	Wed 9/11/13	Tue 10/1/13	26	28
28	Prepare Second Admin Final EIS/EIR	15 days	Wed 10/2/13	Tue 10/22/13	27	31,29
29	PMT Review	10 days	Wed 10/23/13	Tue 11/5/13	28	30
30	Revise and Publish Final EIS/EIR	20 days	Wed 11/6/13	Tue 12/3/13	31,29	32
31	Prepare Findings/Record of Decision	10 days	Wed 10/23/13	Tue 11/5/13	28	30
32	File NOD and Publish ROD	5 days	Wed 12/4/13	Tue 12/10/13	30	33
33	Certify, Approve, NOD	5 days	Mon 12/16/13	Fri 12/20/13	32	
34	**Prepare Permit Applications (Ravenswood and Alviso)**	**89 days**	**Wed 1/30/13**	**Mon 6/3/13**	**10**	
35	Alternatives Feedback Meetings	1 day	Wed 1/30/13	Wed 1/30/13		
36	Regulatory Agencies Feedback Meeting	1 day	Mon 6/3/13	Mon 6/3/13		
37	**GIS Support**	390 days	Tue 6/12/12	Mon 12/9/13	1	



Project:South Bay Salt Ponds Restora

Task | Milestone | Project Summary | External Milestone | Progress
Split | Summary | External Tasks | Inactive Task | Deadline

SAN FRANCISCO
PLANNING DEPARTMENT

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Notice of Preparation of an Environmental Impact Report

Date:	June 24, 2009
Case No.:	**2005.0164E**
Project Title:	**Regional Groundwater Storage and Recovery Project**
Location:	The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin which underlies both San Francisco and San Mateo counties. Proposed facilities are located in the cities of South San Francisco, Colma, San Bruno, Millbrae, and Daly City and in unincorporated portions of San Mateo County.
BPA Nos.:	N/A
Zoning:	N/A
Block/Lot:	N/A
Lot Size:	Various
Project Sponsor	Greg Bartow, San Francisco Public Utilities Commission (415) 934-5724
Lead Agency:	San Francisco Planning Department
Staff Contact:	Diana Sokolove – (415) 575-9046 diana.sokolove@sfgov.org

PROJECT DESCRIPTION

The purpose of the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project) is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies) and San Francisco Public Utilities Commission (SFPUC) wholesale water customers.

The SFPUC proposes to provide surface water, when available, to Partner Agencies, to be used by these agencies in lieu of pumping groundwater during normal and wet rainfall years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet (AF) (approximately 20 billion gallons). Stored groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of 7.2 million gallons per day during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some

increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is one of several facility improvement projects identified in the San Francisco Region as part of the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted by the SFPUC in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area and establishes level of service goals and system performance objectives. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years.

The proposed Project consists of 1) cooperative management of surface water and groundwater to optimize the water demand and supply balance; and 2) construction and operation of groundwater production well facilities on 16 of 19 potential sites in northern San Mateo County. Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Some well facility sites would contain groundwater disinfection units and groundwater treatment facilities. Well facilities would connect to distribution systems for Daly City, San Bruno, Cal Water, and SFPUC. In addition, the Westlake Pump Station in Daly City may need to be upgraded and treatment facilities may need to be added to several well facility sites.

FINDING

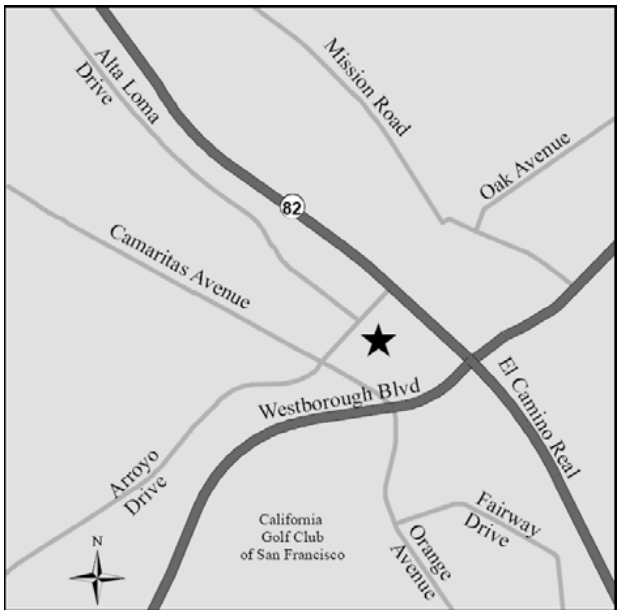
This project may have a significant effect on the environment and an Environmental Impact Report is required. This determination is based upon the criteria of the State CEQA Guidelines, Sections 15063 (Initial Study), 15064 (Determining Significant Effect), and 15065 (Mandatory Findings of Significance), and for the reasons documented in the attached project description and description of potential environmental effects. (Documents are also available online at: http://www.sfgov.org/planning/mea.)

PUBLIC SCOPING PROCESS

Pursuant to the State of California Public Resources Code Section 21083.9 and CEQA Guidelines Section 15206, a public scoping meeting will be held to receive oral comments concerning the scope of the EIR at the following location, date, and time.

DATE: Thursday, July 9, 2009
6:15-7:00 p.m. Informational Session
7:00 p.m. Scoping meeting

LOCATION:
South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, CA



Written comments will also be accepted at this meeting and until the close of business on **July 28, 2009**. Written comments should be sent to Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, San Francisco Planning Department, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409 or sent by email to diana.sokolove@sfgov.org.

If you work for a Responsible or Trustee Agency, we need to know the views of your agency regarding the scope and content of the environmental information that is germane to your agency's statutory responsibilities in connection with the proposed Project. Your agency may need to use the EIR when considering a permit or other approval for this proposed Project. Please include the name of a contact person in your agency.

June 24, 2009
Date

for
Bill Wycko
Environmental Review Officer

Regional Groundwater Storage and Recovery Project

Case No. 2005.0164E

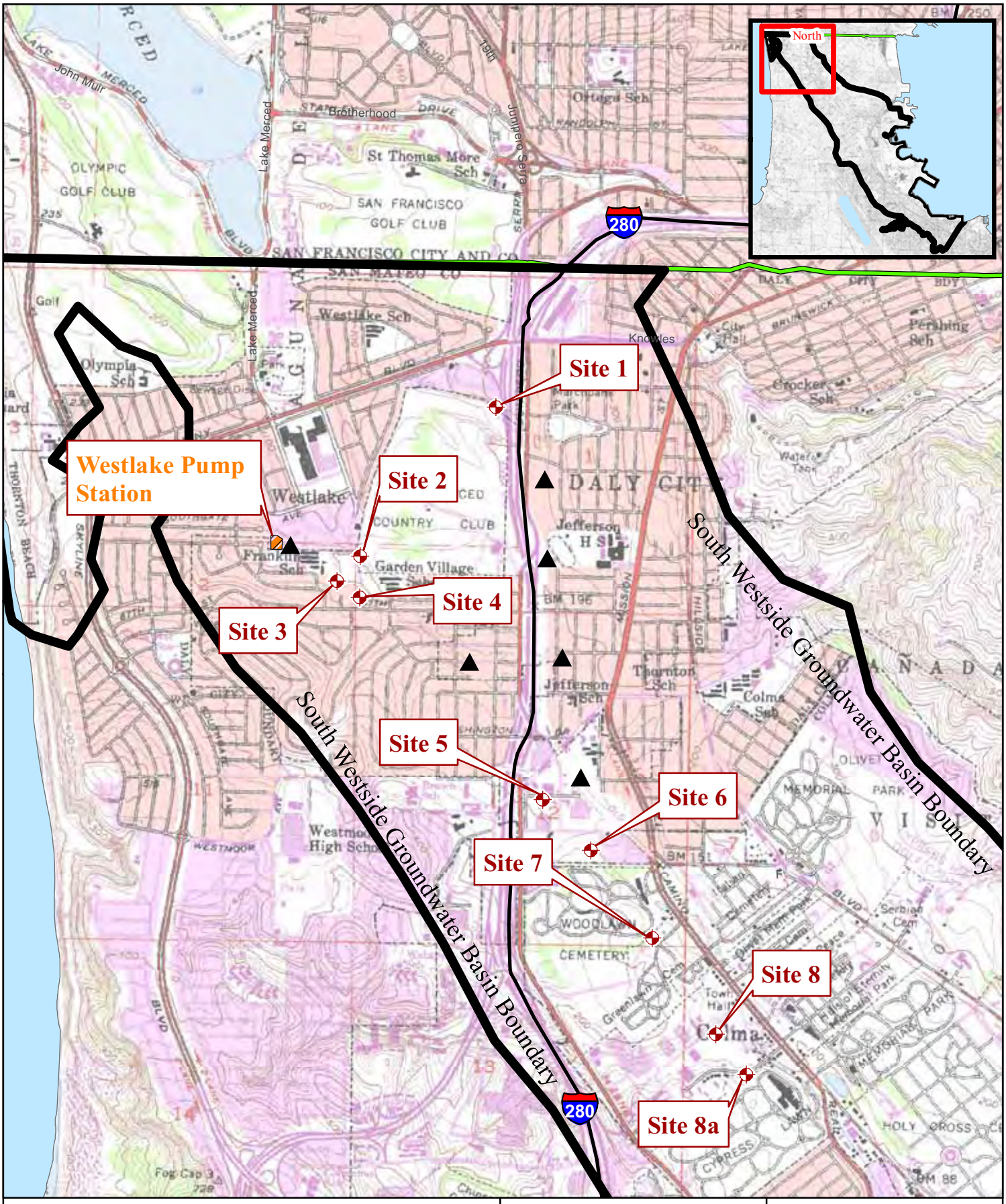
1.0 OVERVIEW AND BACKGROUND

The San Francisco Public Utilities Commission (SFPUC) is proposing the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project), which would be located in northern San Mateo County, California (see Figures 1, 2, and 3). To meet California Environmental Quality Act (CEQA) requirements, the San Francisco Planning Department's Major Environmental Analysis Division (MEA) will prepare and distribute an Environmental Impact Report (EIR) describing and analyzing the environmental effects of the proposed Project. This Notice of Preparation (NOP) provides a description of the Project background, a brief description of the proposed Project elements, and describes some of the proposed Project's potential environmental effects.

The purpose of the proposed Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively designated as Partner Agencies) and SFPUC wholesale water customers.

SFPUC proposes to provide excess surface water when available to the Partner Agencies to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of groundwater pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet[1] (AF) (approximately 20 billion gallons). Stored

[1] The SFPUC plans for an 8.5-year drought. Over this 8.5-year period, the SFPUC anticipates it will exercise its dry-year supplies after the first year of the drought. Therefore, the 61,000 AF of storage is assumed to be used over 7.5 years of the design drought, with wells operating at a maximum capacity of 7.2 MGD.

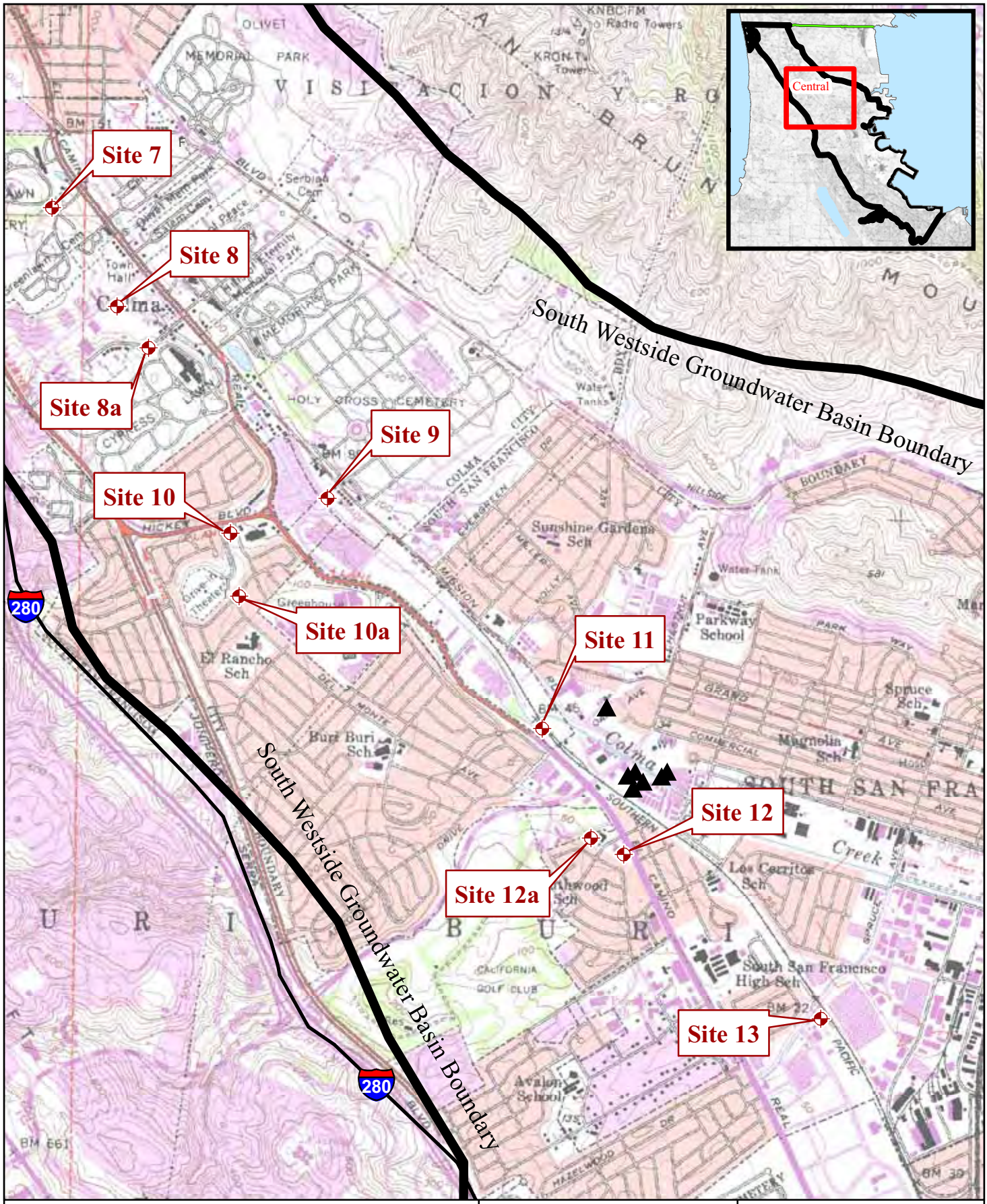


Project Location Map-North

Regional Groundwater Storage and Recovery Project

Figure 1

Source: SFPUC and Kennedy/Jenks



Legend

- Proposed Well Facility Sites
- Partner Agency Well
- South Westside Groundwater Basin

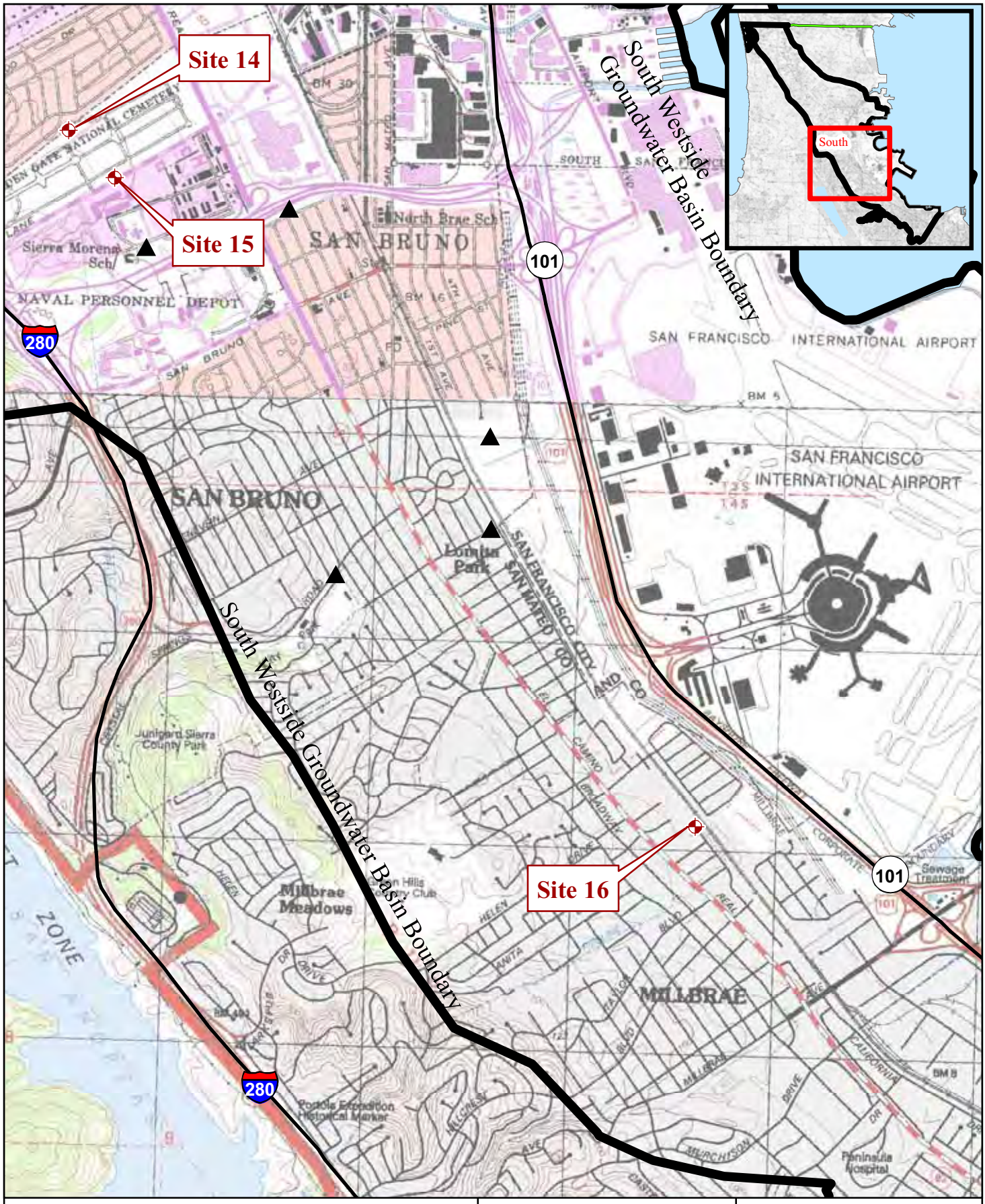
0 1,000 2,000
Scale Feet
1" = 2000'

Project Location Map-Central

Regional Groundwater Storage and Recovery Project

Figure 2

Source: SFPUC and Kennedy/Jenks



Legend

- Proposed Well Facility Sites
- Partner Agency Well
- South Westside Groundwater Basin

0 1,000 2,000
Scale Feet
1" = 2000'

Project Location Map-South

Regional Groundwater Storage and Recovery Project

Figure 3

Source: SFPUC and Kennedy/Jenks

groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would create new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of up to 7.2 million gallons per day (MGD) during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is a component of the SFPUC's proposed Water System Improvement Program (WSIP) (see www.sfwater.org). The basic goals of the WSIP are to increase the reliability of the regional water system with respect to water quality, seismic response, delivery, and water supply to meet water delivery needs in the service area. A Program EIR (PEIR) for the WSIP was certified by the San Francisco Planning Commission, and the WSIP was adopted by the SFPUC on October 30, 2008. The PEIR addresses the potential environmental impacts of the WSIP facilities on a programmatic level and evaluates regional water supply alternatives. The proposed Project, which is the subject of this NOP, is one component of the WSIP[2]; implementation of this proposed Project would contribute to meeting the WSIP's overall goals and objectives.

For purposes of the WSIP PEIR, the SFPUC's regional water system facilities were subdivided into six regions: Hetch Hetchy, San Joaquin, Sunol Valley, Bay Division, Peninsula, and San Francisco. The proposed Project would occur in the San Francisco Region.

2.0 PROPOSED PROJECT FACILITIES

The proposed Project facilities would consist of new groundwater production well facilities within the South Westside Groundwater Basin (Basin); the facilities are designed to withdraw up to 7.2 MGD from the volume of stored groundwater directly resulting from Project-related reduced groundwater

[2] The Regional Groundwater Storage and Recovery Project was listed as the Conjunctive Use Project in the PEIR.

pumping in the Basin by Partner Agencies during normal and wet years. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County to supply the needed withdrawal capacity. Well facilities would be connected to Daly City, San Bruno, Cal Water, or SFPUC distribution systems. In addition, the existing Westlake Pump Station in Daly City may need to be modified and treatment facilities may need to be added.

Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Each well facility would have a disinfection unit as required, unless it is near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities.

3.0 ENVIRONMENTAL REVIEW PROCESS

As described above, the San Francisco Planning Commission certified the WSIP PEIR in October 2008. The PEIR addressed the potential environmental impacts of the WSIP facilities on a programmatic level and evaluated regional water supply alternatives. The PEIR is available on the San Francisco Planning Department website at www.sfgov.org/planning/mea.

The San Francisco Planning Department will prepare a project-specific EIR to evaluate the environmental effects of the proposed Project. The EIR will be prepared in compliance with the CEQA Guidelines Section 15161 and will address project-specific construction and operational impacts.

The first step in the environmental review process is the formal public scoping process, for which this NOP has been prepared. Following the public scoping period, a Draft EIR will be prepared and circulated for a 45-day public review period. Public comments on the Draft EIR will be accepted in writing during the review period or verbally at a formal public hearing to be held by the San Francisco Planning Commission. The San Francisco Planning Department then will prepare written responses to comments on environmental issues raised during the public review period, and a Response to Comments document will be prepared. That document will be considered by the San Francisco Planning

Commission, along with the Draft EIR and any revisions to the draft based on the response to comments, for certification as a Final EIR.

4.0 PUBLIC SCOPING MEETING

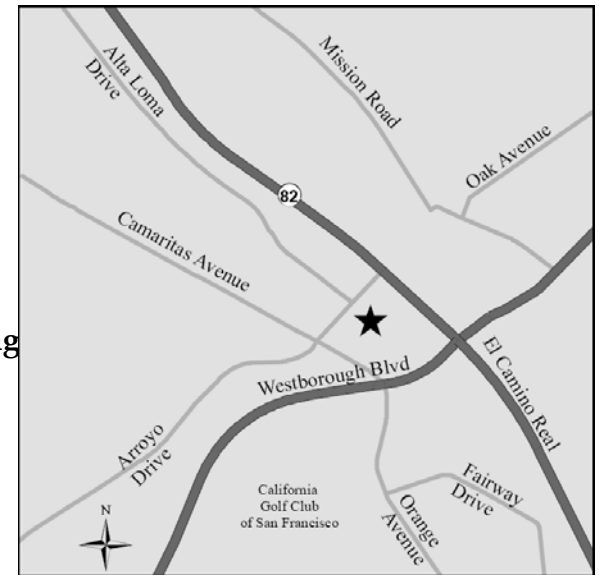
The San Francisco Planning Department will hold a public scoping meeting at the following location, date, and time.

DATE: Thursday, July 9, 2009

6:15-7:00 p.m. Informational Session

7:00 p.m. Scoping meeting

LOCATION:
South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, CA



The purpose of this meeting is to assist the Planning Department with its review of the proposed scope and content of the EIR as summarized in this NOP. The public will be given the opportunity to provide comment for consideration. The San Francisco Planning Department also will accept written comments on the scope of the EIR at the meeting or by mail, email, or fax until close of business (5:00 p.m.) on **July 28, 2009**. Written comments may be submitted by mail to the San Francisco Planning Department, Attn: Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409, or sent by email to diana.sokolove@sfgov.org.

5.0 PROJECT DESCRIPTION

5.1 Project Location

The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County as shown in Figures 1, 2, and 3. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin[3], which underlies both San Francisco and San Mateo counties. The Project is also located within the water service areas for the cities of Daly City, San Bruno, and Millbrae and within the Cal Water service area, which includes portions of South San Francisco, Colma, and unincorporated San Mateo County.

Groundwater well facilities would be constructed and operated at up to 16 locations in the cities of Colma, Daly City, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County (see Figures 1, 2, and 3). Well facilities would be connected to existing water distribution pipelines owned by Daly City, San Bruno, Cal Water, and SFPUC. The Project also includes an upgrade of the existing Westlake Pump Station in Daly City to serve the proposed new well facility sites.

5.2 Project Objectives

The proposed Project is a regional groundwater storage and recovery project that is part of the SFPUC's WSIP. The overall goals of the WSIP for the regional water system are to maintain high-quality water; reduce vulnerability to earthquakes; increase water delivery reliability; meet customer water supply needs; enhance sustainability; and achieve a cost-effective, fully operational system. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years. In addition,

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[3] The Westside Groundwater Basin extends from western San Francisco south into San Mateo County. The Basin has an area of approximately 40 square miles and underlies Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. The Westside Groundwater Basin has been administratively divided at the San Francisco County-San Mateo County line. This is a political boundary, not a physical boundary. The portion of the basin that lies within San Francisco County is referred to as the North Westside Groundwater Basin. The portion of the basin that lies within San Mateo County is referred to as the South Westside Groundwater Basin. The Project would occur solely within the South Westside Groundwater Basin.

the Project may provide some increased level of regional operational flexibility to respond and restore service under unplanned outages.

The specific objectives of the proposed Project are to:

- Cooperatively manage the South Westside Groundwater Basin through the coordinated use of SFPUC surface water and the groundwater pumped by the Partner Agencies;
- Provide increased SFPUC surface water to the Partner Agencies in normal and wet years, resulting in a reduction of groundwater pumping by these agencies and an increase in groundwater storage in the South Westside Groundwater Basin;
- Increase the pumping capacity from the South Westside Groundwater Basin by up to 7.2 MGD to supply water during dry years and emergencies; and
- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8½-year design drought cycle.

5.3 Proposed Project

The proposed Project is a groundwater storage and recovery project, which includes the operation of new groundwater production wells and associated distribution and treatment facilities. This section includes a description of these proposed Project components.

5.3.1 Groundwater Storage and Recovery

The Partner Agencies currently supply potable water to their customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide additional SFPUC surface water to the Partner Agencies during normal and wet years when sufficient surface water supplies are available. The Partner Agencies would reduce their groundwater pumping by a comparable amount and allow the groundwater basin to recharge naturally during these periods.

Figure 4 illustrates the increase in groundwater storage expected from a reduction in pumping during normal and wet years, as well the decrease in groundwater storage projected from an increase in pumping during dry years.

During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would naturally increase due to the reduced groundwater pumping, eventually reaching an increased storage volume of up to 61,000 AF. During dry or drought years, the Partner Agencies and SFPUC would pump previously stored groundwater. This new dry-year water supply would be made available to both the Partner Agencies and SFPUC wholesale customers under the terms of the Shortage Allocation Plan between the SFPUC and its wholesale customers[4]. A groundwater storage and recovery agreement would be negotiated by and between the SFPUC and Partner Agencies for groundwater and surface water management. Specifically, the agreement would cover water accounting; ownership principles; and operation, maintenance and replacement of facilities.

5.3.2 Production Wells and Associated Facilities

The proposed Project includes new groundwater production well facilities within the South Westside Groundwater Basin to withdraw the increased volume of stored groundwater at a rate of 7.2 MGD. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County. Of the 19 sites, 5 well facilities would connect to Daly City's distribution system, 3 well facilities would connect to San Bruno's distribution system, 4 well facilities would connect to Cal Water's distribution system, and 7 well facilities would connect to the SFPUC distribution system. In addition, the Westlake Pump Station in Daly City may be expanded and additional treatment facilities added.

Each groundwater well facility site would contain a groundwater production well, a pump station, underground distribution piping, and

[4] The Shortage Allocation Plan identified a water allocation method to be used to determine the share of water for wholesale customers during shortages caused by drought.

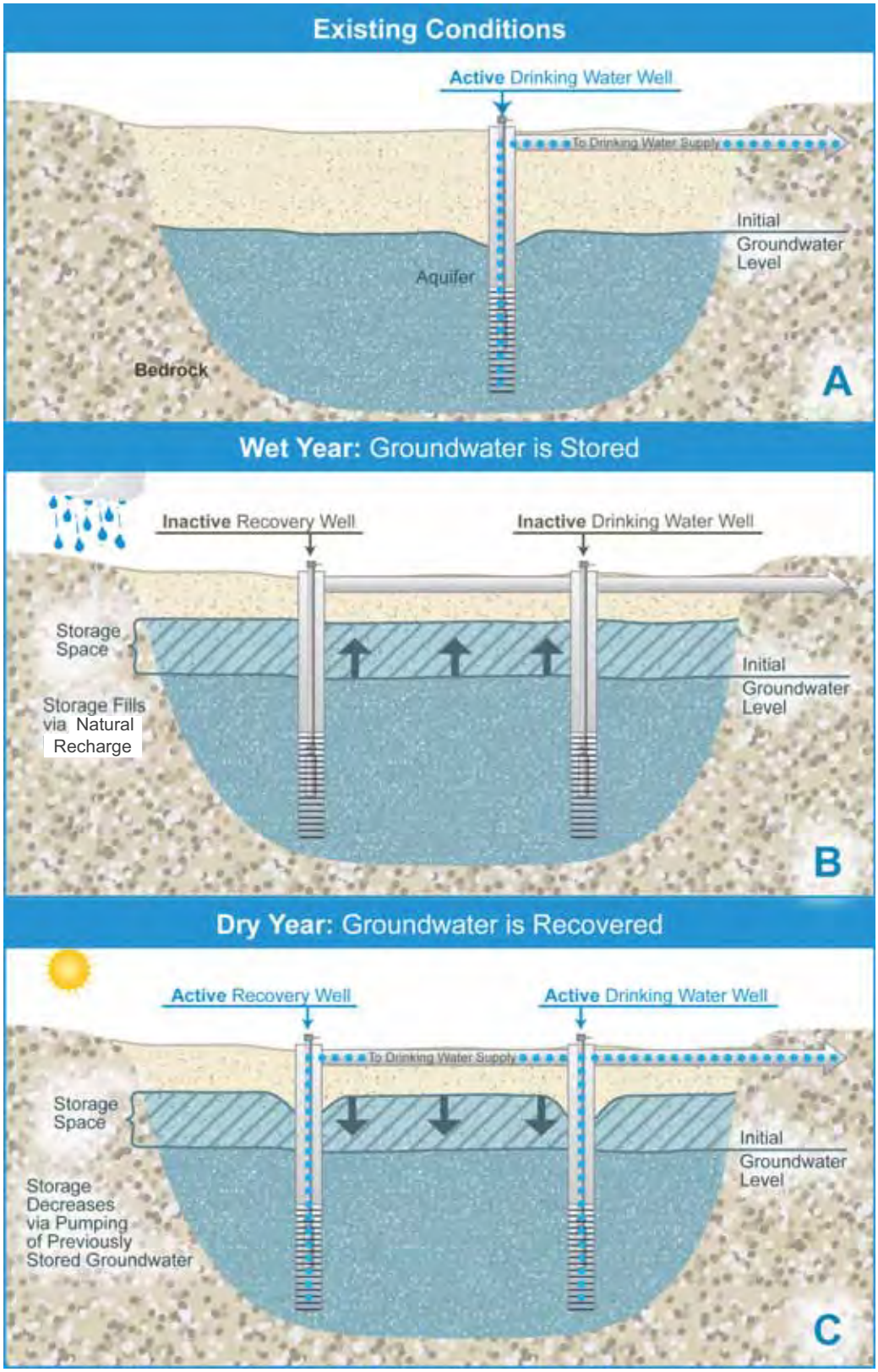

Figure (A) reflects the existing groundwater conditions, showing available storage space above the aquifer. In (B) the upward arrows represent the filling of the storage space with groundwater during wet years; in (C) the downward arrows represent the decline in stored water during dry years. The "Drinking Water Wells" represent the existing wells operated by the Cities of San Bruno and Daly City and California Water Service Company. The "Recovery Wells" represent the new wells that are proposed as part of the Project.

Groundwater Storage and Recovery

Regional Groundwater Storage and Recovery Project

Figure 4

utility connections. Each well facility also would have a disinfection unit, unless it is located near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities (e.g., disinfection and manganese treatment). The facilities and the nature, extent and anticipated duration of construction activities are described further below.

Prior to confirming the final selected sites and full development of the groundwater well facilities, monitoring wells and test wells may be installed at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. If selected, sites would be converted from test wells to permanent production wells; pumps would be added, well enclosures would be built (fencing or building), disinfection units and treatment facilities would be constructed as needed, and utility and distribution pipelines would be installed.

A list of the 19 potential well facility sites and pump station upgrade is provided in Table 1.

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
1	Lake Merced Golf Course	Daly City
2	Park Plaza Meter	Daly City
3	Ben Franklin Intermediate School	Unincorporated San Mateo County (Broadmoor)
4	Garden Village Elementary School	Unincorporated San Mateo County (Broadmoor)
5	Right-of-Way at Serra Bowl	Daly City
6	Right-of-Way at Colma BART	Daly City
7	Right-of-Way at Colma Boulevard	Colma
8	Right-of-Way at Serramonte Boulevard	Colma

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
8a	Standard Plumbing Supply	Colma
9	Treasure Island Trailer Court	South San Francisco
10	Right-of-Way at Hickey Boulevard	South San Francisco
10a	Alta Loma Drive	South San Francisco
11	South San Francisco Main Area	South San Francisco
12	Funeral Home	South San Francisco
12a	Funeral Home	South San Francisco
13	South San Francisco Linear Park	South San Francisco
14	Golden Gate National Cemetery	San Bruno
15	Golden Gate National Cemetery	San Bruno
16	Millbrae Corporation Yard	Millbrae
PS	Westlake Pump Station Upgrade	Daly City

a. The EIR will evaluate the environmental effects of the development of all 19 well facility sites, even though a maximum of 16 well facilities would be constructed.

Well Station Design

The SFPUC has considered institutional, regulatory, operational, maintenance, and technical information in the design of the well stations. Three well station types are included in the proposed Project:

- Type 1 - well only, building or fenced enclosure;
- Type 2 - well plus chemical treatment building; and
- Type 3 - well plus chemical treatment and filtration building.

Site-specific well station design characteristics are listed in Table 2 and described in detail below. These characteristics include proposed building type, pump type, water distribution system connection point, groundwater disinfection location, and the method that would be used to achieve agency-specific water quality goals (i.e., blending with surface water or treatment).

TABLE 2
Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
1	Lake Merced Golf Club	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Daly City	At site	Blending[b]
2	Park Plaza Meter	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
3	Ben Franklin Intermediate School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
4	Garden Village Elementary School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending or iron/manganese treatment
5	Right-of-Way at Serra Bowl	Type 2	Above-ground	Daly City	Cal Water	At site	Blending or iron/manganese treatment
6	Right-of-Way at Colma BART	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
7	Right-of-Way at Colma Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8	Right-of-Way at Serramonte Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8a	Standard Plumbing Supply	Type 2	Above-ground	Cal Water	SFPUC	At site	Blending
9	Treasure Island Trailer Court	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	None	At site	Blending

TABLE 2

Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
10	Right-of-Way at Hickey Boulevard	Type 2	Above-ground	Daly City	SFPUC San Andreas #2	At site	Blending
10a	Alta Loma Drive	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Cal Water	At site	Blending
11	SSF Main Area	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water	At site	Blending
12	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
12a	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
13	SSF Linear Park	Type 3	Above-ground	San Bruno	Cal Water, SFPUC, or other San Bruno	At site	Blending or iron/manganese treatment
14	Golden Gate National Cemetery	Type 1 with building enclosure	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
15	Golden Gate National Cemetery	Type 3	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
16	Millbrae Corp Yard	Type 2	Above-ground	SFPUC Crystal Springs Pipeline #2	None	At site	Blending

a. Type 1 is Well Only; Type 2 is Well plus Chemical Treatment Building; Type 3 is Well plus Chemical Treatment and Filtration Building; see text below for further description of conceptual layouts.

b. Blending is the mixing of groundwater with other potable supply water

Buildings would be about 15 feet tall and constructed of concrete block. Acoustical louvers for noise reduction would be used. The buildings would be painted in neutral colors with anti-graffiti coating.

It is anticipated that all outdoor site lighting would be activated by motion-controlled sensors, with manual switching available for as-needed night operations. Facilities would be designed to meet California's energy efficiency standards outlined in Title 24 of the California Code of Regulations and use recycled materials to the extent possible.

Type 1 Conceptual Layout: Well-Only. The conceptual layout for the "well-only" type includes an approximately 40-foot by 20-foot building or fenced enclosure to house the wellhead, pump, piping, and associated electrical and control equipment.

Type 2 Conceptual Layout: Well plus Chemical Treatment. The conceptual layout for the "well with chemical treatment" type would consist of a 40-foot by 20-foot building to house the wellhead, pump, pipeline, and associated electrical and control equipment, plus an approximately 15-foot by 15-foot building extension for chemical storage and handling. Space would be provided onsite for disinfection, pH adjustment, and fluoride addition if needed.

Type 3 Conceptual Layout: Well plus Chemical Treatment and Filtration. The conceptual layout for the "well with chemical treatment and filtration" type would be similar to Type 2 but with the addition of a filtration system. The building dimensions would be approximately 25 feet by 80 feet. Filtration would be located only at well facilities that require manganese and/or iron removal. This well station type would be larger than the other types to provide space for the wellhead, treatment facilities, and filtration vessels. The filtration system consists of a series of vertical pressure vessels. The number and size of the pressure vessels would depend on the well yield and the number of wells connected to the filtration system. The backwash water from the system would connect to a nearby sanitary sewer. It is anticipated that filters would be backwashed, on average, once a day for 4 minutes.

Well Pumps

Each well facility site would contain either a submersible or above-ground pump. The selection of the pump type is based on the preference of the Partner Agency responsible for well operation. In most cases, the wells would be equipped with above-ground pumps. In comparison to submersible motors, above-ground motors are more efficient, have a longer service life, are more durable in cases where variable frequency drives are required, and are more accessible and thus easier to maintain. In cases where noise, visibility, or lack of space is an issue, submersible pumps would be used. Submersible motors are quieter to operate, but more difficult to maintain, because maintenance requires the removal of the entire pump assembly. Any wells that are in fenced enclosures (i.e., without buildings) have been designated for submersible pumps.

Utility and Distribution Piping

Underground piping would connect the wells to the local distribution systems or SFPUC water distribution system. In addition, underground piping would connect well facilities to the storm drain system and/or the sanitary sewer system to allow discharge of the initial flush of water. Chloraminated water would be de-chlorinated or sent to the local sanitary sewer system. Backwash from the manganese treatment facilities would also be sent to the local sanitary sewer system. The piping for all selected sites would consist of a total of approximately 4,600 feet of 6-inch pipe and 12,500 feet of 8-inch pipe. In general, the pipeline route would be excavated to a depth of 6 feet. The maximum width of the pipeline work area (including the trenches) would be 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Above or underground electrical lines would also be installed from the groundwater well facilities to the nearest power source (PG&E facilities). The dimension of the trenches for the underground electrical lines would be smaller than those of the water pipelines.

Westlake Pump Station Upgrade

Upgrades to the Westlake Pump Station may be necessary to serve the well stations at Sites 2, 3 and 4. The upgrades would include new chemical storage tanks, replaced or upgraded chemical metering pumps, a resized

transformer, and up to three new booster pumps to deliver the additional water into the distribution system.

5.3.3 Construction Methods

Monitoring Wells, Geotechnical Borings, and Test Wells

Prior to the selection and full development of the groundwater production well sites, monitoring wells and test wells may be installed and geotechnical borings may be drilled at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. Depending upon the results of the testing, well facility sites would be selected, and test wells converted to permanent production wells, which would consist of full development of the well facility site to include the addition of pumps to the wells, the addition of enclosures around the well, installation of disinfection units and treatment facilities as needed, and installation of utilities and distribution pipelines.

In the event that additional monitoring or test wells are needed, the selected site would need to be cleared of vegetation and graded for installation and drilling of the borehole. For monitoring wells, a borehole would be drilled to a depth of approximately 750 feet below ground. For test wells, one steel casing would be installed to a depth of approximately 50 feet, with a borehole drilled to a depth of approximately 550 to 700 feet. Equipment used for well drilling and construction would include a mounted drill rig on a support truck, pump and pick up trucks or trailers and similar equipment. Construction of a monitoring well would be completed in approximately three weeks, with construction activities occurring between 8:00 AM and 7:00 PM Monday through Friday only. Construction and testing of test wells would require approximately 4 weeks. Drilling would extend for about a week both during the day and night. If the results of the test wells were favorable and the wells were selected as permanent production well sites, then development of production well facilities would occur, as described below.

Additional geotechnical borings may be required and would be drilled to a depth of approximately 50 feet below ground surface (deeper if fill or soft soil is encountered). A boring would be completed in approximately two days. Drilling activities would occur between 8:00 AM and 7:00 PM Monday through Friday only.

Construction of Well Station Facilities

Each well facility site would include a construction staging area; some sites may have two optional locations for staging areas. The minimum size of the staging area would be 1,500 square feet. Staging areas would be fenced. Any temporary spoils (excavated material) storage would occur inside the staging areas.

Construction of facilities at the well sites would require site clearing and grubbing. Site excavation and grading would be minor, with grading to a maximum depth of 5 feet for the building foundation (if the well facility includes a building) and utilities underneath the building. After the foundation and utilities connections are constructed, the remainder of the building would be constructed and the well pump and other equipment installed, as needed. No significant near-surface groundwater is expected at any site; therefore dewatering for construction of project facilities is not anticipated. Diesel generators with self-contained fuel tanks may be used during construction. Construction equipment is expected to include: a front end loader, backhoe/excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, and arc welder.

It is estimated that during the peak construction period, the maximum number of construction workers at any one site would be 15.

Construction of Distribution and Utility Connections

In general, the pipeline routes would be excavated up to a depth of 6 feet. The width of pipeline construction zones would be generally 20 feet, and the width of the electrical connection construction zones would be less than 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Construction equipment is expected to include: an excavator, front-end loader, hauling trucks, compactor, asphalt trucks, and arc welder. Diesel generators with self-contained fuel tanks may be

used during construction. At some sites, pipeline excavation would generate excess soil (called spoils) that would be reused onsite (for engineering fill) or disposed of at a Class III non-hazardous waste disposal site. After pipeline placement, the trenched area would be restored to its original condition.

5.3.4 Operation and Maintenance

Project operations would be designed to allow natural recharge of the South Westside Groundwater Basin through reduced Partner Agency groundwater pumping, to provide up to 61,000 AF of increased groundwater in storage to be used by the SFPUC and Partner Agencies during drought conditions.

Figure 5 illustrates how the Project would change the source of water supply for the Partner Agencies. During normal and wet years, the portion of water supply coming from SFPUC surface water would increase compared to the existing condition. During dry years, the portion of water supply coming from groundwater would increase compared to the existing condition. For SFPUC wholesale water customers, the source of water supply would not change during normal and wet years; but the portion of groundwater delivered to some SFPUC customers would increase during dry years, compared to existing conditions.

An accounting of additional storage volumes (called the SFPUC Storage Account) would track the amount of water that has been stored during the normal and wet years and the amount of water pumped during dry years. The specific volumes shown in Figure 5 are based on historic rainfall and hydrology (MWH, 2007), but actual volumes in any given year would vary depending on several factors, including: 1) the final location and capacity of the project well facilities, 2) the availability of additional stored water in the SFPUC Storage Account, and 3) direction from the Operating Committee[5] regarding which wells should be used.

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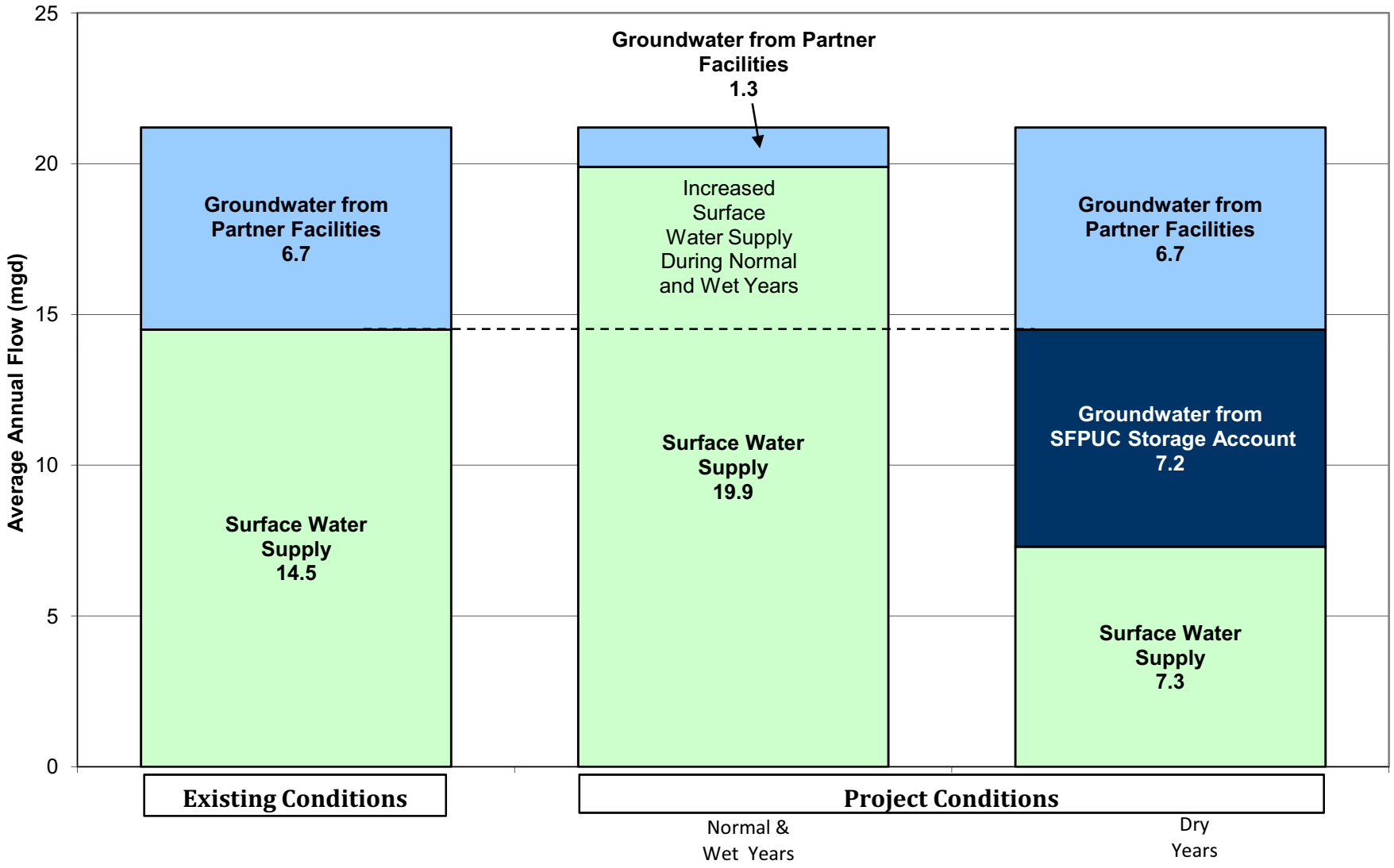
[5] It is expected that a Project agreement by and between SFPUC and the Partner Agencies would establish an Operating Committee. The role of the Operating Committee would be to monitor and track the SFPUC Storage Account, including any losses from the system, and establish pumping schedules for the project wells.



Groundwater from Partner Facilities [1]
Groundwater from Storage Account
Surface Water Supply

[1] Partner facilities are operated by City of Daly City, City of San Bruno, and Cal Water.

Source of Water Supply for Partner Agencies

Regional Groundwater Storage and Recovery Project

Figure 5

During normal and wet years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies only periodically for maintenance purposes. During dry years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies for additional water supply.

All well stations would be unmanned, but subject to remote monitoring and operation by the Partner Agency or SFPUC who would operate the well facility. Each well station would be visited daily when wells are operating for routine equipment checks, lasting approximately 30 minutes each. During normal and wet years, wells would be visited on a weekly basis, would be normally off, but regular exercising would be conducted. Longer term maintenance would include removal and repair or replacement of pumps, valves, and other equipment. Production wells may require redevelopment and/or rehabilitation on an infrequent basis.

6.0 PERMITS AND APPROVALS REQUIRED

The SFPUC may be required to obtain the following permits and approvals for Project construction and operation:

- Section 404 Permit from the U.S. Army Corps of Engineers (USACE) if the Project affects jurisdictional wetlands or waters of the U.S.
- U.S. Department of Veterans Affairs approval and National Environmental Policy Act (NEPA) review for Sites 14 and 15 at the Golden Gate National Cemetery.
- U.S. Fish & Wildlife Service Section 7 consultation under the federal Endangered Species Act, if the Project affects threatened or endangered species or their habitat.
- Review by the Advisory Council on Historic Preservation may be required if the Project affects properties listed on or eligible for the National Register of Historic Places.
- Permit amendments and approval of well construction and operation from the California Department of Public Health, Water Supply Division.
- Section 1602 Lake and Streambed Alteration Agreement from the California Department of Fish and Game if the Project could affect streambeds under California jurisdiction.
- Section 2081/2080.1 Incidental Take Permit from the California Department of Fish and Game if a "take" (to hunt, pursue, catch, capture,

or kill, or attempt the same) could occur to state-listed species as a result of the Project.

- California Department of Fish and Game Memorandum of Agreement if needed to ensure no effect to fully protected species.
- Preparation of a California Department of Toxic Substances Control Contaminated Soil Treatment Work Plan (required only if contaminated soil is encountered during construction).
- San Francisco Bay Regional Water Quality Control Board Discharge permits, if required, for emergency and/or maintenance water discharges, and for "overboard" pumping of well waters.
- San Francisco Bay Regional Water Quality Control Board Section 401 Certification, the state certification of the federal Section 404 Wetlands Permit.
- California Department of Transportation Encroachment permits to cross State roadways and Interstate Highways.
- State Water Resources Control Board Stormwater General Permit and Stormwater Pollution Prevention Plan, if more than one acre of land is disturbed.
- Bay Area Air Quality Management District permit for stationary equipment that may generate air pollutants (e.g., generators).
- EIR certification by the San Francisco Planning Commission.
- Board of Supervisors approval may be needed for funding appropriation or property rights acquisition.
- SFPUC approval, adoption of CEQA findings and mitigation monitoring and reporting program (MMRP).
- Adoption of CEQA findings and MMRP by local City Councils or Boards of Supervisors.
- San Francisco Historic Preservation Commission review of local, state and national landmarks and historical landscapes.
- Determination of Project consistency with park use by local Recreation and Park Commissions and approval of use of property under their jurisdiction.
- Approval of local Unified School District(s) for use of property under their jurisdiction.
- Approval of exterior design of proposed facilities on SFPUC property or right-of-way by the San Francisco Arts Commission.
- Agreements with Partner Agencies.
- Local Department(s) of Public Health approval of well construction and operation permits in accordance with California Department of Water Resources Standards.

- Local Department(s) of Public Health approval of Certified Unified Program Agencies (CUPA)/Hazardous Materials Business Plan for Project operations.
- Local Department(s) of Public Works approval of excavation permits, encroachment permits, and temporary occupancy permits for street space.
- Bay Area Rapid Transit (BART) encroachment permits to cross existing BART system.

7.0 PROPERTY RIGHTS ACQUISITION

Several types of property rights would be needed for Project construction and operation, as shown in Table 3. The process for acquiring right-of-way involves the preparation of deed and appraisal map, an appraisal of fair market value, negotiations with property owners, and condemnation (if necessary).

TABLE 3
Property Rights Proposed for Acquisition

Property Acquisition Type	Rights
Access Easement	Temporary or permanent rights to enter or cross another property
Pipeline Easement	Rights to install and maintain a pipeline over or across another property
Fee Acquisition	Purchase of all the property rights, land, improvements (if any), etc.
Encroachment Permit	Rights to encroach across a publicly-owned street or highway for pipeline or other purposes

Of the 19 potential well sites, 12 sites are on SFPUC fee-owned land or within SFPUC right-of-way. The other seven well sites are on other public and private parcels which would require an acquisition of property use rights for the well(s), connecting pipelines, and/or access. Lastly, several sites have lengthy connecting pipeline requirements that would most likely be constructed on a combination of public and private parcels.

8.0 CONSTRUCTION SCHEDULE

The proposed Project schedule expected at the time of this NOP includes construction of permanent well facilities and pipeline connections from April 2012 through approximately May 2014.

9.0 ENVIRONMENTAL ANALYSIS

9.1 Environmental Issues to be Addressed in the EIR

The EIR will address all environmental issue areas required under CEQA. The EIR will address environmental impacts of the proposed Project due to construction and operation activities and will propose mitigation measures for impacts considered to be significant. The following sections describe the anticipated environmental issues that will be addressed by the EIR.

9.1.1 Land Use and Visual Quality

Construction and operation of the proposed Project could affect land uses and visual quality of the Project sites and surrounding areas. Potential impacts to be evaluated in the EIR include:

- Temporary and permanent disruption or displacement of existing land uses during construction including construction impacts on such sensitive land uses as schools, residences and funeral homes, and the potential temporary closure of a portion of South San Francisco Linear Park to the public.
- Impacts on scenic vistas or visual character, including potential impacts on the visual character of Golden Gate National Cemetery, Woodlawn Cemetery, Greenlawn Memorial Park, and Lake Merced Golf Club.

9.1.2 Geology, Soils and Seismicity

Construction and operation of new well facilities and below-ground distribution pipelines and electrical power lines could result in site-specific impacts on or from local geology and soils conditions. Potential impacts to be evaluated in the EIR include:

- Seismic hazards and/or increased exposure of people and structures to seismic hazards, including impacts from ground-shaking in the event of an earthquake on the San Andreas fault or other Bay Area fault.
- Increased exposure of people or structures to geologic hazards (such as liquefaction, poor soil conditions, or unstable slopes) from construction in geologic hazard zones.
- Soil erosion potential from construction activities.
- Potential land subsidence from drawdown of the groundwater aquifer.

9.1.3 Hydrology and Water Quality

Construction and operation of the Project could affect surface water quality and could affect groundwater levels and quality in the Project area and in the South Westside Groundwater Basin as a whole. Potential impacts to be evaluated include:

- Changes in local groundwater quality and levels within the South Westside Groundwater Basin as a whole.
- Changes in drinking water quality due to use of treated groundwater.
- Alteration of drainage patterns and increase in stormwater flows due to increase in the amount of impervious surfaces.
- Degradation of surface water quality as a result of erosion and sedimentation, hazardous materials release during construction, and construction dewatering discharges.

9.1.4 Biological Resources

The proposed Project could result in a permanent loss of wetlands and sensitive habitats and could directly impact special-status wildlife and plant species. Temporary impacts to biological resources could result from proximity to construction activities, including noise, vibration, and dust. Potential impacts to be evaluated include:

- Impacts on wetlands and aquatic resources.
- Impacts on sensitive wildlife habitats and protected/heritage trees.
- Impacts on special-status wildlife and plant species – direct mortality and/or habitat effects.
- Conflicts with adopted conservation plans or other approved biological resources plans.

9.1.5 Cultural Resources

The proposed Project could affect archaeological, historical, or paleontological resources through ground-disturbing activities during construction, or by introducing new facilities that compromise the historic integrity of historic buildings or landscapes. Potential impacts to be evaluated include:

- Impacts on archaeological and paleontological resources.
- Impacts on the historical significance of a historic district, contributor to a historic district, or historic landscape. Of particular focus will be the proposed well facilities on 1920s Lake Merced Golf Club; the turn of the century Woodlawn Cemetery, the Cypress Lawn Cemetery, and the Golden Gate National Cemetery.
- Impacts on Native American cultural resources.

9.1.6 Traffic, Transportation and Circulation

Construction could have temporary impacts on traffic volumes, traffic safety, and parking in the vicinity of the well facility sites and at the Westlake Pump Station. Potential impacts to be evaluated EIR include:

- Temporary reduction in roadway capacity and increased traffic delays, including impacts from short-term closure of one parking and/or traffic lane. Impaired access to adjacent roadways and land uses.
- Temporary displacement of on- or off-street parking.
- Increased traffic safety hazards during construction.
- Long-term traffic increases during facility operation.

9.1.7 Noise and Vibration

Construction noise and vibration impacts from the proposed Project would be associated with facility construction activities, and therefore, would be temporary and short-term. Operation of the proposed pumps and treatment facilities could create permanent noise impacts. Potential impacts to be evaluated include:

- Impacts of construction noise and vibration on sensitive receptors in the vicinity of Project construction sites, especially such sensitive land uses as schools, health care facilities, cemeteries, funeral homes, and churches.
- Noise impacts from groundwater well station operation, including pumps and groundwater treatment facilities.

9.1.8 Recreational Resources

Construction could temporarily disrupt recreational uses in the vicinity of the well facility sites as a result of noise, dust, and temporary access restrictions. The EIR will evaluate the impact of the Project on recreational resources. Potential impacts to be evaluated include:

- Temporary and permanent impacts on recreational facilities, including but not limited to Lake Merced Golf Club and Linear Park in South San Francisco.

9.1.9 Other Environmental Issues

Other environmental issues that will be evaluated in the EIR include the Project's potential impacts on air quality and greenhouse gas emissions; public services and utilities, including the Project's beneficial effect on water supply; agricultural resources; hazards, including the potential hazards from chemical storage at the well sites; and energy resources.

The EIR also will evaluate any potential growth-inducing impacts that could result from implementation of the Project. The EIR also will address whether the Project could result in impacts that would be significant when combined with the impacts of other SFPUC or non-SFPUC projects occurring in the same geographic area as the Project and at the same time.

9.2 Alternatives

CEQA requires that an EIR evaluate a reasonable range of feasible alternatives to the project, or to the location of the project, that would attain most of the basic project objectives but that could avoid or substantially lessen any of the significant effects of the project. The EIR will identify the potentially significant impacts of the proposed Project. The findings of the EIR impact analysis will guide the refinement of an appropriate range of alternatives to be evaluated in the EIR that would avoid or substantially lessen significant impacts, while still meeting the project objectives. Alternatives suggested during the public scoping period would also be considered. The EIR will include a discussion of impacts associated with the No Project Alterative.

10.0 REFERENCES

MWH. 2007. Final Alternatives Analysis Report, Groundwater Conjunctive Use Project. October.

MWH. 2008. San Francisco Public Utilities Commission Water System Improvement Project Groundwater Conjunctive Use Project WSIP Project CUW30103 Conceptual Engineering Report. November.

SFPUC. 2005. 2005 Urban Water Management Plan for the City and County of San Francisco. December.

SFPUC. 2009. Conceptual Engineering Report Checklist for Environmental Review. February.

City of San Francisco Planning Department. Program Environmental Impact Report for the San Francisco Public Utilities Commission's Water System Improvement Program (State Clearinghouse No. 2005092026). 2008. September.

San Francisco Public Utilities Commission
Water System Improvement Program
Groundwater Conjunctive Use Project
WSIP Project CUW30103

Final
Alternatives Analysis Report
Prepared under Contract CS-826

Final Report
October 2007

Preface

This document is the result of a multi-agency collaborative effort to improve the Bay Area's dry-year water supply. The South Westside Basin is an important local drinking water resource for the cities of Daly City, San Bruno, and South San Francisco. This report evaluates the potential to also use a portion of the Basin to store water for dry years. The groundwater storage component occurs by reducing the municipal groundwater pumping in normal and wet rainfall years and purchasing supplemental surface water from the SFPUC. This so called "in-lieu" recharge will increase the volume of water in storage during normal and wet years that can be pumped in dry years.

Staff from the California Water Service Company, the City of Daly City, the City of San Bruno and the San Francisco Public Utilities Commission have combined efforts to help prepare this Conjunctive Use Alternatives Analysis Report. The Alternatives Analysis process consisted of identifying and ranking new groundwater well locations that would be constructed to pump the stored water in dry years. Future activities that need to occur prior to project implementation include developing formal Conjunctive Use agreements between the SFPUC and California Water Service Company, the City of Daly City, and the City of San Bruno. In addition, the Conjunctive Use project is subject to review under the California Environmental Quality Act. Therefore, given the need to complete these additional activities prior to project implementation, the projects described in this document should be considered preliminary.

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List of Acronyms

AAR	Alternatives Analysis Report
AF	acre-feet
AFY	acre-feet per year
ASR	aquifer storage and recovery
BART	Bay Area Rapid Transit
ccf	hundred cubic feet
CER	Conceptual Engineering Report
DHS	California Department of Health Services
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EKI	Erler and Kalinowski, Inc.
FEMA	Federal Emergency Management Agency
GIS	geographical information system
gpm	gallons per minute
LSCE	Luhdorff and Scalmanini Consulting Engineers
MCL	maximum contaminant level
mg/L	milligrams per liter
MGD	million gallons per day
MTBE	Methyl t-butyl ether
NCCWD	North Coast County Water District
PCE	tetrachloroethylene
psig	pounds per square inch gage
SFIA	San Francisco International Airport
SFPUC	San Francisco Public Utilities Commission
SMCFCD	San Mateo County Flood Control District
TDS	total dissolved solids
ug/L	micrograms per liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WSIP	Water System Improvement Program

Acknowledgments

MWH greatly appreciates the contributions from individuals within SFPUC, the Partner Agencies, and their consultant teams for their guidance and contributions to this document in the form of:

- Identifying potential facility locations
- Providing electronic information enabling MWH to more quickly evaluate, understand and display information
- Providing comments during development of the AAR
- Improving our understanding of basin conditions
- Providing input on the current operation and performance of wells and groundwater treatment systems within the Basin

We especially would like to acknowledge the following individuals:

- Greg Bartow, SFPUC Project Manager
- Frank Kukula, SFPUC Operations Liaison
- Alan R. Wong, SFPUC Water Quality Bureau Representative
- Sam Young, SFPUC Regional Engineer
- Husam Masri, SFPUC Regional Project Manager
- Mike Weisenberger, SFPUC Operations
- Obiajulu Nzewi, SFPUC Water Resources Planning
- Debra Temple, SF Department of Public Works Project Engineer
- Josh Milstein, City and County of San Francisco
- Anne Schneider, Ellison, Schneider & Harris
- Joe Scalmanini, LSCE
- Thomas Elson, LSCE
- Will Halligan, LSCE
- Les Chau, Kennedy Jenks
- Steve Pallad, Kennedy Jenks

Partner Agencies

- Patrick Sweetland, City of Daly City
- Mark Baker, City of Daly City
- Pamela Thompson, City of San Bruno
- Steve Davis, City of San Bruno
- Tom Salzano, Cal Water
- Erin McCauley, Cal Water
- Jeff Yarne, Yarne & Associates
- Ali Taghavi, WRIME
- Jim Blanke, WRIME

We also wish to acknowledge the MWH team and our teaming partners who provided invaluable support during the develop of the AAR, these include,

- Chris Petersen, MWH
- Stefani Harrison, MWH
- Matthew Holt, MWH
- Ping Chen, MWH
- James Darke, MWH
- Janet Atkinson, MWH
- Rob Talavera, Talavera and Richardson (GIS Support)
- Dennis Wong, AGS Consulting (Facility Design and AutoCad Support)
- Martin Lee, M. Lee Corporation (Construction cost estimation)

EXECUTIVE SUMMARY

Scope of Project and Goals

The objective of the South Westside Groundwater Basin (Basin) Conjunctive Use Project is to develop a new dry-year groundwater supply that can be utilized at a rate of 8,100 acre-feet per year over a design 7.5-year drought cycle. This project objective forms the basis of design criteria, to be developed in the Conceptual Engineering Report.

This project is being developed through the coordination of San Francisco Public Utilities Commission (SFPUC) and three Partner Agencies (California Water Service Company [Cal Water], the City of Daly City [Daly City] and the City of San Bruno [San Bruno]), as shown on Figure ES-1, who purchase wholesale water from SFPUC's regional surface water system. Water will be stored in the aquifer through reduced pumping by the Partner Agencies made possible by the provision of SFPUC supplemental surface water supplies in wet and normal years. The program would ultimately develop enough groundwater pumping capacity to produce 8,100 acre-feet per year (AFY), or 7.2 million gallons per day (MGD), in addition to groundwater extraction from existing Partner Agency wells. The project will be designed to provide up to 61,000 acre-feet (AF) of stored water from Conjunctive Use wells to meet SFPUC system demands during the last 7.5 years of SFPUC's design drought. The combined pumping rate of 7.2 mgd and pumping duration of 7.5 years are based on estimates that were developed to meet the SFPUC's 2030 dry-year demands as described in the Urban Water Management Plan (SFPUC, 2005b). For storage size comparison, this 61,000 acre-foot groundwater conjunctive use project is midway in size between the San Antonio Reservoir (50,500 AF) and Crystal Springs Reservoir (69,300 AF).

Construction for the Groundwater Conjunctive Use Project, which is part of the San Francisco Public Utilities Commission (SFPUC) Water System Improvement Program (WSIP), is scheduled to begin in the fourth quarter of 2010 and be fully completed by the third quarter of 2013. All the wells may be constructed in one phase. The projected additional water resources shown above represent increased storage of groundwater in the Basin. Table ES-1 shows the Groundwater Conjunctive Use Project schedule. The conceptual engineering services under this contract will complete the planning phase.

Table ES-1. Groundwater Conjunctive Use Project Schedule

Phase	Start	Finish
Planning (Current Project Phase) *Alternatives Analysis Report* *Conceptual Engineering Report*	16-Jun-2003 *26-Oct-2007* *11-July-2007*	15-Jan-2008 *28-Sep-2007* *15-Jan-2008*
Environmental	2-Jan-2008	28-Aug-2009
Design	5-Dec-2008	8-Apr-2010
Bid & Award	9-Apr-2010	8-Oct-2010
Construction	12-Oct-2010	27-Aug-2013
Closeout	28-Aug-2013	27-Feb-2014

In 2002, Cal Water, Daly City and San Bruno began a pilot study to reduce groundwater pumping. Between 2002 and 2005 their water supply was supplemented with additional surface water purchased from the SFPUC, allowing natural rainwater recharge to accumulate in the subsurface aquifer, and increasing the volume of water in storage in the South Westside Groundwater Basin. Since 2005 the pilot project has continued on a more limited basis. In late March 2007 the SFPUC entered into more detailed discussions with Cal Water, Daly City and San Bruno about a long-term Conjunctive Use Program agreement. As of January 31, 2007, 16,860 acre-feet of water (5.5 billion gallons) have been stored for use in a future drought or emergency in the South Westside Groundwater Basin through this joint groundwater pilot study between the SFPUC, Cal Water, Daly City and San Bruno.

Groundwater Basin Description

The South Westside Groundwater Basin has an area of approximately 31 square miles and underlies Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame (SFPUC, 2005a), as shown in Figure ES-1. The San Bruno Mountains bound the Basin on the east. Its southern limit is defined by bedrock that separates it from the San Mateo Plain Groundwater Basin near Burlingame (DWR website, accessed 2006). The Basin opens to the Pacific Ocean on the northwest and San Francisco Bay on the southeast (Phillips et. al, 1993). Although some maps of the Basin define the western boundary along the San Andreas Fault and Pacific Ocean, the western boundary used for this report roughly follows the surface contact between the Merced Formation and the Colma Formation. This boundary is reportedly based on alluvial formations identified by Eugene Yates (HydroFocus, 2003). This area does not include any land in the City of San Francisco; the North Westside Basin's groundwater resources are addressed separately as part of Groundwater Sub-Project B (SFPUC, 2006).

Groundwater pumping in the Basin includes municipal supply for Daly City, South San Francisco, and San Bruno, and irrigation of golf courses and cemeteries. Documented municipal supply and irrigation wells are shown on Figure ES-2. The total depth of municipal and

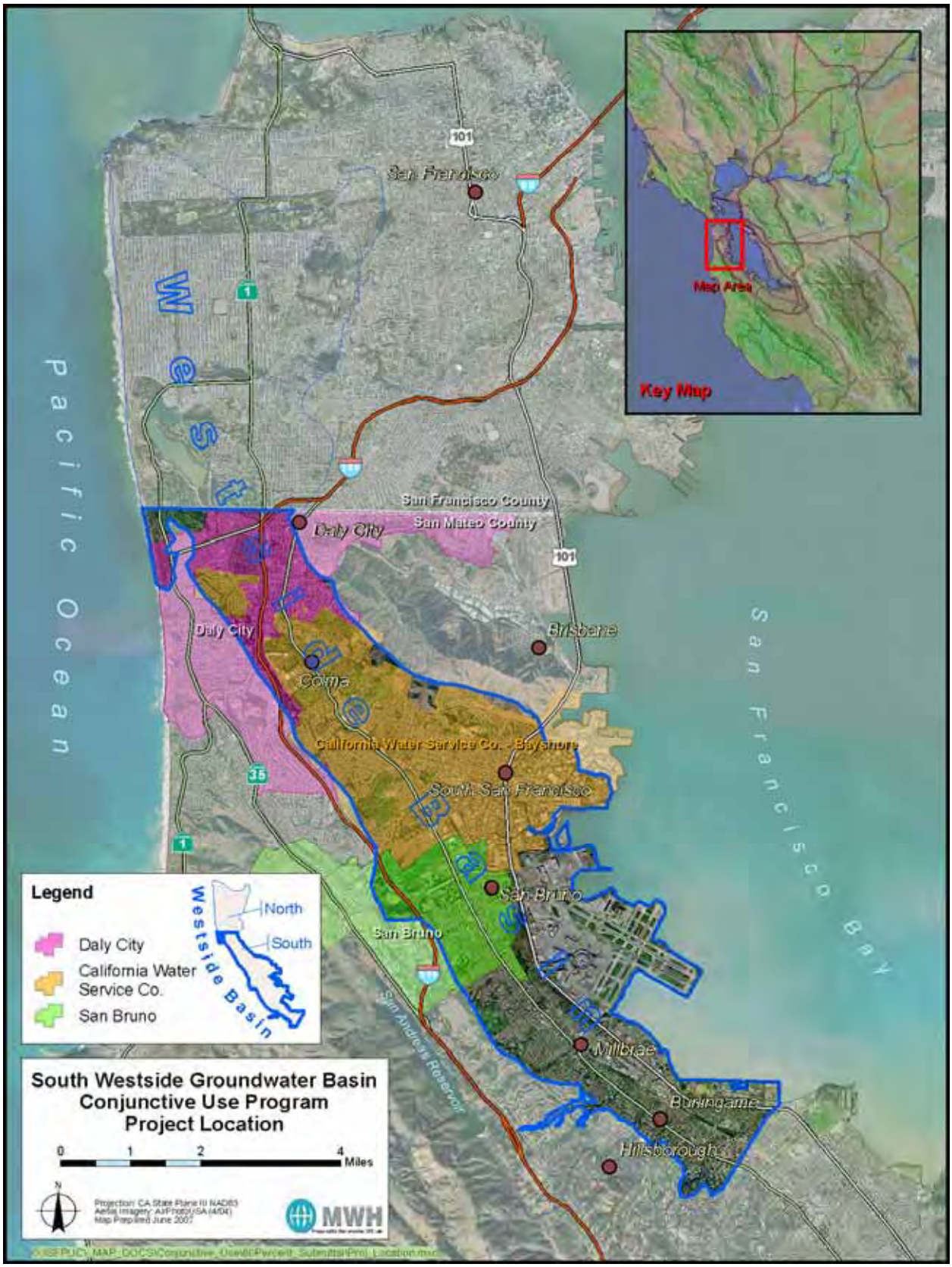

Figure ES-1
Project Location

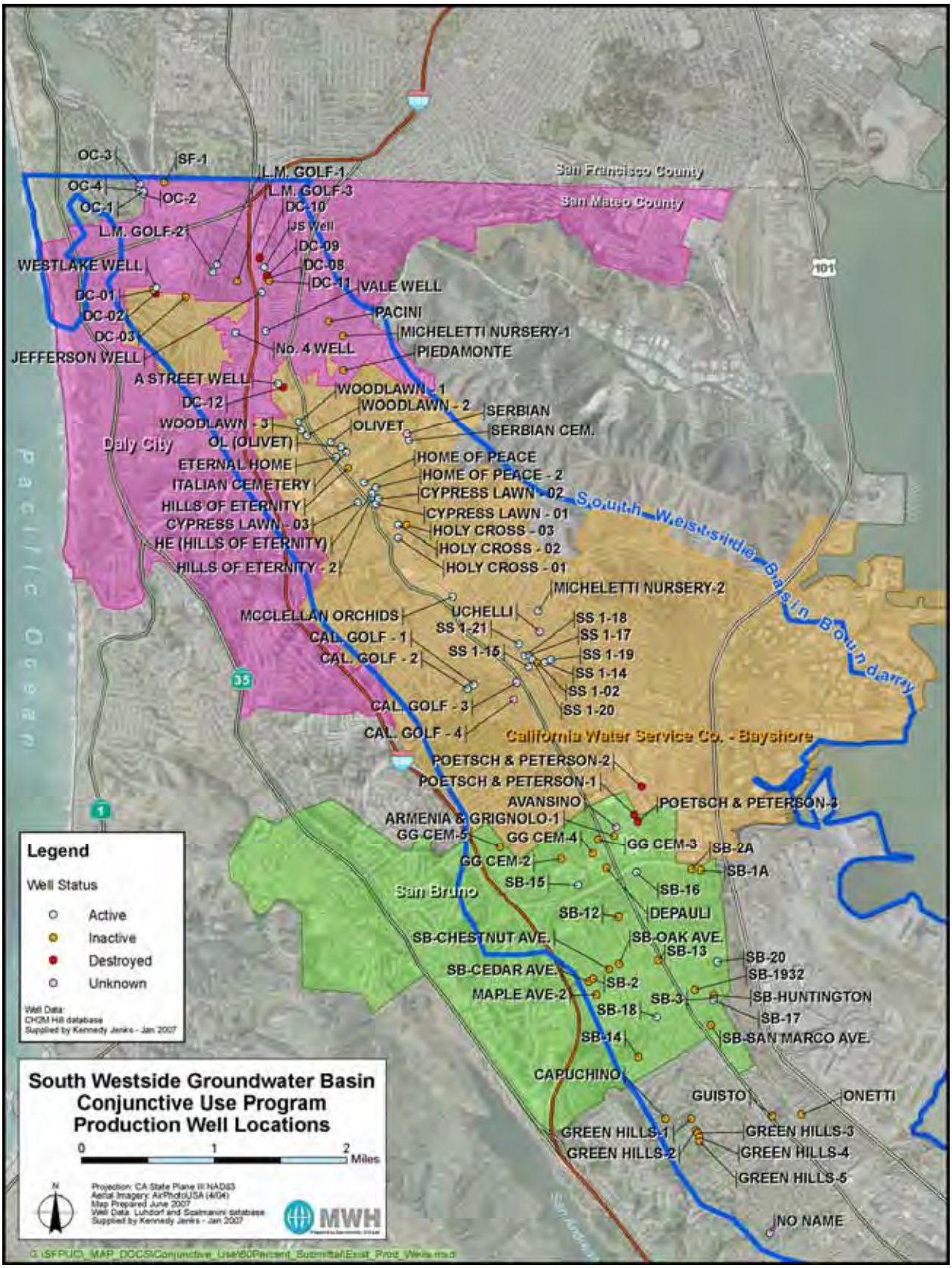

Figure ES-2
Production Well Locations

irrigation wells in the South Westside Basin ranges from 200 to 640 feet (CH2M Hill, 1997; CAL WATER, 2006; EKI, 2007).

Approach to Alternatives Analysis

The purpose of this Alternatives Analysis Report (AAR), in part, is to identify and evaluate potential sites for the facilities needed to support this project. The effort is an iterative process that is illustrated in Figure ES-3.

The first steps involved identifying evaluation criteria and using a geographical information system (GIS) to characterize the Basin and create maps of evaluation criteria. The following is a listing of broad categories of evaluation criteria considered in selection preferred facility locations:

- Well Site Suitability - Including access to the site, footprint on the site, underground obstructions and horizontal setback distances.
- Groundwater System Considerations – Including potential well yield, groundwater quality, well interference, and geologic stability.
- Distribution System Considerations – Including proximity to existing Partner Agency and SFPUC conveyance and treatment facilities.
- Land Use Consideration – Such as land ownership, property acquisition, ease of permitting, and local acceptance.

Candidate well sites were identified, screened for suitability, displayed on criteria maps, and appraised with respect to the evaluation criteria. Preferred well sites were selected and analyzed using a hydraulic model of the water distribution system to evaluate whether the respective water systems can take the estimated additional water at each proposed location.

The AAR was developed in close coordination with SFPUC and the Partner Agencies. Key project meetings are listed below and the timing, relative to other AAR activities, is illustrated on Figure ES-3:

- Kick-Off Meeting at beginning of AAR
- Partner Agency Meeting following completion of 30% AAR
- Partner Agency Meeting following completion of 60% AAR
- Individual Partner Agency Meetings, to fill remaining data gaps, during development of Draft AAR.
- Partner Agency Meeting following completion of Draft AAR

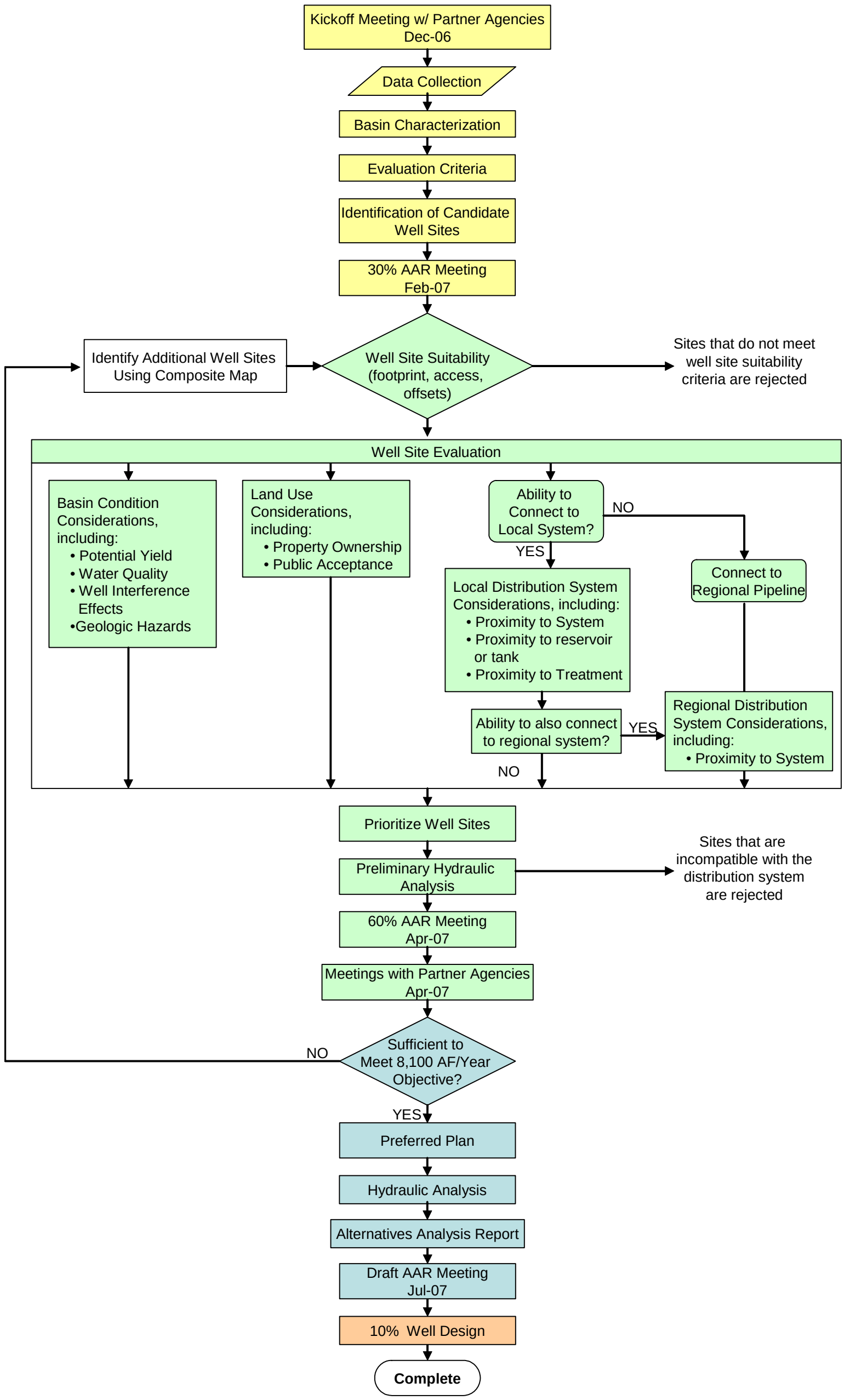

Figure ES-3
Approach to Alternatives Analysis

Alternatives Analysis and Selection of Preferred Plan

A total of 48 potential well locations were developed based on input from SFPUC, the Partner Agencies, and a series of six field visits by MWH occurring between November 2006 and May 2007. These preliminary candidate well locations are shown on Figure ES-4. The evaluation criteria listed above were then applied to these preliminary well locations and a prioritized list of well locations was developed. A preferred project plan was developed from this prioritized listing and is listed in Table ES-2. The preferred plan also includes the following information, also listed in Table ES-2:

- Estimated production range
- Connection to either the Partner Agency or SPFUC system, and
- Anticipated treatment required

This preferred plan will meet the goal of 8,100 acre-feet per year over a design 7.5-year drought cycle. The locations of well sites included in the preferred plan are shown on Figure ES-5.

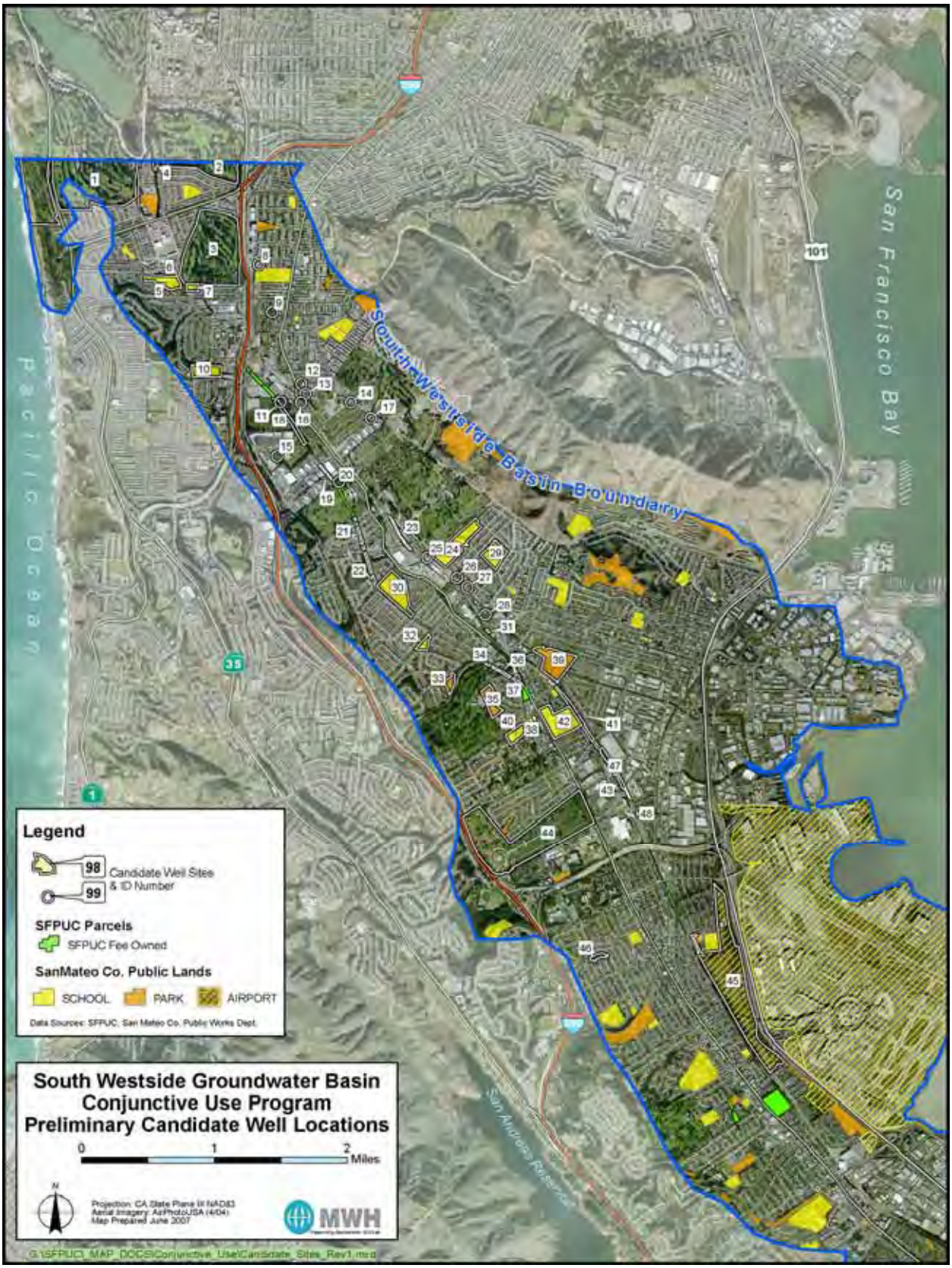

Figure ES-4
Preliminary Candidate Well Locations

Table ES-2 List of Preferred Well Sites
(locations of Site IDs are shown on Figure ES-5)

Site ID	Site Description	Estimated Number of Wells	Estimated Range of Site Pumping Capacity (gpm)	Distribution System Connection [1]	Disinfection Location	Method of Achieving Water Quality Goals	Alternate Distribution System Connection [2]	Additional Considerations
Preferred Sites								
3	Lake Merced Golf Club	1	400 - 650	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	
5	Ben Franklin Intermediate School	1	400 - 650	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	School notification and approval pending.
6	Park Plaza Meter (093242010)	1	400 - 650	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	
7	New CW Well Site 1 - Garden Village Elementary School	1	400 - 650	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	School notification and approval pending.
23	Treasure Island Trailer Court (093330020)	1	300 - 500	SFPUC Sunset Supply	Required at Site	Blending	None	
31	SSF Main Area (093330040)	1	300 - 500	SFPUC Sunset Supply	Required at Site	Blending	Cal Water	
36	Funeral Home (093300020, 093300070, & 093300080)	2	600 - 1,000	SFPUC Sunset Supply	Required at Site	Blending	Cal Water or other SFPUC pipeline	
41	SSF Linear Park (093331040)	4	1,200 - 2,000	Cal Water (3 wells) San Bruno (1 well)	Cal Water Station 1 (3 wells) San Bruno Facility or On-Site (1 well)	Treatment at Station 1 (3 wells) Treatment at Forest Lane or Blending (1 well)	Other combinations to Cal Water, SFPUC, or San Bruno	
44	Golden Gate National Cemetery	2	600 - 1,200	San Bruno	Required at Site	Fe/Mn treatment	SFPUC pipeline	Veterans Administration approval pending.
		Total	4,600 - 7,800 gpm					
		Total	**6.6 - 11.2 MGD**					
Alternate Sites								
22	Alta Loma Drive	1	300 - 500	SFPUC San Andreas #2	Required at Site	Blending	Cal Water	Requires land-use agreement with City of South San Francisco.
18	Colma ROW (093280010) Colma Boulevard	1 to 2	300 - 1,000	SFPUC San Andreas #2	Required at Site	Blending	Cal Water or other SFPUC pipeline	Requires land-use agreement with Woodlawn Memorial Park and/or Greenlawn Memorial Park.
25	New CW Well Site 7	1	300 - 500	Cal Water	Required at Site	Possible Fe/Mn treatment, NO3?	SFPUC Sunset Supply	Requires property acquisition.

Notes:
[1] The distribution system which receives groundwater from a particular site will determine which agency will be responsible for operations and maintenance of the wells and facilities.
[2] Alternate distribution system connections are not described in Section 7 or shown Preliminary Site Layout maps and have not been included in the opinion of probable construction costs. Selection of an alternate distribution system connection may require modifications to the proposed disinfection system or method of achieving water quality goals.

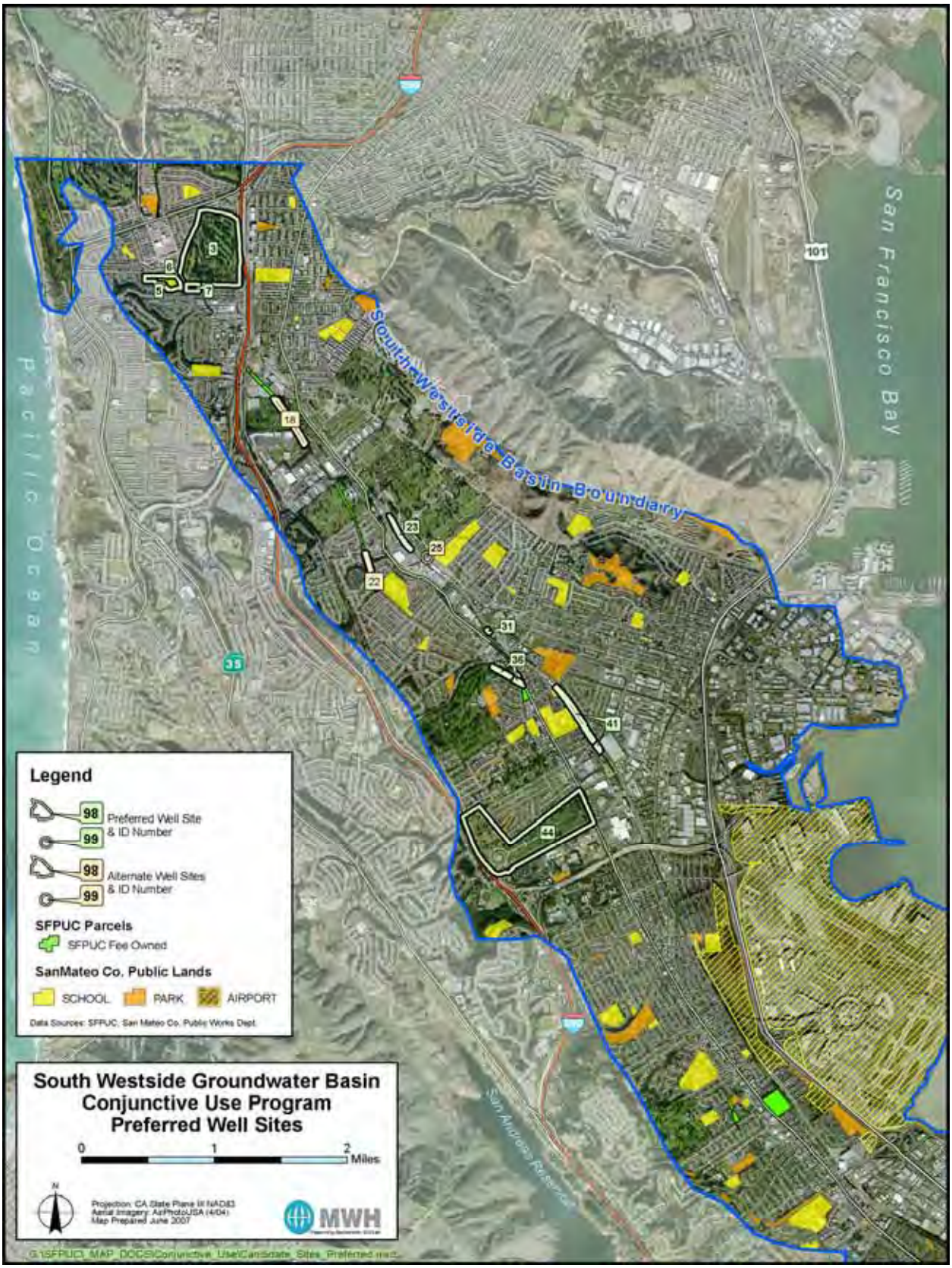

Figure ES-5
Preferred Well Sites

Water Quality Objectives

The Conjunctive Use Project will be operated to meet agency-specific water quality goals. If these targets are not achievable with raw groundwater from Conjunctive Use Wells, site-specific treatment strategies should be designed to meet or exceed these operating goals. Blending is the preferred treatment strategy for most constituents due to the costs of treatment system construction and operation.

Cost of Preferred Project

A preliminary estimate of probable construction costs for discrete well and well facility units was used to determine the construction cost of the preferred plan. This cost estimate will be further developed to include estimates of engineering, operations and maintenance cost in the Conceptual Engineering Report.

A mobilization fee of 10% and a contingency of 35% have been included in this estimate. Cost escalation factors are not included in the estimate. We recommend that an 8% escalation per year to mid-point of construction be included as a separate line item in the total project cost.

Table ES-3 lists the construction cost estimated for each of the specific well locations, based on the number of wells, type of pump, building size, disinfection equipment, treatment system equipment, length of connection piping, and additional cost such as local system plant upgrades and connections to regional pipelines.

The total construction cost of $25,600,000 is considered very preliminary and will be further developed and refined in the CER after more information is obtained on facility modifications required at Daly City's Westlake and Cal Water's South San Francisco treatment plants and after completing 10% facilities designs at the preferred well locations.

Table ES-3
Preliminary Opinion of Probable Construction Cost for Preferred Well Sites

Site ID	Description of Alternative	Quantity Well A	Cost Well A	Quantity Well B	Cost Well B	Building-Only (640 sf)	Cost Building-Only	Building w/ Disinf (928 sf)	Cost Building w/ Disinf	Well Station (1,500 sf)	Cost Well Station	Length 6" Piping	Cost 6" Piping	Length 8" Piping	Cost 8" Piping	Length 10" or 12" Piping	Cost 10" or 12" Piping	Electrical Service	Addt'l Costs	Cost Total
3: Lake Merced Golf Course	1 Well B, Fenced-Enclosure (no costs incl.) 850 ft 8" pipe to local water dist sys 700 ft 6" pipe to sanitary sewer (pump to waste)		$0	1	$683,000	0	$0	0	$0	0	$0	700	$51,100	850	$69,700			$50,000	$750	**$854,550**
5: Ben Franklin Intermediate School	1 Well B, Building Only 400 ft 8" pipe to local water dist sys 500 ft 6" pipe to sanitary sewer (pump to waste)		$0	1	$683,000	1	$128,000	0	$0	0	$0	500	$36,500	400	$32,800			$50,000	$750	**$931,050**
6: Park Plaza Meter	1 Well B, Building Only 300 ft 8" pipe to local water dist sys 150 ft 6" pipe to sanitary sewer (pump to waste)		$0	1	$683,000	1	$128,000	0	$0	0	$0	150	$10,950	300	$24,600			$50,000	$750	**$897,300**
7: Garden Village Elementary School	1 Well B, Building Only 800 ft 8" pipe to local water dist sys 300 ft 6" pipe to sanitary sewer (pump to waste)		$0	1	$683,000	1	$128,000	0	$0	0	$0	300	$21,900	800	$65,600			$50,000	$750	**$949,250**
Additional Costs Park Plaza Area	Install 1,400 ft 12" pipe to Westlake PS Replace 4 (?) chemical metering pumps, and storage tanks Add two 125 hp pumps (allowance of $40,000 each)		$0	0	$0	0	$0	0	$0	0	$0		$0		$0	1400	$140,000		$89,000	**$229,000**
23: Treasure Island Trailer Court	1 Well A, Building w/ Disinf 1 Nested Monitoring Well 170 ft 8" pipe to Sunset Supply Line 60 ft 6" pipe to sanitary sewer (pump to waste)	1	$676,000		$0	0	$0	1	$203,000	0	$0	60	$4,380	170	$13,940			$50,000	$108,000	**$1,055,320**
31: SSF Main Area	1 Well A, Building w/ Disinf 1 Nested Monitoring Well 120 ft 8" pipe to Sunset Supply Line 620 ft 6" pipe to sanitary sewer (pump to waste)	1	$676,000		$0	0	$0	1	$203,000	0	$0	620	$45,260	120	$9,840			$50,000	$108,000	**$1,092,100**
36: Funeral Home	1 Well B, 1 Well A, 1 Fenced Enclosure, 1 Building w/ Disinf, 1 Nested Monitoring Well 530 ft 8" pipe to San Andreas #2 300 (?) ft 6" pipe to sanitary sewer (pump to waste)	1	$676,000	1	$683,000	0	$0	1	$207,000	0	$0	300	$21,900	530	$43,460			$100,000	$108,000	**$1,839,360**
41a: Linear Park to Cal Water Station 1	3 Well A, 3 Building Only 2,130 ft 8" pipe to Orange Avenue 2,130 ft 6" pipe to sanitary sewer (pump to waste)	3	$2,028,000		$0	3	$384,000		$0	0	$0	2130	$155,490	2130	$174,660			$150,000	$100,750	**$2,992,900**
41b: Linear Park to San Bruno	1 Well A, Building w/ Disinf 180 ft 6" pipe to sanitary sewer (pump to waste)	1	$676,000		$0		$0	1	$203,000	0	$0	180	$13,140		$0			$50,000	$750	**$942,890**
Additional Costs Linear Park	Install 3,165 ft 10" pipe to Station 1 (1/2 paved) Install 4,875 ft 8" pipe to Forest Lane (1/2 paved) Upgrade Station 1 treatment facilities (Approx-imated at 1/4 cost of Centralized Treatment System)		$0	0	$0	0	$0	0	$0	0	$0		$0	4875	$504,563	3165	$395,625		$973,500	**$1,873,688**
44: Golden Gate National Cemetery	2 Well A, 1 Building Only, 1 Well Station 1,000 ft 8" pipe to San Bruno 1,000 ft 6" pipe to sanitary sewer (pump to waste)	2	$1,352,000		$0	1	$128,000	0	$0	1	$1,758,000	1100	$80,300	1000	$82,000			$100,000	$100,750	**$3,601,050**
																			Project Subtotal:	**$17,258,458**
																			Mobilization (10%)	$1,725,846
																			Subtotal + Mob	**$18,984,303**
																			Contingency (35%)	$6,644,506
																			Project Total:	**$25,628,809**

Notes:
Well A is completed to a depth of 650 feet and is equipped with a vertical turbine pump.
Well B is completed to a depth of 650 feet and is equipped with a submersible pump.
Well Station is a 1,500 sq-ft building with Fe/Mn treatment and disinfection equipment for 2 wells.
Pipe lengths will be refined in the CER.
An allowance for site electrical service of $50,000 per well is included.
Additional costs (last column) include connections to local main or regional pipeline, nested monitoring well costs, and upgrades to local system infrastructure.

Remaining Data Gaps and Uncertainties

Remaining data gaps and uncertainties are summarized below in Table ES-4.

Table ES-4 Remaining Data Gaps and Uncertainties

Remaining Data Gaps and Uncertainties	Relevant Issues	Recommendations
Well Yield	Although preferred well sites have been selected to maximize groundwater production, actual well yields will remain unknown until wells and pumps are installed and tested at preferred well sites.	SFPUC should perform geophysical logging and install test wells at each site. Information collected from these activities should be incorporated into the well design during preliminary design stage. Test wells can later be converted to production wells.
Groundwater Quality	Groundwater quality at preferred well sites will remain unknown until site-specific groundwater samples are collected.	SFPUC should install monitoring wells at each site and collect groundwater samples in advance of preliminary design and construction.
Well Performance	Reductions in well performance observed in Basin wells may be attributed to clogging of well screens due to incrustation and iron-oxidizing bacteria. Decreases in well performance have reportedly become more problematic during and after periods of well inactivity.	SFPUC and Partner Agencies should continue to gather information related to the performance of wells in the Basin. Potential solutions to well performance issues include low flows (“trickle flows”) of chlorinated potable water into Conjunctive Use Wells during periods of inactivity

Table ES-4 Remaining Data Gaps and Uncertainties

Remaining Data Gaps and Uncertainties	Relevant Issues	Recommendations
Property Access	Some wells and well facilities are planned for property that is not owned by SFPUC or Partner Agencies. Vehicle access to one preferred well site owned by SFPUC is also currently blocked.	SFPUC should begin the process of obtaining site access agreements before well design begins. If agreements or land purchases cannot be obtained, SFPUC should select the next well site from the prioritized list of candidate well sites and attempt to obtain access agreements.
Hydraulic System Evaluation	There are existing limitations to the Partner Agency hydraulic models. For example, San Bruno's model was developed in 2000 and has not been updated since. Daly City's model was developed in 2000 and is currently being updated.	Partner Agencies should verify the compatibility of applicable Conjunctive Use Wells with their distribution systems after updating their respective hydraulic models.
Water Demand in Winter Months	Extraction of conjunctive use groundwater that is delivered to a local system may have to be reduced during winter months. This could potentially impact the ability to achieve an extraction rate of 8,100 AFY during "take" years.	Winter demand for conjunctive use groundwater should be verified with updated hydraulic models.

Table ES-4 Remaining Data Gaps and Uncertainties

Remaining Data Gaps and Uncertainties	Relevant Issues	Recommendations
Aquifer Storage and Recovery (ASR) Feasibility	The feasibility of directly recharging the groundwater aquifer with the proposed conjunctive use wells was not evaluated in detail in the AAR. Injection rates in the Westside Basin would likely range between 30% and 50% of extraction rates.	If SFPUC desires to further explore the feasibility of ASR in the Basin, then SFPUC should work with the Partner Agencies to identify and evaluate the use of existing wells for short term injection tests. Also, cores samples and water quality samples should be collected and analyzed to evaluate the compatibility of mixing SFPUC water with native groundwater in the Basin.

San Francisco Public Utilities Commission
Water System Improvement Program
Groundwater Conjunctive Use Project
WSIP Project CUW30103

Conceptual Engineering Report

Prepared under Contract CS-826

Final Report
November 2008

WSIP PROJECT NO. CUW 301-03

CONCEPTUAL ENGINEERING REPORT

GROUNDWATER CONJUNCTIVE USE PROJECT

Prepared for

WATER RESOURCES DIVISION

By

MWH, in association with
AGS, M. Lee, and Talavera & Richardson

Under the Direction of

WATER RESOURCES DIVISION
PUBLIC UTILITIES COMMISSION
CITY AND COUNTY OF SAN FRANCISCO

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Preface

This document is the result of a multi-agency collaborative effort to improve the Bay Area's dry-year water supply. The South Westside Basin is an important local drinking water resource for the cities of Daly City, San Bruno, South San Francisco and Colma.

This report evaluates the potential to utilize vacant aquifer space to store water for dry years. The groundwater storage component occurs by reducing the municipal groundwater pumping in normal rainfall years and purchasing supplemental surface water from the SFPUC. This concept is commonly known as "in-lieu" recharge and will increase the volume of water in storage during normal and wet years that can be pumped in dry years.

Staff from the California Water Service Company, the City of Daly City, the City of San Bruno and the San Francisco Public Utilities Commission have combined efforts to help prepare this Conjunctive Use Conceptual Engineering Report. The CER builds on the Alternatives Analysis Report. The Alternatives Analysis process consisted of identifying and ranking new groundwater well locations that would be constructed to pump the stored water in dry years and selecting a preferred plan for implementation. The Conceptual Engineering process consisted of bringing the preferred plan to a 10% design level.

Future activities that need to occur prior to project implementation include developing formal Conjunctive Use agreements between the SFPUC and California Water Service Company, the City of Daly City, and the City of San Bruno. Negotiations are currently underway to formalize the institutional agreements between SFPUC and the other agencies. In addition, the Conjunctive Use project is subject to review under the California Environmental Quality Act. Therefore, given the need to complete these additional activities prior to project implementation, this document is considered preliminary.

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List of Acronyms

AAR	Alternatives Analysis Report
AF	acre-feet
AFY	acre-feet per year
ANSI	American National Standards Institute
ASR	aquifer storage and recovery
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BART	Bay Area Rapid Transit
bgs	below ground surface
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
CMU	concrete masonry unit
CS2	Crystal Springs Pipeline No. 2
CT	contact time
CUP	Conjunctive Use Project
CUPA	Certified Unified Permit Agency
DIP	Ductile Iron Pipe
DPH	California Department of Public Health
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
FEMA	Federal Emergency Management Agency
FTE	full time equivalent
GGNC	Golden Gate National Cemetery
GIS	geographical information system
gpm	gallons per minute
gpd	gallons per day
GW	groundwater
HFA	Hydrofluorosilicic acid
HHA	Hetch Hetchy Aqueduct
HMI	human machine interface
hp	horsepower
LSCE	Luhdorff and Scalmanini Consulting Engineers

List of Acronyms

MCL	maximum contaminant level
MEA	San Francisco Planning Department Major Environmental Analysis Division
mg/L	milligrams per liter
MGD	million gallons per day
msl	mean sea level
MTBE	methyl t-butyl ether
ND	non detect
NEMA	National Electrical Manufacturers Association
O&M	Operation and maintenance
PCE	tetrachloroethylene
PG&E	Pacific Gas and Electric
PLC	programmable logic controller
POE	Point-of-entry
PVC	Polyvinyl chloride
R&R	repair and replacement
SA2	San Andreas Pipeline No. 2
SA3	San Andreas Pipeline No. 3
SCADA	Supervisory Control And Data Acquisition
SFPUC	San Francisco Public Utilities Commission
SMCFCD	San Mateo County Flood Control District
SSF	South San Francisco
SSL	Sunset Supply Line
SMCL	secondary maximum contaminant level
STC	Sound Transmission Class
SW	surface water
TDS	total dissolved solids
TSS	total suspended solids
ug/L	micrograms per liter
USGS	United States Geological Survey
VFD	variable-frequency drive
VOC	volatile organic compound
WSIP	Water System Improvement Program

Acknowledgments

MWH greatly appreciates the contributions from individuals within SFPUC, the Partner Agencies, and their consultant teams for their guidance and contributions to this document in the form of:

- Identifying potential facility locations
- Providing electronic information enabling MWH to more quickly evaluate, understand and display information
- Providing comments during development of the AAR and CER
- Improving our understanding of basin conditions
- Providing input on the design, operation, and performance of existing and future wells and groundwater treatment systems within the Basin

We especially would like to acknowledge the following individuals:

- Greg Bartow, SFPUC Project Manager
- Debra Temple, SF Department of Public Works Project Engineer
- Frank Kukula, SFPUC Operations Liaison
- Paul Mazza, SFPUC Regional Operations Liaison
- Alan R. Wong, SFPUC Water Quality Bureau Representative
- Sam Young, SFPUC Regional Engineer
- Husam Masri, SFPUC Regional Project Manager
- Mike Weisenberger, SFPUC Operations
- Obiajulu Nzewi, SFPUC Water Resources Planning
- Barry Pearl, SFPUC Bureau of Environmental Management
- Josh Milstein, City and County of San Francisco
- Anne Schneider, Ellison, Schneider & Harris
- Joe Scalmanini, LSCE
- Thomas Elson, LSCE
- Will Halligan, LSCE
- Les Chau, Kennedy Jenks
- Steve Pallad, Kennedy Jenks

Partner Agencies

- Patrick Sweetland, City of Daly City
- Mark Baker, City of Daly City
- Pamela Thompson, City of San Bruno
- Steve Davis, City of San Bruno
- Mark Reinhardt, City of San Bruno
- Tom Salzano, Cal Water
- Erin McCauley, Cal Water

- Jeff Yarne, Yarne & Associates
- Ali Taghavi, WRIME
- Jim Blanke, WRIME

We also wish to acknowledge the MWH team and our teaming partners who provided invaluable support during the development of the CER, these include,

- Chris Petersen, MWH
- Janet Atkinson, MWH
- Stefani Harrison, MWH
- Matthew Holt, MWH
- Emily Lau, MWH
- Peter Kreft, MWH (Manganese Treatment)
- Carolyn McAlpin, MWH (Manganese Treatment)
- Mike Price, MWH (Disinfection Treatment)
- Edward Gosse, MWH (Well Station Design)
- Jeff Lodge, MWH (Well Station Design)
- Trevor Joseph, MWH (Well Design and Drilling)
- Sandy Lawson, MWH (Scheduling and Constructability)
- Sherman Honeycutt, MWH (Scheduling and Constructability)
- Gene Nelms, MWH (Operations)
- Rob Talavera, Talavera and Richardson (GIS Support)
- Dennis Wong, AGS Consulting (Facility Design and Drafting Support)
- Martin Lee, M. Lee Corporation (Construction cost estimation)

EXECUTIVE SUMMARY

Project Overview

The objective of the South Westside Groundwater Basin (Basin) Conjunctive Use Project is to develop a new dry-year groundwater supply that can be utilized at a rate of 8,100 acre-feet per year over a design 7.5-year drought cycle.

This project is being developed through the coordination of San Francisco Public Utilities Commission (SFPUC) and three Partner Agencies (California Water Service Company [Cal Water], the City of Daly City [Daly City] and the City of San Bruno [San Bruno]), who purchase wholesale water from SFPUC's regional surface water system and also operate their own groundwater production wells. Water will be stored in the aquifer through reduced pumping by the Partner Agencies made possible by the provision of SFPUC supplemental surface water supplies in wet and normal years. The program would ultimately develop enough groundwater pumping capacity to produce 8,100 acre-feet per year (AFY), or 7.2 million gallons per day (MGD), in addition to groundwater extraction from existing Partner Agency wells. The project will be designed to provide up to 61,000 acre-feet (AF) of stored water from Conjunctive Use wells to meet SFPUC system demands during the last 7.5 years of SFPUC's design drought. The combined pumping rate of 7.2 mgd and pumping duration of 7.5 years are based on estimates that were developed to meet the SFPUC's 2030 dry-year demands as described in the Urban Water Management Plan (SFPUC, 2005b). For storage size comparison, this 61,000 acre-foot groundwater conjunctive use project is midway in size between the San Antonio Reservoir (50,500 AF) and Crystal Springs Reservoir (69,300 AF).

Sixteen Conjunctive Use wells are planned for 15 sites, as shown in Table ES-1. Five wells will connect to SFPUC regional transmission pipelines, five wells will connect to Daly City's distribution system, three wells will connect to Cal Water's distribution system, and three wells will connect to San Bruno's distribution system. Four alternate well locations have also been selected.

Well and Well Station Design Considerations

Design criteria have been developed for wells, well stations, and piping. The criteria establish the type of pumps, well materials, pipe materials, construction materials, and treatment systems that will be used for the project. Site-specific well station design criteria were also established, as shown in Table ES-2.

Agency-specific water quality objectives have been identified. These water quality objectives must be met for blended water, whether those objectives are met through blending with surface water or treatment.

Three well station prototypes have been developed: well only, well plus chemical treatment, and well plus chemical treatment and filtration. The well station prototypes have been displayed for

Table ES-1 List of Project Well Sites

Site ID	Site Description	Estimated Number of Wells	Estimated Range of Site Pumping Capacity (gpm)	Distribution System Connection [1]	Disinfection Location	Method of Achieving Water Quality Goals	Alternate Distribution System Connection [2]	Additional Considerations
Project Sites								
3A	Lake Merced Golf Club	1	300 - 600	SFPUC San Andreas #2	Required at Site	Blending	Daly City	
5	Ben Franklin Intermediate School	1	300 - 600	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	School notification and approval pending.
6	Park Plaza Meter	1	300 - 600	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	
7	Garden Village Elementary School	1	300 - 600	Daly City	Westlake Pump Station	Blending	SFPUC Sunset Supply	School notification and approval pending.
10A	ROW at Serra Bowl	1	300 - 600	Daly City	Required at Site	Blending	Cal Water	
11A	ROW at Colma BART	1	300 - 600	Cal Water	Required at Site	Blending	SFPUC pipeline	
18	ROW at Colma Boulevard	1	300 - 600	Cal Water	Required at Site	Blending	SFPUC pipeline	
19	ROW at Serramonte Boulevard	1	300 - 600	Cal Water	Required at Site	Blending	SFPUC pipeline	
22A	ROW at Hickey Boulevard	1	200 - 500	Daly City	Required at Site	Blending	SFPUC San Andreas #2	
23	Treasure Island Trailer Court	1	200 - 500	SFPUC Sunset Supply	Required at Site	Blending	None	
31	SSF Main Area	1	200 - 500	SFPUC Sunset Supply	Required at Site	Blending	Cal Water	
36	Funeral Home	1	200 - 500	SFPUC Sunset Supply	Required at Site	Blending	Cal Water or other SFPUC pipeline	
41	SSF Linear Park	1	200 - 500	San Bruno	Required at Site	Fe/Mn treatment	Cal Water, SFPUC, or other San Bruno	
44	Golden Gate National Cemetery	2	600 - 1,200 [3]	San Bruno	Required at Site	Possible Fe/Mn treatment	SFPUC pipeline	Veterans Administration approval pending.
M-1	Millbrae Corp Yard	1	100 - 200	SFPUC Crystal Springs #2	Required at Site	Blending	None	
		Total	4,000 - 8,700 gpm					
		Total	**5.8 - 12.5 MGD**					

Table ES-1 List of Project Well Sites

Site ID	Site Description	Estimated Number of Wells	Estimated Range of Site Pumping Capacity (gpm)	Distribution System Connection [1]	Disinfection Location	Method of Achieving Water Quality Goals	Alternate Distribution System Connection [2]	Additional Considerations
Alternate Sites								
10	Margaret P. Brown Elementary School	1	300 - 600	Daly City	Required at Site	Blending	None	Requires school notification and approval.
20A	Standard Plumbing Supply	1	300 - 600	Cal Water	Required at Site	Blending	SFPUC pipeline	Requires property acquisition.
22	Alta Loma Drive	1	200 - 500	SFPUC San Andreas #2	Required at Site	Blending	Cal Water	Requires land-use agreement with City of South San Francisco.
36-2	Funeral Home	1	200 - 500	SFPUC Sunset Supply	Required at Site	Blending	Cal Water or other SFPUC pipeline	

Notes:
[1] The distribution system which receives groundwater from a particular site will determine which agency will be responsible for operations and maintenance of the wells and facilities.
[2] Alternate distribution system connections are not described in Section 2.4.2 or shown site layout maps and have not been included in the opinion of probable construction costs. Selection of an alternate distribution system connection may require modifications to the proposed disinfection system or method of achieving water quality goals.
[3] 300 - 600 gpm per well

Table ES-2 Site-Specific Well Station Design Criteria

Description	Site 3A Lake Merced Golf Club	Sites 5,6,7 Park Plaza Area	Site 10A ROW at Serra Bowl	Sites 11A, 18, 19 ROWs in Colma	Site 22A ROW at Hickey Boulevard	Site 23 Treasure Is. Trailer Ct.	Site 31 SSF Main Area	Site 36 Funeral Home	Site 41 SSF Linear Park	Site 44 GG Nat'l Cemetery	Site M-1 Millbrae Corp Yard
No. of Wells	1	3	1	3	1	1	1	1	1	2	1
Connection Point	SFPUC San Antonio #2	Daly City Westlake Pump Station	Daly City	Cal Water	Daly City	SFPUC Sunset Supply	SFPUC Sunset Supply	SFPUC Sunset Supply	San Bruno	San Bruno	SFPUC Crystal Springs #2
Type of Pump	Above Ground	Submersible	Above Ground	Above Ground	Above Ground	Above Ground	Above Ground	Above Ground	Above Ground	Above Ground	Above Ground
Estimated Pumping Capacity (gpm), per well	300 - 600	300 - 600	300 - 600	300 - 600	200 - 500	200 - 500	200 - 500	200 - 500	200 - 500	300 - 600	100 - 200
Assumed Pumping Rate (gpm), per well	400	300	400	400	330	330	220	220	220	330	160
Assumed Well Depth (ft) [1]	625	730	730	730 (Site 10A), 640 (Sites 18, 19)	640	640	580	580	580	620	Exploratory Boring Needed
Total Site Motor Power (hp)	200	100	150	200 (Site 10A), 150 (Sites 18, 19)	125	100	100	100	100	150 (Well 1), 200 (Well 2)	50
Possible Well Screen Depth Intervals (ft)[1]	410 - 625	410 - 730 (Site 5), 420 - 730 (Sites 6,7)	430 - 730	440 - 730 (Site 10A), 430 - 640 (Site 18), 400 - 640 (Site 19)	400 - 640	400 - 640	375 - 580	395 - 580	375 - 580	400 - 620 (Well 1), 410 – 620 (Well 2)	Exploratory Boring Needed
Building Type	1 well plus chem treatment	0	1 well plus chem treatment	1 well plus chem treatment	1 well plus chem treatment	1 well plus chem treatment	1 well plus chem treatment	1 well plus chem treatment	1 well plus filtration	1 well-only, 1 well plus filtration	1 well plus chem treatment
Wells with Fenced Enclosures (no building)	0	3	0	0	0	0	0	0	0	0	0
Onsite chemical treatment anticipated?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Onsite fluoridation?	No	No	Yes	If Required by DPH	Yes	No	No	No	If Required by DPH	If Required by DPH	No
Onsite Mn/Fe treatment anticipated?	No	No				No	No	No	Yes	Yes	No

Notes:
1 Well depth and screen depth intervals to be determined during design phase based on site borehole data.

each site on preliminary site layouts that identify pipe routes for connections to a distribution system and pump-to-waste to the sanitary sewer.

Well Installation and Well Station Construction Considerations

The SFPUC developed Standard Construction Measures dated February 7, 2007 that must be followed for all WSIP Projects. All construction contractors are required to comply with the SFPUC Standard Construction Measures for well installation and facility construction. Environmental documentation, inspection and permit requirements, work area restrictions, traffic control plan, and right-of-way acquisitions are discussed in this Final CER.

Project Schedule

Well installation is scheduled to begin in September 2009 and be fully completed by June 2010. Construction of the well facilities is scheduled to begin in the second quarter of 2012 and be fully completed by the second quarter of 2014. Table ES-3 shows the Groundwater Conjunctive Use Project schedule. This CER completes the planning phase.

Table ES-3 Groundwater Conjunctive Use Project Schedule

Phase	Start	Finish
Planning (Current Project Phase)	Jun-2003	Nov-2008
Environmental	Oct-2007	Dec-2010
Well Design	Oct-2008	Jul-2009
Well Installation and Testing	Sep-2009	Jun-2010
Well Facility Design	Oct-2009	Sep-2011
Construction Bid & Award	Oct-2011	Jun-2012
Well Facility Construction	Apr-2012	May-2014
Closeout	Dec-2013	Nov-2014

Operation and Maintenance

Conjunctive Use wells will be operated by SFPUC or one of the Partner Agencies, depending upon which distribution system the water is sent to. Routine operations strategies for each well are described in the Preliminary O&M Plan in Appendix F, including pump startup, chemical deliveries, filter maintenance procedures, and sample logsheets for daily to weekly well site visits.

During “take” years, the Groundwater Conjunctive Use project wells will be normally on. During “put” years, the Groundwater Conjunctive Use project wells will be normally off, but regular exercising will be conducted.

Each well will be injecting water into an SFPUC Regional Pipeline or a Partner Agency distribution system. Transmission and connection to the distribution system should be operated and maintained in accordance with the operating procedures of the Partner Agency receiving the water.

Project Costs

A preliminary Opinion of Probable Construction Costs (OPCC) for each well site was prepared by M. Lee Corporation and is included as Appendix N. The total estimated construction cost for the project is approximately $28 million. This includes an estimated direct cost of $21 million, 7.5% mobilization costs of $1.6 million, and 25% contingency costs of $5.6 million. Escalating the construction cost to the midpoint of construction by 3.5% for 4.5 years brings the construction cost to approximately $33 million. Takeoffs from the escalated construction cost include 12% for design and engineering, 8% for construction management, 3% for permitting and legal, and 5% for Owners' administration, for a total estimated capital cost of $42 million.

Operation and maintenance (O&M) costs associated with the Conjunctive Use Program would be paid for by the SFPUC, in accordance with the CUP Agreement between the SFPUC and Partner Agencies. A present value analysis calculation was completed for the Conjunctive Use Project's total O&M costs. Due to the different O&M costs for put years and take years, the present value O&M calculation accounted for 4 put years followed by 2 take years starting in 2013; the 6-year cycle repeated five times for a total 30-year life cycle. The O&M cost for each year was adjusted for inflation (3.5%) and interest (5%). The present value O&M cost is estimated at $37 million.

The total cost of the Conjunctive Use Project is the capital cost in 2008 dollars ($42 million) plus the present value O&M cost ($37 million). The total cost is $79 million.

South Westside Basin Groundwater Management Plan

July 2012

South Westside Basin
Groundwater Management Plan

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ACRONYMS AND ABBREVIATIONS

1999 Plan	proposed Westside Basin AB 3030 Groundwater Management Plan
AB	Assembly Bill
Advisory Committee	South Westside Basin GWMP Advisory Committee
AF	acre-feet
AFY	acre-feet per year
Basin Plan	San Francisco Bay Basin Water Quality Control Plan
BMO	Basin Management Objective
CalWater	California Water Service Company
cfs	cubic feet per second
DPH	California Department of Public Health
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
ft	feet
GAMA	Groundwater Ambient Monitoring Assessment
gpm	gallons per minute
GPS	global positioning satellites
Groundwater Task Force	South Westside Basin Groundwater Task Force
GSR	Regional Groundwater Storage and Recovery Project
GWMP	groundwater management plan
Groundwater Model	Westside Basin Groundwater Flow Model
ILPS	In-Lieu Pilot Study
InSAR	interferometric synthetic aperture radar
IRWMP	Integrated Regional Water Management Plan
JPA	joint powers agreement
MCL	maximum contaminant level

mgd	million gallons per day
µg/L	micrograms per liter
mg/L	milligrams per liter
MOU	Memorandum of Understanding
N	nitrogen
NAWQA	National Ambient Water Quality Assessment
NCCWD	North Coast County Water District
NPDES	National Pollutant Discharge Elimination System
NSMCSD	North San Mateo County Sanitation District
PCE	Tetrachloroethylene
Plan Area	area covered by South Westside Basin Groundwater Management Plan
ppm	parts per million
psi	pounds per square inch
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SB	Senate Bill
SFIA	San Francisco International Airport
SFPUC	San Francisco Public Utilities Commission
SMCL	secondary maximum contaminant level
SVOCs	semi-volatile organic compounds
TCE	Trichloroethylene
TDS	total dissolved solids
USGS	United States Geological Survey
USDA-NRCS	United States Department of Agriculture Natural Resources Conservation Service
Water Board	California State Water Resources Control Board
Westside Basin	Westside Groundwater Subbasin
Wholesale Water Supply Agreement	Water Supply Agreement between The City And County of San Francisco And Wholesale Customers in Alameda County, San Mateo County, And Santa Clara County

1 INTRODUCTION AND BACKGROUND

1.1 PURPOSE OF THE GROUNDWATER MANAGEMENT PLAN

The purpose of the South Westside Basin Groundwater Management Plan (GWMP), including development of the plan and the plan document itself, is to provide a framework for regional groundwater management in the South Westside Basin that sustains the beneficial use of the groundwater resource. This includes:

- Informing the public of the importance of groundwater and of the challenges and opportunities presented by groundwater supplies;
- Developing consensus among stakeholders on issues and solutions related to groundwater;
- Building relationships among stakeholders within the basin and between state and federal agencies; and
- Defining actions to ensure the long-term sustainability of groundwater resources in the South Westside Basin.

This GWMP provides recommendations that, when implemented, are intended to maintain or enhance long-term groundwater levels and quality and minimize land subsidence.

The goal of the GWMP is to ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management.

1.2 DESCRIPTION OF THE GROUNDWATER BASIN AND PLAN AREA

The South Westside Basin GWMP area (Plan Area) is the portion of the Westside Groundwater Subbasin (Westside Basin), Basin 2-35, as defined by the California Department of Water Resources (DWR), within the boundaries of San Mateo County. The Plan Area is shown in Figure 1.1. Areas within the northern portion of the DWR-defined Westside Basin, in the City and County of San Francisco, are described in the draft *North Westside Basin Groundwater Basin Management Plan* (SFPUC, 2005).

Overlying municipalities, shown in Figure 1.2, include Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. Water agencies serving the Plan Area are shown in Figure 1.3 and include Daly City, California Water Service Company (CalWater) – South San Francisco District, San Bruno, Millbrae, and Burlingame. Additionally, the San Francisco Public Utilities Commission (SFPUC) provides retail water service to the Golden Gate National Cemetery in San Bruno and wholesale water to the retail agencies.

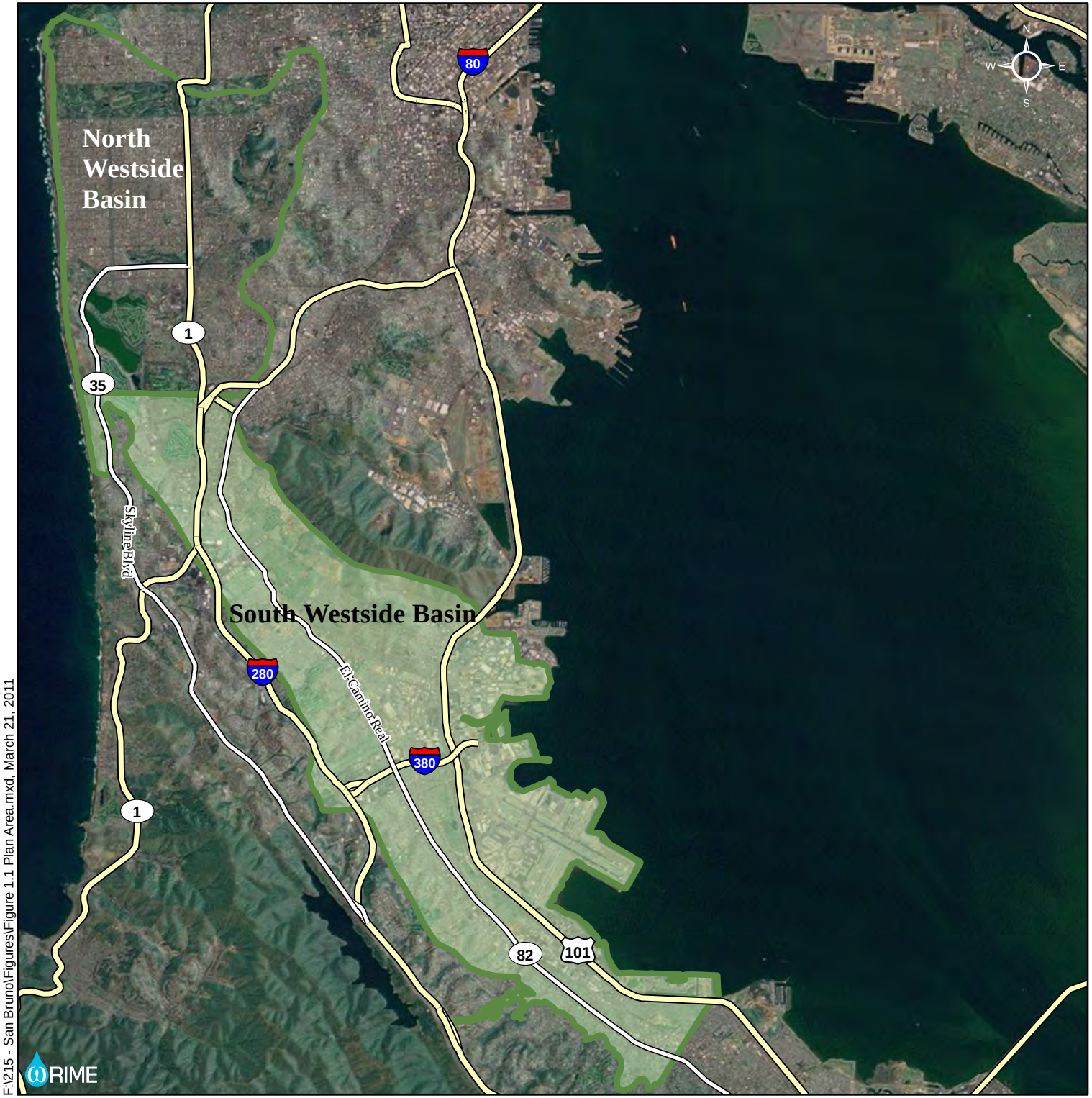

Figure 1.1
Plan Area

Legend

- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: Groundwater Basin: DWR, 2003

F:\215 - San Bruno\Figures\Figure 1.1 Plan Area.mxd, March 21, 2011

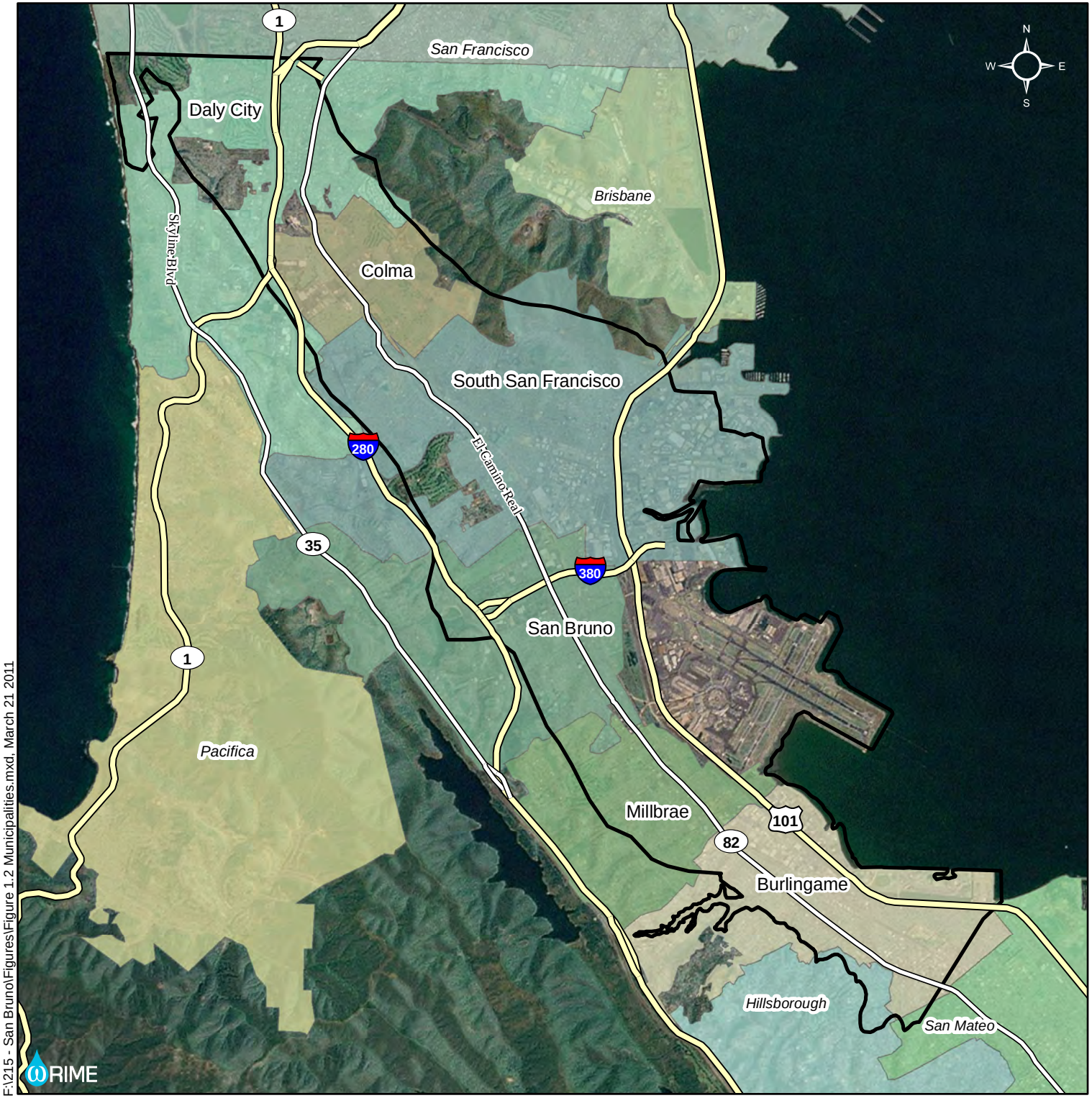

Figure 1.2
Municipalities

Legend

- Highways
- Plan Area

0 0.5 1 2 Miles

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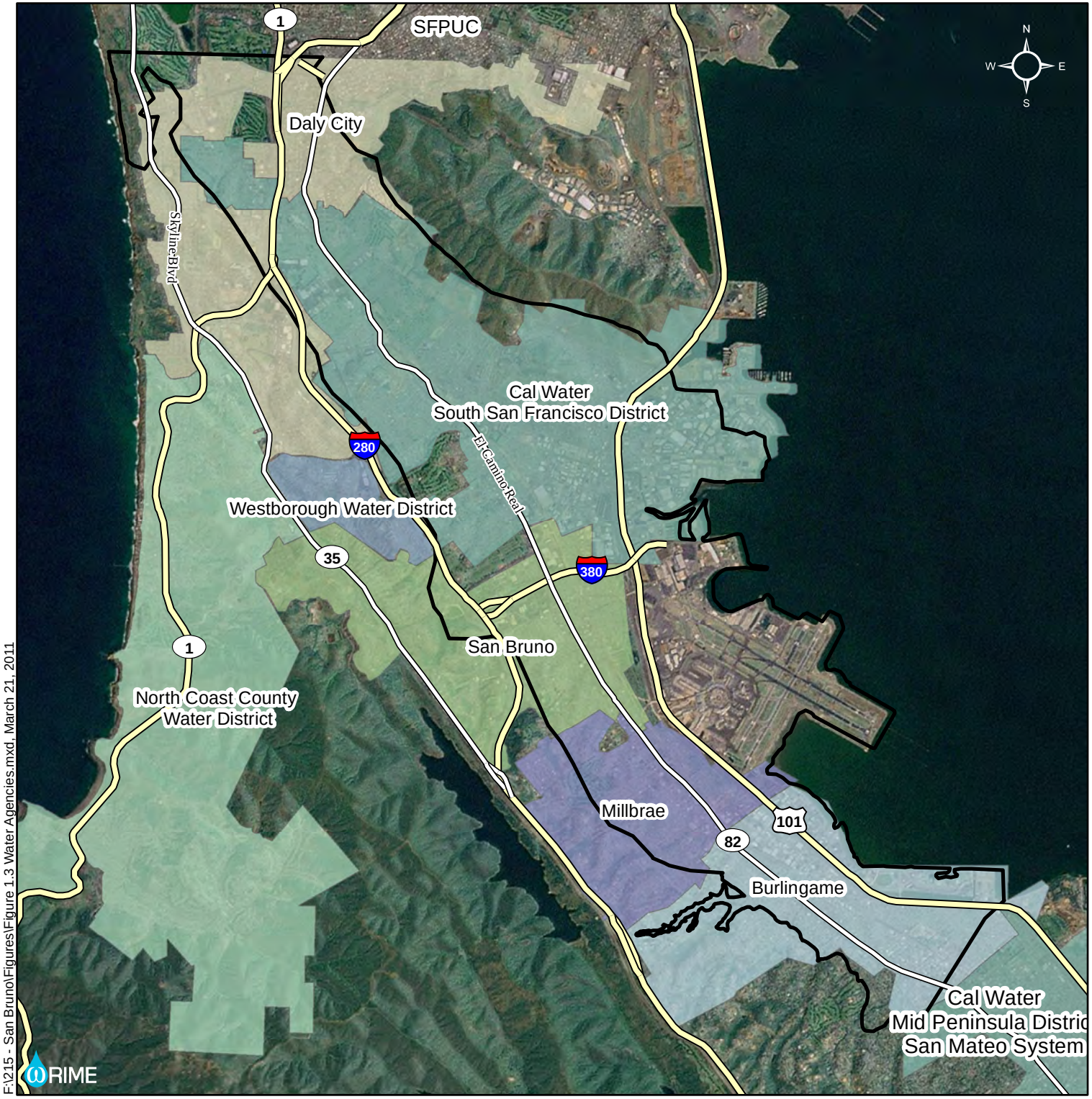

Figure 1.3
Water Agencies

Legend

- Highways
- Plan Area

0 0.5 1 2 Miles

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1.3 OVERVIEW OF WATER REQUIREMENTS AND SUPPLIES

Located on the San Francisco Peninsula, the South Westside Basin underlies approximately 25 square miles and provides groundwater to Colma, Daly City, San Bruno, South San Francisco, unincorporated areas, cemeteries, golf courses, and several smaller users.

The Plan Area is considered built-out, with very little undeveloped land available for development. Future growth will occur through infill, including increased density on existing developed parcels. Land use in the basin is approximately 80 percent urban; 15 percent irrigated parks, golf courses, and cemeteries; and 5 percent unirrigated open space, as shown in Figures 1.4a and 1.4b. Urban areas include large portions of the cities of Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame, as well as urbanized unincorporated areas. The total 2010 water demand for the area was approximately 29,000 acre-feet (AF) (Bay Area Water Supply & Conservation Agency [BAWSCA] 2011; SFPUC, 2011).

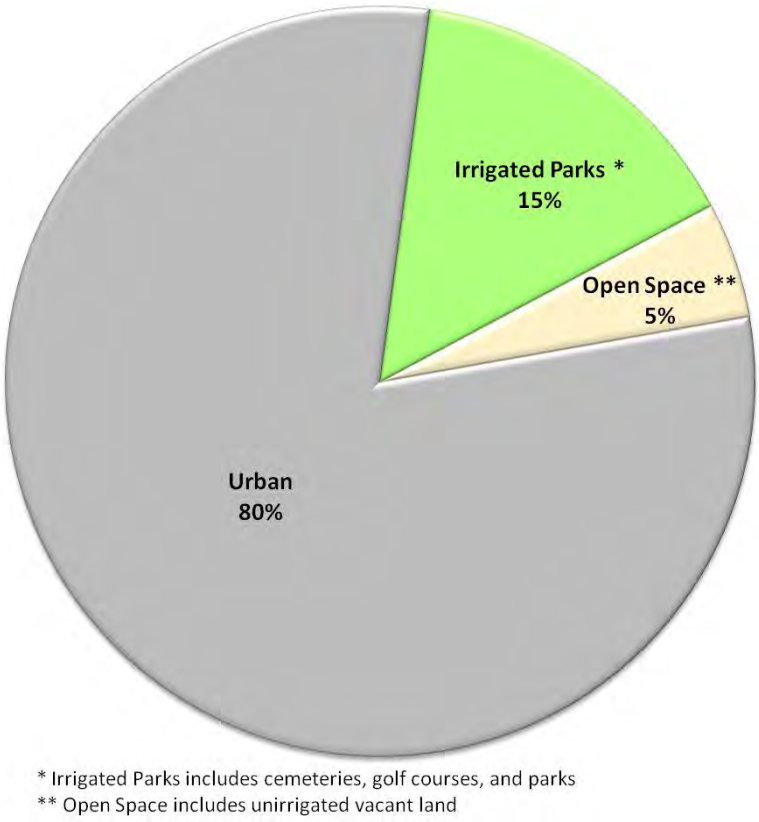


Figure1.4a Current Land Use Summary

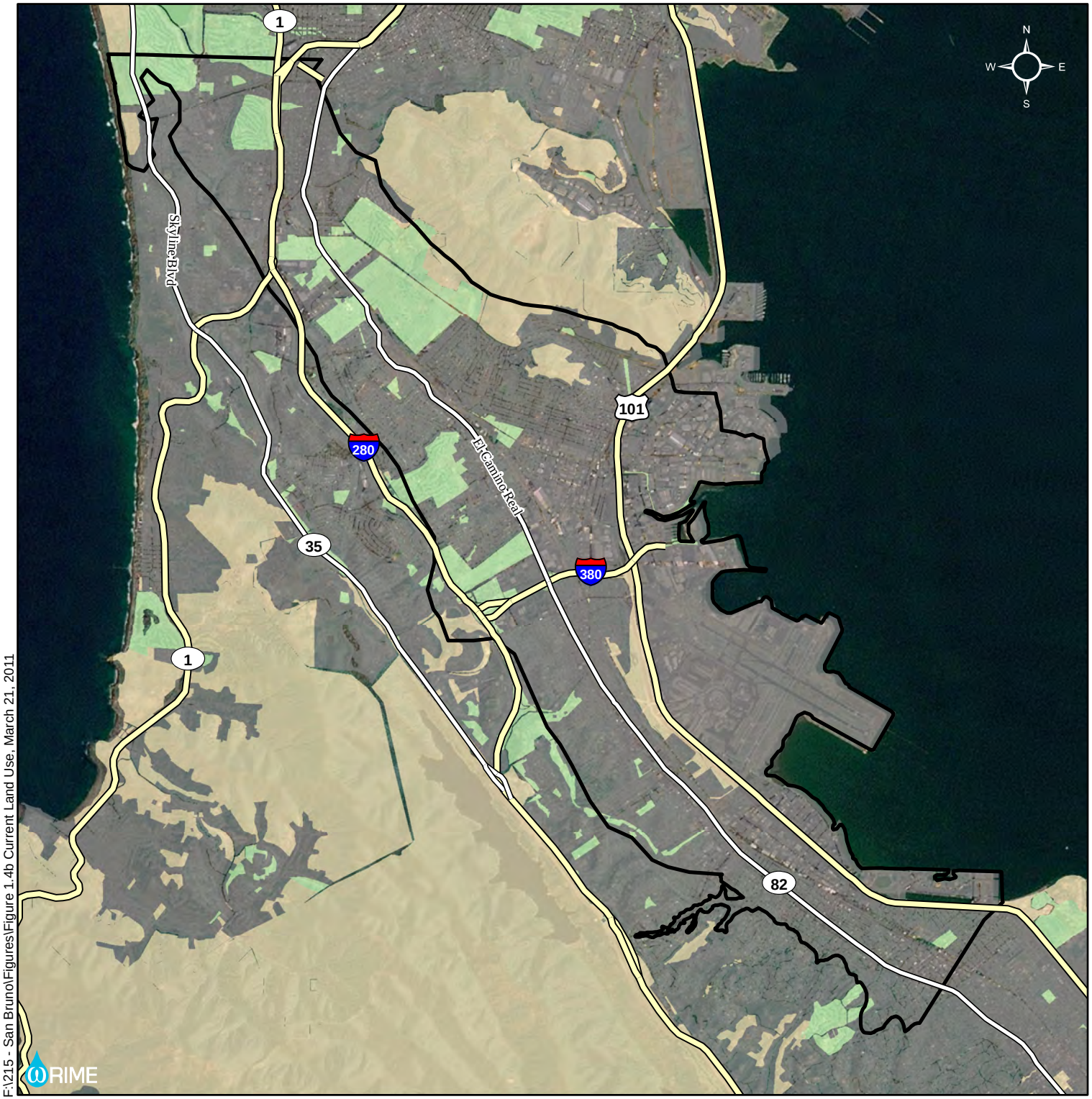


Figure 1.4b
Current Land Use

Legend

- Highways
- Plan Area

Planned Land Use

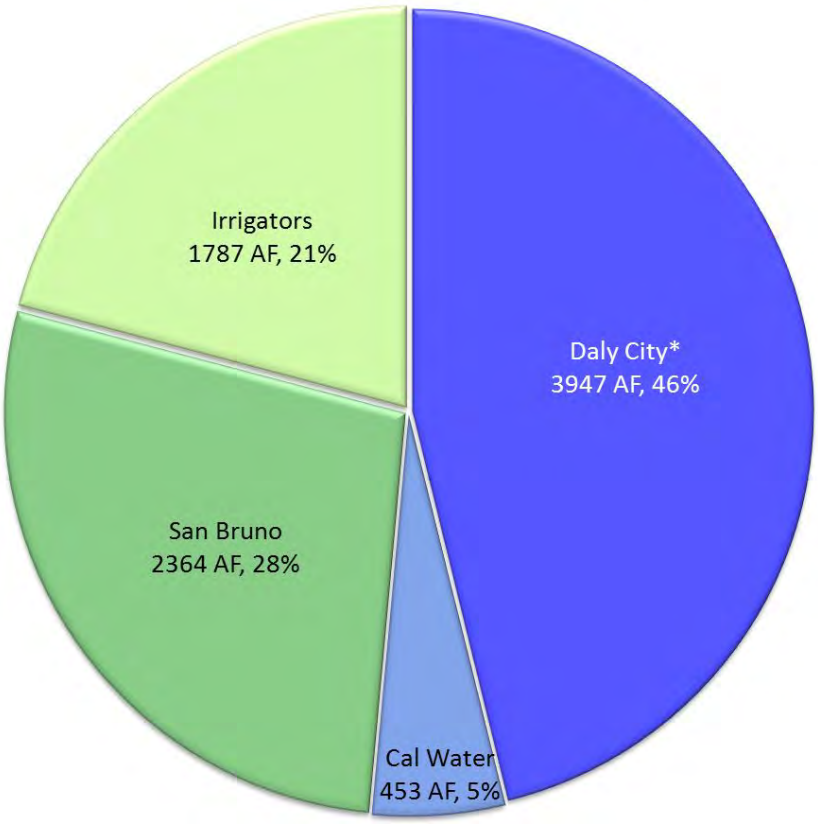
- Urban
- Parks, Cemeteries, Golf Courses
- Open or Vacant Land

0 0.5 1 2 Miles

Source: Land Use - Based on ABAG, 2006

F:\215 - San Bruno\Figures\Figure 1.4b Current Land Use, March 21, 2011

In the South Westside Basin, groundwater plays a critical role, providing up to 50 percent of some localities' water supplies, making it an important resource for the future prosperity and sustainability of the region. Approximately 8,600 AF of groundwater was produced from the South Westside Basin in 2010 (SFPUC, 2011) including 2,200 AF of groundwater banked through in-lieu recharge under the In-Lieu Pilot Study (see Section 1.5.3). Figure 1.5 shows the breakdown of groundwater production by producer for 2010. Imported water from SFPUC's Hetch Hetchy system, along with small quantities of recycled water, provides the remaining supply.



*** Value includes 2,204 AF of banked in-lieu recharge water**

Figure 1.5 Groundwater Production by Entity, 2010

While the Plan Area and surrounding region are largely built-out, additional growth through infill is expected, along with associated increases in water demands. As demands for imported water supplies continue to rise, groundwater will continue to play a key role in delivering a cost-effective and reliable water supply to the South Westside Basin.

1.4 LEGISLATION RELATED TO GROUNDWATER MANAGEMENT PLANS

Groundwater is a resource shared by numerous users; it does not recognize or adhere to jurisdictional lines and cannot be tagged for use by certain users. Groundwater rights have evolved through case law since the late 1800s. Currently, three basic methods are available for managing groundwater resources in California:

- Local agency management under authority granted by the California Water Code or other applicable state statutes (such as through a GWMP);
- Local government groundwater ordinances or joint powers agreements (JPA); and
- Court adjudications.

No law requires that any of these forms be applied within a basin. As such, management is often instituted after local agencies or landowners recognize specific issues in groundwater conditions. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand, as well as groundwater quality.

In an effort to standardize groundwater management, the California Legislature passed Assembly Bill (AB) 255 (Stats. 1991, Ch. 903) in 1991. This legislation authorized local agencies overlying basins subject to critical overdraft conditions, as defined in DWR's Bulletin 118-80 (DWR, 1980), to establish programs for groundwater management within their service areas. Water Code § 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality management. Seven local agencies adopted plans under this authority. The South Westside Basin has never been defined by DWR as being critically overdrafted, as such it was not subject to AB 255.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation greatly increased the number of local agencies authorized to develop a GWMP and set forth a common management framework for local agencies throughout California. AB 3030, codified in Water Code § 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by DWR's Bulletin 118 (DWR, 1975) and updates (DWR, 1980, 2003). Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3).

By 2003, more than 200 agencies (shown in Figure 1.6) had adopted an AB 3030 GWMP (DWR, 2003). None of these agencies is known to have exercised the authority of a water replenishment district.

Water Code § 10755.2 expands groundwater management opportunities by encouraging coordinated plans and authorizing public agencies to enter into a JPA or memorandum of understanding (MOU) with public or private entities providing water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

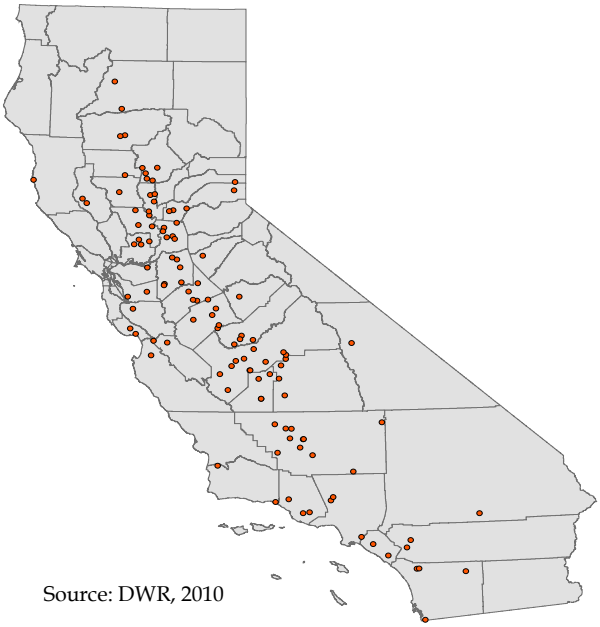


Figure 1.6. Location of areas with groundwater management plans

In 2002, the California Legislature passed Senate Bill (SB) 1938 (Stats. 2002, ch. 603), which provides local agencies with incentives for improved groundwater management. While not providing a new vehicle for groundwater management, SB 1938 modified the Water Code by requiring specific elements be included in a GWMP for an agency to be eligible for certain funding administered by DWR for groundwater projects.

Through AB 3030 and SB 1938, local agencies can now develop GWMPs that guide the sustainable use of the groundwater resource while also providing access to certain DWR funding sources.

1.5 PRIOR AND CURRENT WATER MANAGEMENT PLANNING EFFORTS

The South Westside Basin has an extensive history of management of groundwater and surface water resources. This document builds upon those efforts, described below.

1.5.1 DRAFT WESTSIDE BASIN GROUNDWATER MANAGEMENT PLAN

In 1999, cities and water purveyors overlying much of the Westside Basin (Daly City, CalWater, San Bruno, and SFPUC) cooperatively developed a proposed Westside Basin AB 3030 Groundwater Management Plan (1999 Plan; Bookman-Edmonston, 1999), pursuant to the guidelines in AB 3030. Although not adopted by the cities due to data gaps and other concerns

at the time, the four cities and water purveyors have voluntarily implemented much of the recommendations and other aspects of the 1999 Plan.

The 1999 Plan established a goal of protecting water quality and enhancing water supply reliability in the Westside Basin. This goal was supported by five plan elements:

- **Groundwater Storage and Quality Monitoring –** development of a basin-wide monitoring program
- **Saline Water Intrusion –** use of monitoring data to indicate any occurrence of saltwater intrusion and to provide technical information needed to develop appropriate management responses if intrusion occurs
- **Conjunctive Use –** development of a multi-agency conjunctive use program, including monitoring
- **Recycled Water –** development of a recycled water program for landscape irrigation and other non-potable uses
- **Source Water and Wellhead Protection –** protection of groundwater from contamination from methyl tert-butyl ether (MTBE) and other contaminants through source water assessment methodologies

1.5.2 Regional Groundwater Storage and Recovery Project

The proposed Regional Groundwater Storage and Recovery (GSR) Project is designed to balance the use of both groundwater and surface water to increase water supply reliability during dry years or in emergencies. Located in the South Westside Basin, the proposed project is sponsored by SFPUC in coordination with partner agencies: CalWater, Daly City, and San Bruno. The partner agencies currently purchase wholesale surface water from SFPUC and also independently operate groundwater production wells for drinking water and irrigation.

The project would consist of installing up to 16 new recovery well facilities in the South Westside Basin to pump stored groundwater during a drought. During years of normal or above normal precipitation, the proposed project would provide surface water to the partner agencies to reduce the amount of groundwater pumped. The reduced pumping is estimated to result in the storage of approximately 61,000 AF of water in the long-term. This is estimated to allow recovery of stored water at a rate of up to 7.2 million gallons per day (mgd) for a 7.5-year drought period, if the full 61,000 AF is stored prior to the drought period (MWH, 2007). The storage of water in the basin was analyzed through the In-Lieu Pilot Study (ILPS), which is described in the following section.

The GSR Project is in the design and environmental review phases and is envisioned to coordinate management of groundwater supplies through an Operating Committee. The development of the GSR Project includes extensive study of the hydrogeology of the South

Westside Basin and was documented in the Alternatives Analysis Report (MWH, 2007) and in reports documenting monitoring well installation (Kennedy/Jenks, 2009 and 2010).

The parties are working to develop an operating agreement in connection with the proposed GSR Project. To-date, the SFPUC has installed ten multi-level monitoring wells in the South Westside Basin (each consisting of 4 nested monitoring wells). The Proposed Project Draft EIR is scheduled to be circulated in 2012.

1.5.3 IN-LIEU PILOT STUDY

Beginning in 2002, SFPUC delivered surface water in-lieu of groundwater through the ILPS to Daly City, San Bruno and CalWater - South San Francisco District. The ILPS demonstrated that SFPUC system water can be stored in the Basin through the delivery of in-lieu water to replace groundwater that Daly City, San Bruno, and CalWater refrained from pumping (Luhdorff & Scalmanini Consulting Engineers [LSCE], 2005).

During the ILPS, significant quantities of water were banked as shown in Figure 1.7 and discussed below:

- **Daly City -** Through May 7, 2007, SFPUC delivered 13,077 AF of in-lieu water to Daly City. Beginning in May 2009, SFPUC resumed delivery of in-lieu water to Daly City, resulting in additional banking of water. In 2009 and 2010, 1,921 AF and 2,204 AF of water was banked by Daly City, respectively.
- **CalWater – South San Francisco District -** Between February 1, 2003 and November 1, 2003, SFPUC delivered 802 AF of in-lieu water to CalWater – South San Francisco District. When the ILPS restarted on April 1, 2004, CalWater did not participate and did not resume pumping, but continued to rely on wholesale water for all of its water needs in its South San Francisco service area. This resulted in an increase in basin water levels as if CalWater had continued to participate in the ILPS, and a corresponding increase in stored water of 930 AF between April 1, 2004 and March 1, 2005.
- **San Bruno –** From January 28, 2003 **t**hrough March 1, 2005, SFPUC delivered 3,915 AF of in-lieu water to San Bruno.

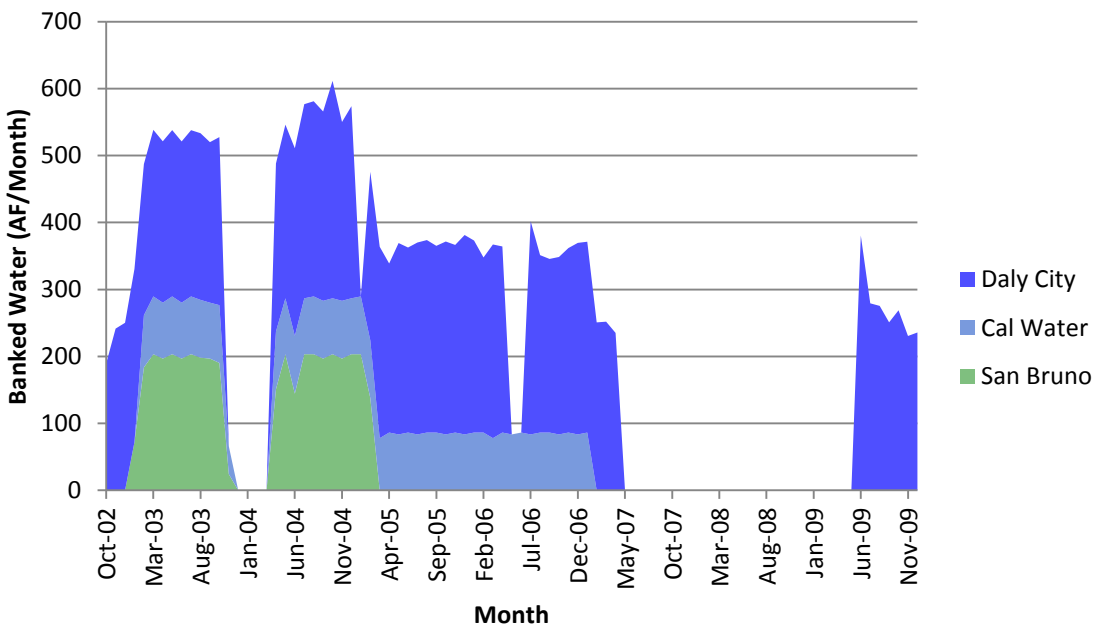


Figure 1.7 Banked Groundwater in In-Lieu Pilot Study

1.5.4 SAN FRANCISCO BAY BASIN WATER QUALITY CONTROL PLAN

The *San Francisco Bay Basin Water Quality Control Plan* (Basin Plan) (California Regional Water Quality Control Board, San Francisco Bay Region [RWQCB], 2010) was developed by the RWQCB to provide positive and firm direction for future water quality control.

The Basin Plan fulfills the following needs:

- Requirements from the U.S. Environmental Protection Agency (EPA) for such a plan to allocate federal grants to cities and districts for construction of wastewater treatment facilities.
- A basis for establishing priorities for disbursing both state and federal grants for constructing and upgrading wastewater treatment facilities.
- Requirements of the Porter-Cologne Act that call for water quality control plans in California.
- A basis for the RWQCB to establish or revise waste discharge requirements and for the State Water Resources Control Board (Water Board) to establish or revise water rights permits.
- Conditions (discharge prohibitions) that must be met at all times.
- Water quality standards applicable to waters of the Region, as required by the federal Clean Water Act.

- Water quality attainment strategies, including total maximum daily loads required by the Clean Water Act, for pollutants and water bodies where water quality standards are not currently met.

While the Basin Plan has a definite focus on surface water resources, groundwater quality is included as well, particularly through the watershed management approach. This approach includes groundwater as well as surface water bodies (e.g., streams, rivers, lakes, reservoirs, wetlands, and the surrounding landscape) in an effort to develop unique, integrated solutions for individual watersheds through a stakeholder process.

As with surface water, the Basin Plan establishes beneficial uses for groundwater throughout the San Francisco Bay Region. For the South Westside Basin, the Basin Plan identifies two areas: Westside C (2-35C), extending from the San Francisco County line to the City of South San Francisco, and Westside D (2-35D), extending from South San Francisco to the southern extent of the South Westside Basin. The designated beneficial uses for groundwater within these areas, and within areas in the North Westside Basin, are shown in Table 1.1.

Table 1.1 Basin Plan Beneficial Uses for Groundwater

Basin Plan Basin	Location	Beneficial Uses			
		Municipal and Domestic Water Supply	Industrial Process Water Supply	Industrial Service Water Supply	Agricultural Water Supply
Westside C	South Westside Basin	Existing	Potential	Potential	Existing
Westside D	South Westside Basin	Existing	Existing	Existing	Potential
Westside A	North Westside Basin	Existing	Potential	Potential	Existing
Westside B	North Westside Basin	Potential	Potential	Potential	Existing

The Basin Plan sets objectives for groundwater, with maintenance of existing high-quality of groundwater being the primary objective. In addition, at a minimum, groundwater shall not contain concentrations of bacteria, chemical constituents, radioactivity, or substances producing taste and odor in excess of the objectives unless naturally occurring background concentrations

are greater. Under existing law, the Water Board regulates waste discharges to land that could affect water quality, including both groundwater and surface water quality. Waste discharges that reach groundwater are regulated to protect both groundwater and any surface water in continuity with groundwater. Waste discharges that affect groundwater in continuity with surface water cannot cause violations of any applicable surface water standards.

For implementation, the RWQCB focuses on 28 groundwater basins and 7 sub-basins in the Bay Area that serve, or could serve, as sources of high quality drinking water. The Westside Basin is one of these basins. The Basin Plan establishes the following groundwater protection and management goals for the Bay Area region:

- Identify and update beneficial uses and water quality objectives for each groundwater basin.
- Regulate activities that impact or have the potential to impact the beneficial uses of groundwater of the region.
- Prevent future impacts to the groundwater resource through local and regional planning, management, education, and monitoring.

1.5.5 SAN FRANCISCO AND NORTHERN SAN MATEO COUNTY PILOT BENEFICIAL USE DESIGNATION PROJECT

RWQCB staff, with contributions from local agencies, evaluated existing groundwater protection programs and beneficial uses of groundwater in San Francisco and northern San Mateo County (RWQCB, 1996). Extensive research was conducted and numerous references were compiled to complete the project. The project included the following goals:

- Describe the hydrogeology and groundwater uses for the groundwater basins
- Identify major threats to groundwater and groundwater protection programs
- Identify locations where groundwater is vulnerable to contamination
- Identify locations where groundwater monitoring is needed
- Use GIS to compile complex data sets to use as a decision-making tool for groundwater protection
- Refine beneficial use designations for some groundwater basins
- Identify inactive well locations
- Describe groundwater extraction for municipal, agricultural, and industrial water supply
- Summarize statewide initiatives for groundwater protection and data sharing

- Evaluate special problem areas not typically addressed by groundwater protection programs

The results of the project identified the Westside Basin as a valuable resource deserving of full protection and restoration, including aggressive remediation of contaminated groundwater, enhanced source control and groundwater protection to prevent additional pollution, and groundwater basin management to prevent overdraft.

1.5.6 GROUNDWATER AMBIENT MONITORING AND ASSESSMENT PROGRAM: SAN FRANCISCO BAY STUDY UNIT

The Groundwater Ambient Monitoring and Assessment (GAMA) program is a comprehensive assessment of statewide groundwater quality implemented by the Water Board in coordination with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The program is designed to help better understand and identify risks to groundwater resources. The South Westside Basin was included in the study through the investigation of the San Francisco Bay study unit, which includes portions of San Francisco, San Mateo, Santa Clara, and Alameda Counties, with sampling from April through June 2007.

Groundwater was sampled from 79 wells within the San Francisco Bay study unit to characterize its constituents and identify trends in groundwater quality through a spatially unbiased assessment of raw groundwater quality. Four grid cell wells (SF-03, SF-04, SF-05, and SF-06) and seven understanding wells (SFM-A1, SFM-A2, SFM-A3 SFM-A4, SFM-B1, SFM-B2, and SFU-01) are located in or near the South Westside Basin. The focus on raw water quality rather than treated water quality and the spatially unbiased nature of the program set it apart from other sampling programs that typically use available data from existing wells that are biased toward better water quality and have data intended to meet regulatory requirements for drinking water supplies.

The test results provide information to address a variety of issues ranging in scale from local water supply to statewide resource management. Full analysis of the results will be included in a future USGS report.

1.5.7 BAY AREA INTEGRATED REGIONAL WATER MANAGEMENT PLAN

The Bay Area Integrated Regional Water Management Plan (IRWMP) (RMC and Jones & Stokes, 2006) was developed through a Letter of Mutual Understanding by San Francisco Bay Area water, wastewater, flood protection, and stormwater management agencies; cities and counties represented by the Association of Bay Area Governments; and watershed management interests represented by the California Coastal Conservancy and non-governmental environmental organizations. The IRWMP outlines the region's water resource management needs and objectives, and presents innovative strategies and a detailed implementation plan to

achieve these objectives, contributing to sustainable water resources management in the Bay Area.

The following are the overall objectives of the Bay Area IRWMP:

1) Foster coordination, collaboration and communication among Bay Area agencies responsible for water and habitat-related issues.
2) Achieve greater efficiencies and build public support for vital projects.
3) Improve regional competitiveness for project funding.

The Bay Area IRWMP identifies regional priority projects, including two in the South Westside Basin: the Lomita Canal / Cupid Row Canal Upgrades at San Francisco International Airport and SFPUC Groundwater Projects (including Lake Merced Project, Local Groundwater Projects, and the Regional Groundwater Storage and Recovery Project).

The Bay Area IRWMP will be going through an update during 2011 – 2012 to ensure that the IRWMP is in compliance with Proposition 84 requirements, including a climate change impact assessment and integrated flood management.

1.5.8 WATER SUPPLY AGREEMENT BETWEEN THE CITY AND COUNTY OF SAN FRANCISCO AND WHOLESALE CUSTOMERS IN ALAMEDA COUNTY, SAN MATEO COUNTY, AND SANTA CLARA COUNTY

The Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County, and Santa Clara County (Wholesale Water Supply Agreement) (July, 2009) defines the agreement for San Francisco to deliver, up to a defined quantity (Supply Assurance), water to the wholesale customers, including the water agencies in the South Westside Basin. The Supply Assurance includes the wholesale customers as a group, while Individual Supply Guarantees are defined for each agency (Table 1.2). These quantities are expressed in terms of daily deliveries on an annual average basis, although San Francisco agrees to operate the system to meet peak requirements to the extent possible without adversely impacting the ability to meet peak demands of retail customers.

The Wholesale Water Supply Agreement includes details on allocation, service areas, permanent transfers, resale, conservation, other supplies, water quality, maintenance, operation, shortages, wheeling, new customers, metering, the proposed conjunctive use program for the South Westside Basin, implementation of interim supply limitations, wholesale revenues, accounting, and other agreements.

Table 1.2 Individual Supply Guarantees

Wholesale Customer	Individual Supply Guarantee (mgd)	Water Purchases Fiscal Year 2009-2010 (mgd)*
California Water Services Company	35.68 (includes South San Francisco and areas outside the South Westside Basin)	32.6 (7.2 mgd for South San Francisco District)
City of Burlingame	5.234	3.9
City of Daly City	4.292	3.2**
City of Millbrae	3.152	2.2
City of San Bruno	3.246	1.5
Town of Hillsborough	4.090	3.0

* BAWSCA, 2011

** Amount shown does not include 1.9 mgd of in-lieu water purchases

1.5.9 URBAN WATER MANAGEMENT PLANS

Urban water management plans (UWMP) include descriptions and evaluations of historical, current, and future sources of water supply; efficient uses of water; demand management measures; implementation strategies and schedules; and other information as required by the Urban Water Management Planning Act. They are important components for the planning process of each agency and values from these plans are used extensively in Section 3, Water Requirements and Supplies, of this GWMP.

A UWMP is required for water agencies with more than 3,000 customers or that provide over 3,000 AF of water annually. Within the South Westside Basin, UWMPs have been developed and adopted by Burlingame, Daly City, Hillsborough, Millbrae, San Bruno, and CalWater. In the North Westside Basin, SFPUC has developed a UWMP.

1.6 PUBLIC PROCESS IN DEVELOPING THE GROUNDWATER MANAGEMENT PLAN

The development of any GWMP is a collaborative process involving all interested stakeholders. Public input is critical to the success of the South Westside Basin GWMP and was a key component of its development.

The public was informed and encouraged to provide input and participate in the development of the GWMP in the following ways:

- GWMP web site: **www.southwestsideplan.com** provided information to the public regarding the GWMP. Details about groundwater management in general and specific to the South Westside Basin were provided. Meeting dates, locations, and materials were posted along with details of the South Westside Basin GWMP Advisory Committee (Advisory Committee) and contact information.
- Newspaper advertisements in the San Mateo County Times gave notice of public hearings.
- Public hearings provided opportunities for personal communications captured in the public record on specific topics, including resolution of intent to draft a GWMP and resolution of adoption of the GWMP.
- Public meetings provided details on the GWMP process and solicited input.
- Advisory Committee meetings provided detailed technical information on the GWMP and solicited input.
- Direct communication by telephone, email, and mail was encouraged at meetings and on the web site. Comments could be sent to the City of San Bruno project manager, local water agency staff, or the consultant project manager.

1.6.1 JUNE 2009 PRESENTATION TO IRRIGATION PUMPERS IN THE SOUTH WESTSIDE BASIN

A presentation on the South Westside Basin GWMP was given on June 25, 2009 to cemetery and golf course interests as part of a SFPUC meeting on the proposed GSR and its potential impacts and benefits for cemeteries and golf courses. The meeting was held at 10:30 a.m. at the Colma Town Hall. The presentation gave an overview of groundwater planning, the proposed GWMP, and the process of developing the GWMP. Attendees were invited to provide contact information and to continue to provide guidance as the GWMP is developed and implemented. Copies of the presentation were provided to interested parties via email. Attendees included representatives from the following:

- Holy Cross Cemetery
- Lake Merced area golf courses
- Town of Colma

- City of Daly City
- City of San Bruno
- SFPUC

1.6.2 PUBLIC HEARINGS

1.6.2.1 Intent to Adopt

A public hearing of Intent to Adopt a Groundwater Management Plan was held at the regular meeting of the San Bruno City Council at 7 p.m. on August 24, 2010 at the San Bruno Senior Center. The hearing was advertised in the *San Mateo Times*, on August 10, 2010 and August 17, 2010. A resolution was adopted by the City Council and subsequently was published in the San Mateo Times on September 8, 2010 and September 15, 2010. The advertisements and the resolution are included in Appendix A.

1.6.2.2 Adoption

A public hearing to adopt the Groundwater Management Plan was held at the regular meeting of the San Bruno City Council at 7 p.m. on July 10, 2012 at the San Bruno Senior Center. The hearing was advertised in the *San Mateo Tim*es twice prior to the hearing. The advertisements and the resolution are included in Appendix A.

1.6.3 PUBLIC MEETINGS

A total of five public meetings were held to inform the public on the development of the groundwater management plan.

1.6.3.1 Background, Components, and Process

Three public meetings were held at locations across the South Westside Basin to provide information on the importance of groundwater as a water supply, the need for management of the groundwater resource, the role of a GWMP, the role of the public in the development and implementation of the GWMP, and the preliminary goals, objectives, and elements of the groundwater management plan.

1.6.3.1.1 San Bruno Presentation

The presentation in the southern portion of the South Westside Basin was given at San Bruno City Hall on Thursday September 9, 2010 at 5:30 pm. The meeting was advertised on San Bruno's cable television station, noticed at City Hall, and advertised in the *San Mateo Times* on September 4, 2010.

1.6.3.1.2 Daly City Presentation

A presentation in the northern portion of the South Westside Basin at was given at Daly City City Hall on Thursday September 23, 2010 at 7:00 pm. The meeting was noticed at City Hall, on the city's web page, and on the city's cable television station. Interviews were provided to a student from San Francisco State University for airing on the campus radio station, KSFS.

1.6.3.1.3 Colma Presentation

The presentation in the central portion of the South Westside Basin was given at Colma Town Hall on Thursday October 13, 2010 at 11:30 am. The meeting was noticed at Town Hall. Extensive personal outreach was conducted to inform the numerous cemeteries that utilize private groundwater wells for their irrigation supply.

1.6.3.2 Draft Plan Presentation

The fourth public meeting was held at Colma Town Hall on May 24, 2011 at 11:30am. The meeting was noticed at Town Hall and outreach was performed to inform the cemeteries. The draft Groundwater Management Plan was presented and stakeholders were provided an opportunity to discuss the draft Plan and provide comments either in person or at a later date.

1.6.3.3 Distribution of Draft GWMP

The draft text of the GWMP was distributed to the public for comment on May 10, 2012. The comment period extended until June 9, 2012. One email was received with comments, which were addressed.

1.6.3.4 Final Draft Plan Presentation

The fifth public meeting was held at San Bruno City Hall on May 23, 2012 at 5:30 pm. The meeting was noticed at City Hall and advertised in the *San Mateo Times* on May 20, 2012. The final draft Groundwater Management Plan and the activities moving forward were discussed.

1.7 SOUTH WESTSIDE BASIN GWMP ADVISORY COMMITTEE

The Advisory Committee was organized to solicit input and direct the development of the GWMP. Agencies and key stakeholders were provided written invitations to send to their representatives to invite them to participate in the Advisory Committee. Other stakeholders were invited to join through the public notification process, hearings, the web site, and public meetings. Table 1.3 lists the Advisory Committee members and their affiliations. Meetings were held from 2009 through 2011 to coordinate stakeholder input and incrementally build the GWMP. Agendas and minutes are included in Appendix A.

During implementation of the GWMP, it is anticipated that most of the members of the Advisory Committee will join the Groundwater Task Force. The Groundwater Task Force will guide the implementation of the GWMP and is described in more detail in Section 6.1.

Table 1.3 Advisory Committee Members

Entity	Representative
Bay Area Water Supply and Conservation Agency	Anona Dutton
City of Brisbane	Randy L. Breault
City of Burlingame	Phil Monaghan
California Water Services Company	Tom Salzano
DWR	Mark Nordberg
Cemeteries	Roger Appleby
Town of Colma	Brad Donohue
City of Daly City	Patrick Sweetland
RWQCB	Kevin D. Brown
City of San Bruno	Will Anderson
SFPUC	Greg Bartow
City of South San Francisco	Terry White
Interested citizens	Robert Riechel

1.7.1 DECEMBER 18, 2009 ADVISORY COMMITTEE MEETING 1

An Advisory Committee meeting was held on December 18, 2009 to coordinate the Advisory Committee, develop a common understanding of basin conditions and groundwater management plans, and to develop a goal or goals for the basin. The meeting was held at San Bruno City Hall and was well attended, including representatives of the following:

- California Water Services Company
- City of Brisbane
- City of Burlingame
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC
- Town of Colma
- Private citizens
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.2 MARCH 11, 2010 ADVISORY COMMITTEE MEETING 2

The second Advisory Committee meeting was held on March 11, 2010 to discuss Basin Management Objectives (BMOs), both in general and specific to the South Westside Basin. The meeting was held at San Bruno City Hall and was attended by representatives of the following:

- Bay Area Water Supply and Conservation Agency
- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.3 JUNE 24, 2010 ADVISORY COMMITTEE MEETING 3

An Advisory Committee meeting was held on June 24, 2010 to discuss comments received on the BMOs and to discuss the Elements of the Plan. The meeting was held at San Bruno City Hall and was attended by representatives of:

- Bay Area Water Supply and Conservation Agency
- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma

The meeting minutes are included in Appendix A.

1.7.4 AUGUST 16, 2010 ADVISORY COMMITTEE MEETING 4

An Advisory Committee meeting was held on August 16, 2010 to discuss basin governance and financing of the implementation of the groundwater management plan. The meeting was held at San Bruno City Hall and was attended by representatives of:

- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC

- Town of Colma

The meeting minutes are included in Appendix A.

1.7.5 FEBRUARY 3, 2011 ADVISORY COMMITTEE MEETING 5

An Advisory Committee meeting was held on February 3, 2011 to discuss the recent completion of a revision to the Westside Basin Groundwater Flow Model and the utility of the model in the development of the GWMP. The discussion included using the model to estimate the basin yield. The meeting was held at San Bruno City Hall and was attended by representatives of:

- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.6 APRIL 28, 2011 ADVISORY COMMITTEE MEETING 6

An Advisory Committee meeting was held on April 28, 2011 to update the current status of the Groundwater Management Plan to provide information to focus the review to be performed by the Advisory Committee. Progress toward participation in the CASGEM program was also discussed.

The meeting was held at San Bruno City Hall and was attended by representatives of:

- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.7 APRIL 15, 2011 DISTRIBUTION OF DRAFT GWMP

The draft text of the GWMP was distributed to the Advisory Committee for comment on April 15, 2011. Comments were received from BAWSCA, CalWater, San Bruno, SFPUC, and Steve Lawrence and incorporated into the text as appropriate.

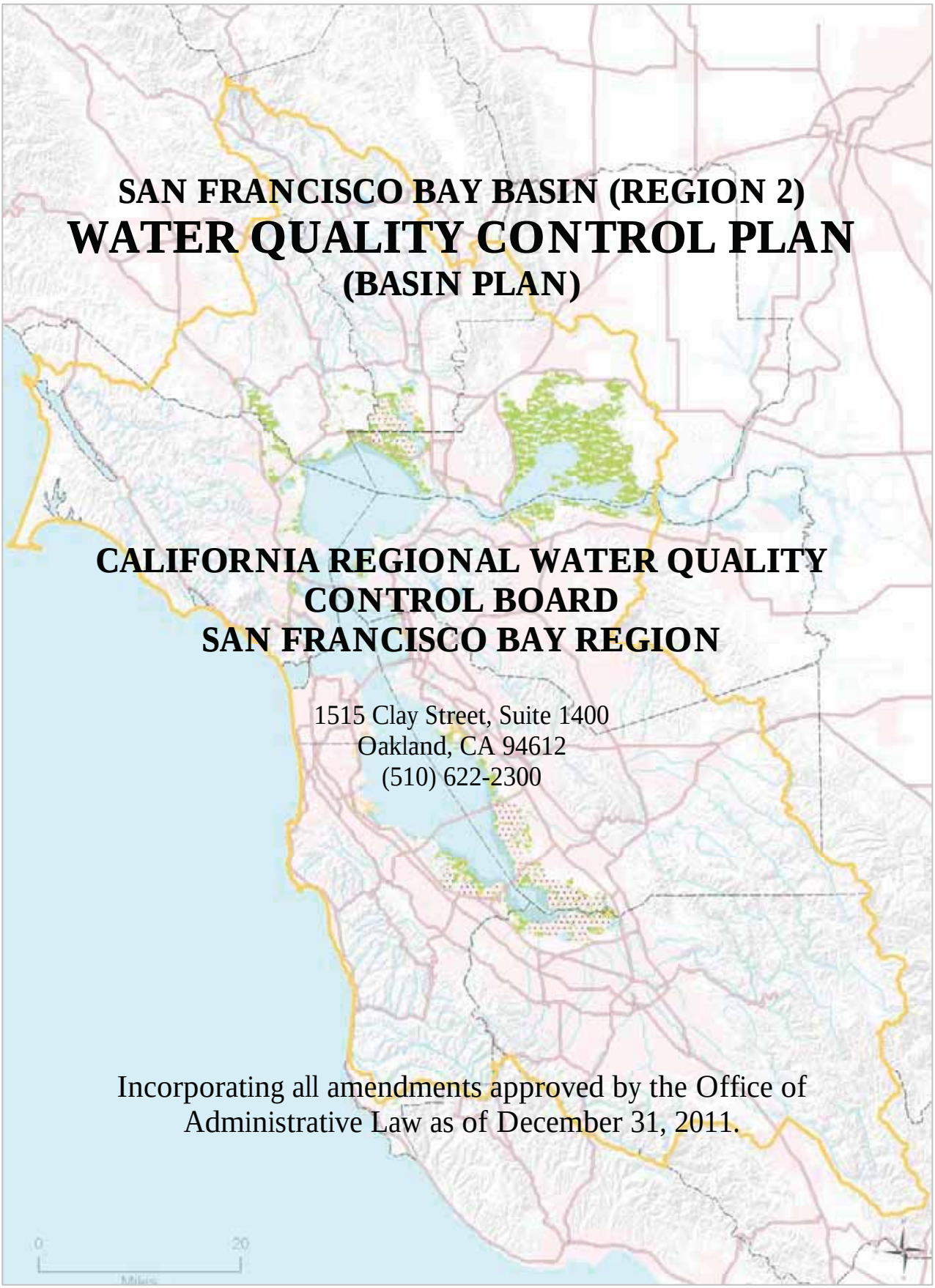
1.8 GROUNDWATER MANANGEMENT PLAN AND CONSISTENCY WITH CALIFORNIA WATER CODE

Groundwater management is the planned and coordinated local effort of sustaining the groundwater basin in order to meet future water supply needs. With the passage of AB 3030 in 1992, local water agencies were provided a systematic way of formulating GWMPs (California Water Code, § 10750 et. seq.). SB 1938, passed in 2002, further emphasizes the need for groundwater management in California. SB 1938 requires AB 3030 GWMPs to contain specific plan components in order to receive state funding for water projects.

The South Westside Basin Groundwater Management Plan is prepared consistent with the provisions of California Water Code § 10750 et seq. as amended January 1, 2003. The South Westside Basin GWMP includes the seven components that are required to be eligible for DWR funds for the construction of groundwater projects or groundwater quality projects. The GWMP also addresses the 12 specific technical issues identified in the Water Code along with the seven recommended components identified in DWR Bulletin 118-03 (DWR, 2003). Table 1.4 lists the required and recommended components and identifies the specific section of this GWMP in which the components are discussed.

Table 1.4 South Westside Basin GWMP Components

Component	GWMP Section(s)
SB 1938 Mandatory	
1. Documentation of public involvement	1.6, 1.7, App. A
2. BMOs	4.3
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality	5.2
4. Plan to involve other agencies located in the groundwater basin	5.1
5. Adoption of monitoring protocols	5.2, App. C
6. Map of groundwater basin boundary, as delineated by DWR Bulletin 118, with boundaries of agencies subject to the GWMP	Figures 1.1, 1.2, and 1.3
7. For agencies not overlying groundwater basins, GWMP prepared using appropriate geologic and hydrogeologic principles	n/a
AB 3030 and SB 1938 Voluntary	
1. Control of saline water intrusion	5.4.1
2. Identification and management of well protection and recharge areas	5.4.2
3. Regulation of the migration of contaminated groundwater	5.4.3
4. Administration of well abandonment and destruction program	5.4.4
5. Control and mitigation of groundwater overdraft	5.3.1
6. Replenishment of groundwater	5.3.2
7. Monitoring of groundwater levels	5.2.1, App. C
8. Development and operation of conjunctive use projects	5.3.3
9. Identification of well construction policies	5.4.5
10. Construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	5.5
11. Development of relationships with state and federal regulatory agencies	5.6.1
12. Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination	5.6.3
DWR Bulletin 118 Recommended	
1. Management with guidance of advisory committee	1.7, 5.1
2. Description of area to be managed under GWMP	1.1, Figures 1.1, 1.2, and 1.3
3. Links between BMOs and goals and actions of GWMP	4, 6
4. Description of GWMP monitoring programs	5.2, App. C
5. Description of integrated water management planning efforts	1.5, 5.6.2
6. Report of implementation of GWMP	5.7
7. Periodic evaluation of GWMP	5.7



SAN FRANCISCO BAY BASIN (REGION 2)
WATER QUALITY CONTROL PLAN
(BASIN PLAN)

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

1515 Clay Street, Suite 1400
Oakland, CA 94612
(510) 622-2300

Incorporating all amendments approved by the Office of Administrative Law as of December 31, 2011.

CHAPTER 1: INTRODUCTION

1.1 THE SAN FRANCISCO BAY REGION

The San Francisco Bay Region (Region) is 4,603 square miles, roughly the size of the State of Connecticut, and characterized by its dominant feature, 1,100 square miles of the 1,600 square mile San Francisco Bay Estuary (Estuary), the largest estuary on the west coast of the United States, where fresh waters from California's Central Valley mix with the saline waters of the Pacific Ocean. The Region also includes coastal portions of Marin and San Mateo counties, from Tomales Bay in the north to Pescadero and Butano Creeks in the south.

The Estuary conveys the waters of the Sacramento and San Joaquin rivers into the Pacific Ocean. Located on the central coast of California (Figure 1-1), the Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks natural topographic separation between the northern and southern coastal mountain ranges. The Region's waterways, wetlands, and bays form the centerpiece of the United States' fourth-largest metropolitan region, including all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties.

Because of its highly dynamic and complex environmental conditions, the Bay system supports an extraordinarily diverse and productive ecosystem. Within each section of the Bay lie deepwater areas that are adjacent to large expanses of very shallow water. Salinity levels range from hypersaline to fresh water, and water temperature varies throughout the Bay system. These factors greatly increase the number of species that can live in the Estuary and enhance its biological stability.

The Bay system's deepwater channels, tidelands, marshlands, freshwater streams, and rivers provide a wide variety of habitats that have become increasingly vital to the survival of several plant and animal species as other estuaries are reduced in size or lost to development. These areas sustain rich communities of crabs, clams, fish, birds, and other aquatic life and serve both as important wintering sites for migrating waterfowl and as spawning areas for anadromous fish.

1.2 THE BAY SYSTEM'S SURFACE WATER & GROUNDWATER

The Sacramento and San Joaquin rivers, which enter the Bay system through the Delta at the eastern end of Suisun Bay, contribute almost all the freshwater inflow to the Bay. Many small rivers and streams also convey fresh water to the Bay system. The rate and timing of these freshwater flows are among the most important factors influencing physical, chemical, and biological conditions in the Estuary. Much of the freshwater inflow, however, is trapped upstream by the dams, canals, and reservoirs of California's water diversion projects, which provide vital water to industries, farms, homes, and businesses throughout the state. This freshwater diversion has sparked statewide controversy over possible adverse effects on the Estuary's water quality, fisheries, and ecosystem.

Flows in the Region are highly seasonal, with more than 90 percent of the annual runoff occurring during the winter rainy season between October and April. Many streams go dry during the middle or late summer. For example, the Napa River, which is least affected by

upstream regulation, clearly shows the seasonal nature of runoff. Only 4-1/2 percent of this river's average annual runoff occurs during the summer months.

Groundwater is an important component of the hydrologic system in the Region. Groundwater provides excellent natural storage, distribution, and treatment systems. Groundwater also supplies high quality water for drinking, irrigation, and industrial processing and service. As an important source of freshwater replenishment, groundwater may also discharge to surface streams, wetlands, and San Francisco Bay.

A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges degrade groundwater quality, including industrial and agricultural chemical spills, underground and above-ground tank and sump leaks, landfill leachate, septic tank failures, and chemical seepage via shallow drainage wells and abandoned wells. In addition, saltwater intrusion directly attributed to over- pumping has degraded the purity of some groundwater aquifers.

These adverse impacts on groundwater quality often have long-term effects that are costly to remediate. Consequently, as additional discharges are identified, source removal, pollution containment, and cleanup must be undertaken as quickly as possible. Activities that may potentially pollute groundwater must be managed to ensure that groundwater quality is protected.

1.3 PROTECTING SAN FRANCISCO BAY: THE WATER BOARD

Because of its unique characteristics, the San Francisco Bay estuarine system merits special protection. The adverse effects of waste discharges must be controlled. Extensive upstream water diversions must be limited, and their effects mitigated. To address these and other water issues, the California Legislature established the State Water Resources Control Board (State Water Board) and the nine Regional Water Quality Control Boards (Regional Water Boards) in 1949. Operating under the provisions of the California Water Code (Water Code), their unique relationship couples state-level coordination and regional familiarity with local needs and conditions. Their joint actions constitute a comprehensive program for managing water quality in California, as well as for effective state administration of federal water pollution control laws.

The State Water Board administers water rights, water pollution control, and water quality functions for the state as part of the California Environmental Protection Agency (Cal/EPA). It provides policy guidance and budgetary authority to the Regional Water Boards, which conduct planning, permitting, and enforcement activities. The State Water Board shares authority for implementation of the federal Clean Water Act and the state Porter-Cologne Act with the Regional Water Boards.

The San Francisco Bay Regional Water Quality Control Board (Water Board) regulates surface water and groundwater quality in the Region. The area under the Water Board's jurisdiction comprises all of the San Francisco Bay segments extending to the mouth of the Sacramento-San Joaquin Delta (Winter Island near Pittsburg).

California's governor appoints the nine-member Water Board, whose members serve for four-year terms. Water Board members must reside or maintain a place of business within the Region and must be associated with or have special knowledge of specific activities related to water quality control. Members of the Water Board serve without pay and conduct their business at regular meetings and frequent public hearings where public participation is encouraged.

The Water Board's overall mission is to protect surface waters and groundwater in the Region. The Water Board carries out its mission by:

- Addressing Region-wide water quality concerns through the creation and triennial update of a Water Quality Control Plan (Basin Plan);
- Preparing new or revised policies addressing Region-wide water quality concerns;
- Adopting, monitoring compliance with, and enforcing waste discharge requirements and National Pollutant Discharge Elimination System (NPDES) permits;
- Providing recommendations to the State Water Board on financial assistance programs, proposals for water diversion, budget development, and other statewide programs and policies;
- Coordinating with other public agencies that are concerned with water quality control; and
- Informing and involving the public on water quality issues.

1.4 WATER QUALITY CONTROL PLAN

By law, the Water Board is required to develop, adopt (after public hearing), and implement a Basin Plan for the Region. The Basin Plan is the master policy document that contains descriptions of the legal, technical, and programmatic bases of water quality regulation in the Region. The plan must include:

- A statement of beneficial water uses that the Water Board will protect;
- The water quality objectives needed to protect the designated beneficial water uses; and
- The strategies and time schedules for achieving the water quality objectives.

The Water Board first adopted a plan for waters inland from the Golden Gate in 1968. After several revisions, the first comprehensive Basin Plan for the Region was adopted by the Water Board and approved by the State Water Board in April 1975. Subsequently, major revisions were adopted in 1982, 1986, 1992, 1995, 2002, and 2004. Each proposed amendment to the Basin Plan is subject to an extensive public review process. The Water Board must then adopt the amendment, which is then subject to approval by the State Water Board. In most cases, the Office of Administrative Law and the U.S. Environmental Protection Agency (U.S. EPA) must approve the amendment as well.

The basin planning process drives the Water Board's effort to manage water quality. The Basin Plan provides a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses in a manner that will result in maximum benefit to the people of California. The Basin Plan fulfills the following needs:

- The U.S. EPA requires such a plan in order to allocate federal grants to cities and districts for construction of wastewater treatment facilities.
- The Basin Plan provides a basis for establishing priorities as to how both state and federal grants are disbursed for constructing and upgrading wastewater treatment facilities.
- The Basin Plan fulfills the requirements of the Porter-Cologne Act that call for water quality control plans in California.
- The Basin Plan, by defining the resources, services, and qualities of aquatic ecosystems to be maintained, provides a basis for the Water Board to establish or revise waste discharge requirements and for the State Water Board to establish or revise water rights permits.
- The Basin Plan establishes conditions (discharge prohibitions) that must be met at all times.
- The Basin Plan establishes or indicates water quality standards applicable to waters of the Region, as required by the federal Clean Water Act.
- The Basin Plan establishes water quality attainment strategies, including total maximum daily loads (TMDLs) required by the Clean Water Act, for pollutants and water bodies where water quality standards are not currently met.

The intent of this comprehensive planning effort is to provide positive and firm direction for future water quality control. However, adequate provision must be made for changing conditions and technology. The Water Board will review the Basin Plan at least once every three years. Unlike traditional plans, which often become obsolete within a few years after their preparation, the Basin Plan is updated as deemed necessary to maintain pace with technological, hydrological, political, and physical changes in the Region.

This Basin Plan contains water quality regulations adopted by the Water Board, and approved by the State Water Board, the Office of Administrative Law, and U.S. EPA. It also contains statewide regulations adopted by the State Water Board and other state agencies that refer to activities regulated by the Water Board. For the most recent list of statewide regulations applicable in the Region, please refer to the State Water Board's "Compendium of Current, Statewide Applicable Water Quality Regulations." Federal laws and regulations also specify water quality standards and are available at U.S. EPA's website.

1.5 WATERSHED MANAGEMENT PLANNING

In 1995, the Water Board initiated a watershed management approach to regulating water quality, expanding its primary focus from point sources of pollution to include more diffuse sources such as urban and agricultural runoff. A five-year statewide Strategic Plan was completed in 2001 and guides the water resource protection efforts by the State and Regional Water Boards. A key component of the Strategic Plan is the Watershed Management Initiative (WMI).

A watershed is the area of land drained by a stream or river system. It is where water precipitates and collects, extending from ridges down to the topographic low points where the water drains into a river, bay, ocean, or other water body. A watershed includes surface water bodies (e.g., streams, rivers, lakes, reservoirs, wetlands, and estuaries), groundwater (e.g., aquifers and

groundwater basins) and the surrounding landscape. Watershed management is a strategy for protecting water quality in all water bodies by looking at all components that make up a watershed area, including the natural environment, water supply, land uses and their effects on drainage, wastewater collection and discharges, and the ways humans interact with the water bodies.

In the Water Board's watershed management approach to water quality protection, water resource problems are identified and prioritized primarily on the basis of water quality within individual watersheds (i.e., the geographic drainage areas and groundwater basins used for management purposes). Unique solutions are developed for each watershed that consider all local conditions and pollution sources and rely on the input and involvement of local stakeholders. Major features of a watershed management approach are: targeting priority problems based on water quality information and monitoring, promoting stakeholder involvement in prioritization and management decisions, developing integrated solutions that make use of the expertise and authority of multiple agencies and organizations, and measuring success through monitoring and other collected data. The approach culminates in the creation and implementation of "watershed action plans."

The water quality of many water bodies continues to be degraded from pollutants discharged from diffuse sources, referred to as nonpoint sources, and from the cumulative impacts of multiple point sources such as drainage from urban areas, known as urban runoff. This degradation persists despite successful pollutant reduction efforts in the regulation of municipal and industrial wastewater point source discharges through the NPDES program. Watershed management represents a shift from the approach that focuses on regulation of point sources to a more regional approach that acknowledges environmental impacts from all activities, and prioritizes regulation of these activities with input from local stakeholders.

Watersheds transcend political, social, and economic boundaries. It is important to engage all affected stakeholders in designing and implementing goals for the watershed to protect water quality. Groups formed to create watershed action plans may include representatives from all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens and others. Tasks in a watershed action plan could include a wide range of actions, such as improving coordination between regulatory and permitting agencies, increasing citizen participation in watershed planning activities, improving public education on water quality and protection issues, and enforcing current regulations on a more consistent and prioritized basis.

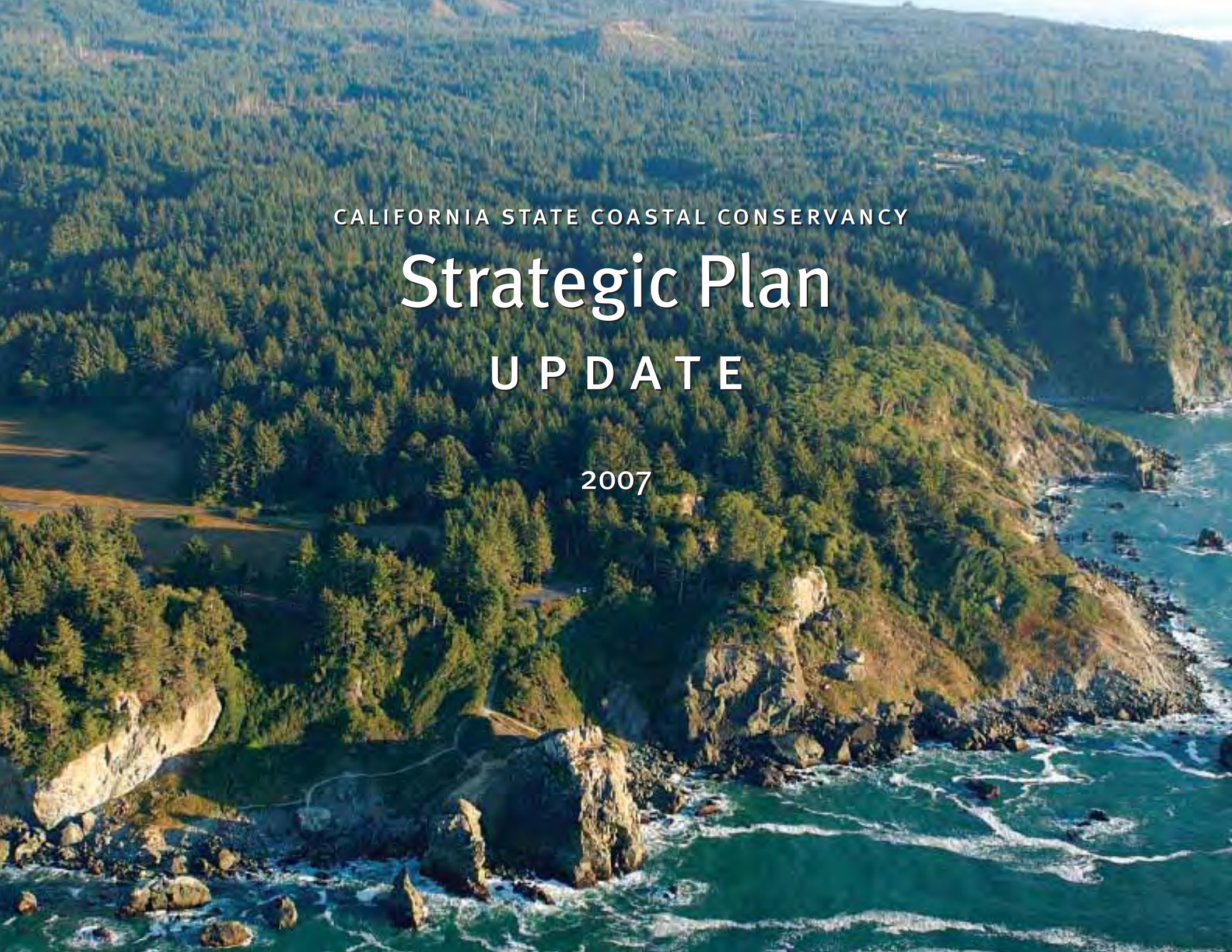
1.6 THE SAN FRANCISCO ESTUARY PROJECT

The Water Board has been an active participant in the San Francisco Estuary Project (Estuary Project), a cooperative program aimed at promoting effective, environmentally sound management of the San Francisco Bay Estuary while protecting and restoring its natural resources. In 1993, the Estuary Project reached its goal of developing a Comprehensive Conservation and Management Plan (CCMP). The CCMP addresses five critical concerns identified by the Estuary Project's broad-based advisory committees: decline of biological resources; increased pollutants; freshwater diversion and altered flow regime; dredging and waterway modification; and intensified land use.

Implementation of the CCMP's over 140 recommended actions has been ongoing since the early 1990s. The Water Board serves as lead state agency, undertaking responsibility for ensuring that CCMP actions are carried out. The Estuary Project's Public Involvement and Education Program, which seeks to inform and involve the public in Estuary issues, is currently housed at the Water Board office.

FIGURES

Figure 1-1: San Francisco Bay Basin



CALIFORNIA STATE COASTAL CONSERVANCY

Strategic Plan

UPDATE

2007

CALIFORNIA STATE COASTAL CONSERVANCY

STRATEGIC PLAN

2007

Coastal Conservancy

Coastal Conservancy

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The Coastal Conservancy acts with others to preserve, protect, and restore the resources of the California coast. Our vision is of a beautiful, restored, and accessible coastline.

Plan prepared by Coastal Conservancy staff
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DESIGN AND PRODUCTION: Seventeenth Street Studios

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Executive Summary

THE 2003 COASTAL CONSERVANCY *Strategic Plan* was prepared pursuant to the direction and guidelines provided by the Department of Finance in Management Memo 96-23 (8/9/96) and Budget Letter 96-16 (9/23/96). The Conservancy conducted public hearings and reviewed preliminary drafts on March 8, 2007 and May 24, 2007, and a final draft on July 16, 2007. The Strategic Plan was approved by the Coastal Conservancy at a public hearing on July 16, 2007.

The document describes current and historical resource allocation by the Conservancy, public needs served by the agency, policies and principles guiding the Conservancy and its staff, and the intended and recommended future course of the agency's efforts. The plan starts with background information about the Conservancy, including the Conservancy's mission and vision, its business principles, and project selection criteria. The Conservancy's mission is based on 13 statutory authorities contained in Division 21 of the Public Resources Code, and these make up four program areas:

- Public Access
- The San Francisco Bay Area Conservancy
- Coastal Resource Conservation
- Ocean Protection Council

For each program area, there is a description of the pertinent statutory authorities, followed by the issues and the Conservancy's priorities for the program. This is followed by specific programs goals and objectives, strategies to meet the objective, expected outcome measures, and a breakout of how the overall objective will be met within the Conservancy's four administrative geographic regions:

- North Coast (Del Norte through coastal Marin counties)
- San Francisco Bay Area Conservancy (nine Bay Area counties)
- Central Coast (coastal San Mateo through Santa Barbara)
- South Coast (Ventura through San Diego counties)

The Strategic Plan is a "living" document, intended for reference in the course of conducting the daily activities of the Conservancy, and it will be subject to an annual formal evaluation, and updating within five years.

Introduction and Background

Audiences for the Plan are:

- *The Conservancy and its staff,* to provide a policy reference, a comprehensive context for evaluating new opportunities and allocating resources, and a set of expectations for measuring the effectiveness of our efforts
- *The Resources Agency,* to assist in coordinating the work of the Conservancy with other agencies and departments and provide a basis for a comprehensive strategy to conserve California's natural heritage
- *Members of the Legislature,* to provide the understanding necessary for management and oversight of the agency and to justify allocation of the financial resources needed to carry out California's Coastal Management Program and other statutory activities
- *Control agencies,* such as the Department of Finance, Legislative Analyst, State Auditor, and Department of General Services, to explain the contribution of the Conservancy to the accomplishment of the state's resource conservation priorities, and to provide a detailed projection of the Conservancy's needs for funding and staffing
- *Our clients*—local governments, other state agencies, private landowners, nonprofit conservation organizations, and private conservation funders—to build on their knowledge of the Conservancy as a cooperative, assisting agency that will be available as a problem-solving partner
- *The general public,* to invite comment on the activities of the Conservancy and to explain the continued need for state investment in coastal resource protection

Assumptions

FUNDING WILL CONTINUE to be provided to the Conservancy to enable it to continue a full program of coastal resource protection and development.

The Conservancy has experienced phenomenal growth in capital outlay funding for expenditure on projects since its inception. In its first 20 years, the Conservancy spent approximately $200 million on restoration, acquisition, and access projects. During the next five years the Conservancy dedicated $400 million to that work. In the past five years, between 2001 and 2006, Propositions 40 and 50 allocated $380 million directly to the Conservancy, the Legislature allocated an additional $46.4 million from Proposition 40 for watershed management projects, and the California Wildlife Conservation Board granted the Conservancy $40 million for San Francisco Bay Area wetland projects.

It is anticipated that the next five years' funding will be at levels similar to or greater than the past five years. The passage of Proposition 84 in November 2006 allocated $360 million to the Conservancy. Another $90 million is available to the Conservancy for purposes of ocean protection through the Ocean Protection Trust Fund.

Total funds available to the Conservancy for expenditure on projects over the next five years is approximately $500 million, including balances from recent bonds and Proposition 84. For purposes of planning and prioritizing expenditures for the next five years, the Conservancy assumes that $100–150 million of additional funds will be available for expenditure within the five-year life of the 2007 Strategic Plan. These funds will be derived from legislative appropriations of unallocated sections of Proposition 84, one additional state resource bond, and some newly developed or allocated non-bond sources, such as a Bay Area license plate. In total, this plan assumes the Conservancy will have a total of $600 to $650 million to spend, $100 to $130 million per year over the next five years, and that we will continue to leverage Conservancy funds on average by at least two to one (the amount leveraged varies with project type, by region, and depending on existence of other funds, but this average is relatively constant over the years). Therefore the monetary value of the combined objectives within this plan totals $1.8–1.9 billion.

THE CONSERVANCY'S RECENTLY completed Five-Year Capital Infrastructure Plan FY08/09–12/13 identified a need for approximately two times the dollar amount assumed to be available to the Conservancy. Additionally, like this strategic plan, it also assumes the Conservancy's funds will be matched by at least 2–1.

As a result, in order to fully meet identified needs and achieve its mission and goals, the Conservancy must be exceptionally strategic in targeting expenditures to the highest priority needs, pursue all opportunities to obtain additional funding, and where feasible, increase the level of matching funds.

THE STATE WILL maintain a strong regulatory program controlling the use of coastal resources.

As a result, there will continue to be a need for assistance to landowners and local governments to achieve permit compliance and facilitate appropriate new development.

THE LEGAL SYSTEM will continue to be unable to resolve all threats to sensitive resources and public use of the coast.

As a result, public acquisition of coastal access routes and environmentally sensitive lands will continue to be needed.

THE INCREASING POPULATION will continue to drive up the demand for coastal real estate and for coastal recreation opportunities.

This will pose market threats to coastal access, coastal agriculture, and the preservation of wildlife habitat. It will also increase opportunities for the restoration of older urban waterfronts.

As a result, state government will continue to need an agency able to meet these challenges in the private market, including skills in landowner negotiation, less-than-fee acquisition, agricultural economics, public development, multi-agency partnerships, and other collaborative, noncoercive means of meeting public goals.

THE STATE WILL experience an increasingly ethnically diverse population.

As a result, state government will need to increase staff resources and expenditures for environmental education, and public access in underserved areas, and ensure that projects consider and, where appropriate, address environmental justice issues.

CLIMATE CHANGE WILL have dramatic physical, ecological, economic, and social impacts on coastal, marine, and inland resources.

As a result, the State will need to work with other organizations to reduce atmospheric carbon, and support planning for adaptation to environmental changes, such as inundation of low-elevation coastal areas, alteration of river and stream flows, increased erosion, and habitat alteration. In addition, expenditures for infrastructure and other projects need to include projected climate changes in project designs and siting, and need to incorporate appropriate mitigation measures.

Other planning documents

The 2007 *Coastal Conservancy Strategic Plan* is the extension of a process of planning begun by the Conservancy in 1992. It is the third strategic plan written and approved by the Conservancy, and builds on the first plan completed in 1997 and, more significantly, the second plan completed in 2003. A number of other key planning documents that should be considered a part of this document are included on the accompanying CD.

Coastal Conservancy's Mission and Vision

THE COASTAL CONSERVANCY acts with others to preserve, protect, and restore the resources of the California coast, ocean, and the San Francisco Bay Area. Our vision is of a beautiful, restored, and accessible coastline, ocean and San Francisco Bay Area.

Business Principles

THE CONSERVANCY IS a problem-solving agency, emphasizing "doing" projects that solve problems (including needed project planning) rather than "planning" (for the purpose of adopting public policy).

- The Conservancy works in cooperation with others and strives to be an agency whose involvement is sought by others.

- The Conservancy works on landscape-wide projects that serve significant regional or statewide objectives.
- The Conservancy employs the best available science for each project, subjecting its projects to independent scientific review when necessary and feasible.
- The Conservancy values and employs bottom-up community-based planning. The Conservancy believes that the best resource protection ensues when local citizens participate in planning the future of their own natural heritage.
- The Conservancy staff adds value by its combination of technical knowledge, commitment to community involvement, and skill at communicating the needs of the coast to political decision makers. That skill level is a resource for California and should be constantly improved and kept current.
- The Conservancy is accountable to the citizens of California, and all of the Conservancy projects are discussed and acted upon by the board with a full opportunity for public involvement.
- The Conservancy strives to minimize procedural delay and complexity in its work.

Project Selection Criteria

(For use in the determination of the priority of Conservancy projects under Division 21 of the Public Resources Code)

Key Criteria Required by the Conservancy

- *Promotion of the Conservancy's statutory programs and purposes*
- *Consistency with purposes of the funding source*
- *Support* from the public
- *Location* (must benefit coastal, ocean resources, or the San Francisco Bay region)
- *Need* (desired project or result will not occur without Conservancy participation)
- *Greater-than-local interest*

Additional Conservancy-Adopted Criteria

- *Urgency* (threat to a coastal or ocean resource from development, natural or economic conditions; pressing need; or a fleeting opportunity)
- *Resolution* of more than one issue
- *Leverage* (contribution of funds or services by other entities)
- *Conflict resolution*
- *Innovation* (for example, environmental or economic demonstration)
- *Readiness* (ability of the grantee and others to start and finish the project in a timely manner)
- *Realization of prior Conservancy goals* (advances previous Conservancy projects)
- *Return to Conservancy* (funds will be repaid to the Conservancy, consistent with the Conservancy's long-term financial strategy)
- *Cooperation* (extent to which the public, nonprofit groups, landowners, and others will contribute to the project)

Public Access

Coastal Accessways

- Coastal Trail
- Inland Trail Links/River Parkways
- Diverse Accessways
- OTDs (Offers to Dedicate)
- Alternative Transit Options

Urban Waterfront Restoration

- Revitalize waterfronts/ Promote excellence of design
- Commercial Fishing/Ports/Harbors

Environmental Education

Authorities:
Coastal Access Program (1978)
Urban Waterfronts Program (1984)
Coastal Trail (2000)
Environmental Education (2001)

Coastal Resources Conservation

Acquisition of Resource/ Open Space Lands

Coastal and Ocean Habitats

Protecting, Restoring and Enhancing Biological Diversity

- Threatened/Endangered Habitats
- Habitat Corridors
- Invasive Species

Wetlands, Rivers, Watersheds

- Watershed Functions
- Water Quality
- Sand Supply

Preserving Coastal Agriculture

Coastal Zone Management/ Conflict Resolution

Environmental Education

Authorities:
Coastal Restoration Program (1978)
Site Reservation Program (1978)
Enhancement Program (1978)
Coastal Agriculture Program (1978)
Coastal Restoration Program (1978)
Enhancement Program (1978)
Watershed Restoration (2003)
Coastal and Marine Resource Protection (2003, 2005)

SF Bay Conservancy

Protecting, Restoring and Enhancing Biological Diversity

- Threatened/Endangered Habitats (e.g., wetlands)
- Invasive Species
- Habitat Corridors
- Fish Passage
- Water Quality
- Urban Creeks

Public Access, Recreation, and Education

- Bay, Ridge and Connector Trails
- Recreation and Education Facilities

Acquisition of Resource/ Open Space and Agricultural Lands

Environmental Education

Authorities:
SF Bay Trail (1988)
SF Bay Conservancy Program (1997)
Water Trail (2005)
Education (2001, 2005)

Ocean Protection Council

Governance

- Funding
- Interagency Collaboration
- Enforcement
- Ecosystem-based Management
- Federal Support
- Regional Coordination

Research and Monitoring

- Basic Research
- Ocean Monitoring (Mapping, Physical, and Biological Monitoring)

Ocean and Coastal Water Quality

- Support Enforcement of Pollution Controls
- Support Innovation
- Assist in Reducing the Impacts of Once-through Cooling
- Help to Advance Water Quality Testing

Physical Processes and Habitat Structure

- Habitat Restoration
- Regional Sediment Management
- Climate Change

Ocean and Coastal Ecosystems

- Marine Life Protection Act
- Marine Life Management Act
- Invasive Species
- Market-based Fisheries
- Sustainable Economic Activity

Education and Outreach

Authorities:
Ocean Protection Council (2005)

Program Summaries/Statutory Authorities/Goals/Objectives

The four broad areas outlined on the previous two pages provide an overview of the Conservancy's work. Within these areas—which are open to flexible interpretation—the Conservancy undertakes projects. In this document, the projects are grouped into subprograms that roughly correspond to the chapter headings in Division 21. The projects are selected and evaluated according to specific goals and objectives. In addition, the Legislature has accorded particular importance to certain major, long-term efforts (such as the Coastal Trail and river parkways), and has specified funding sources. Some of these efforts, such as the Southern California Wetlands Recovery Project, are being undertaken in collaboration with multiple agencies and other partners.

For each program, there is a brief description here of its statutory authorities, and of corresponding issues and priorities, that precedes specific goals and objectives. In some cases, projects to address various problems may be addressed under a range of statutory authorities and with the help of funding sources available to the Conservancy. For instance, agricultural preservation is dealt with mainly through the agricultural conservation chapter of Division 21. However, projects benefiting agriculture are also carried out through the resource enhancement, watershed, and San Francisco Bay Area and public-access programs.

Monitoring and Tracking

Unless otherwise noted, all goals and objectives are meant to be completed over a five-year period beginning in July 2007. The primary tool to be used to monitor and track the degree to which goals and objectives are accomplished will be the Conservancy's project database. Where other tools are necessary to monitor progress, they are identified following the outcome measure for that objective. The results of monitoring and tracking objectives will be evaluated and summarized in an annual progress report.

PUBLIC ACCESS

Statutory Authorities

The California Constitution and the Coastal Act require that public access to and along the shoreline be maximized (Coastal Access Action Plan, Coastal Commission 1999). Widespread concern about losing public access to the coast was the impetus for Proposition 20 in 1972, which created the Coastal Commission and the ultimate passage of the Coastal Act in 1976. Section 30001.5 (c) of the Coastal Act provides that it is the state's goal to "maximize public access to and along the coast and maximize public recreational opportunities in the Coastal Zone consistent with sound resource conservation principles and constitutionally protected rights of private property owners.

The Coastal Conservancy is directed to "have a principal role in the implementation of a system of public accessways to and along the state's coastline" (Public Resources Code Section 31400, 31400.1). In 2001, legislation was enacted requiring the Conservancy to coordinate the development of a trail in consultation with the Department of Parks and Recreation and the California Coastal Commission. The legislation specifically directs the Conservancy to prepare a plan and coordinate the development of the California Coastal Trail, and the Conservancy may award grants and undertake projects to expand inland trail systems that link to the Coastal Trail (Public Resources Code Sections 31408, 31409).

In 2002, the Legislature declared that in order to prevent the potential loss of public accessways to and along the state's coastline, it is in the best interest of the state to accept all offers to dedicate real property that protect open space or have the potential to provide access to the shoreline and view areas, or that provide a connection to other public properties or easements. These offers to dedicate frequently result from conditions specified in development permits issued by the Coastal Commission. The Legislature has mandated that the Conservancy accept any outstanding offers to dedicate a public accessway that is not accepted by others within 90 days of its expiration date (Public Resources Code 31402.2).

The Coastal Conservancy's Waterfronts Program was initiated under the Urban Waterfront Restoration Act of 1981 (Public Resources Code Section 31300 et seq.). In passing the act, the Legislature determined that many urban waterfront areas in California "are in need of restoration in order to be the vital economic and cultural component of the community which they once were," and it provided the Conservancy with authority to undertake projects and award grants for restoration of urban waterfronts.

The Conservancy's waterfront authority was expanded in 2005 to work within urban coastal watersheds by supporting projects and activities that are compatible with the preservation, restoration, or enhancement of ocean, coastal, or watershed resources, or that facilitate environmental education related to these resources. The Conservancy is further allowed to undertake activities and to support events or infrastructure related to coastal, watershed, or ocean resource education and maritime history.

The Conservancy's authority was further expanded to allow for the Conservancy to undertake or support educational projects and programs for pupils in kindergarten through grade 12, that relate to the preservation, protection, enhancement, and maintenance of coastal resources.

SUBPROGRAMS: ISSUES AND PRIORITIES

California Coastal Trail

Development of the California Coastal Trail is a key coastal access mandate for the Conservancy. With the spectacular beauty, unique coastal towns, and renowned cities of the California coast, a continuous trail along the coast is gaining national and international prominence. To support the development of the Coastal Trail and comply with legislative mandates, the Conservancy established a Coastal Trail Working Group that guided the completion of a plan for the development of the trail which is "to the extent feasible . . . constructed along the state's coastline from the Oregon border to the border with Mexico." The Coastal Trail Plan is completed and was approved by the Governor's Office. The Conservancy is working in partnership with California Department of Parks and Recreation, the California Coastal Commission, and others to implement the recommendations of the Coastal Trail Plan, including making existing trails part of the system and developing and acquiring new and existing rights-of-way.

Public Accessways

There are currently over 1,000 access points to the coast, serving a population of over 37 million Californians and countless tourists. These stairways, trails, parking lots, restrooms, hzostels, and campgrounds are the maintenance and operational responsibilities of local, state, and federal agencies and, in some cases, private concessions and nonprofit organizations. Many facilities suffer from lack of long-term maintenance and need reconstruction. Additional access points are greatly needed to serve a growing population. The Coastal Commission has a goal of ultimately having one public accessway to the shore approximately every quarter of a mile. Under legislation passed in 2002, the Conservancy is required to open at least three new accessways each year.

The Conservancy will provide funding for the acquisition of land, major repairs and reconstruction, and the construction of new facilities. To the extent special funds are available (e.g., Coastal Access Account, Whale Tail License Plate Fund) the Conservancy will provide funds for annual operations, for unique projects, and special events. The Conservancy will work to develop one or more projects that promote alternative means of transportation to coastal areas, which will reduce traffic congestion and pollution.

Offers to Dedicate

There are already 119 offers to dedicate public access easements to or along the coast that will expire in the next five years. These offers, required by regulatory actions of the Coastal Commission, may be accepted by public or private organizations. The Coastal Conservancy is required by statute to accept any offer that will expire within 90 days. The Conservancy will ensure that these offers are accepted and will also work with the Coastal Commission to persuade other organizations to accept such offers, and to open and manage them for public use, where possible.

Urban Waterfront Restoration

Many of the state's waterfront areas have fallen into disrepair. Repair, reconstruction and redevelopment of these waterfronts can be the key to the economic revitalization of coastal towns, especially those suffering from declines in local industries such as logging and commercial fishing. The Coastal Conservancy will support planning and implementation of waterfront redevelopment in smaller cities and towns, especially those suffering from declines in local industries.

Waterfront facilities such as piers, parks, promenades, science and maritime museums, and interpretive centers in the state's major cities and tourist centers are regional amenities and attractions for visitors from around the United States and the world, bolstering the California economy. The Conservancy will support development and reconstruction of major waterfront and riverfront infrastructure and facilities with bond funds. The Conservancy will also support restoration of the state's urban waterfronts for coastal-dependent uses, including the maritime industry, commercial fishing, and harbor improvements that serve foreign trade. The Conservancy seeks to promote excellence of design and the sensitive integration of buildings into the natural coastal environment. To the extent that appropriate special funds are available, the Conservancy will support operations of regional facilities and special waterfront educational events.

Commercial Fishing/ Ports/Harbors

The commercial fishing industry is in decline due to depleted stocks of various fish species. This adversely affects communities and regional economies. The Conservancy will work with other resource agencies to improve the health of fisheries. It will also work with the fishing industry to increase its efficiency by supporting public infrastructure improvements and installations.

Maritime commerce is a key California industry. The expansion or restoration of port and harbor facilities may conflict with natural resources protection. The Conservancy will provide technical and other resources to further the revitalization of California ports and harbors consistent with other goals.

Education

Coastal protection has enjoyed wide popular support over the past three decades. By educating citizens about the sensitivity of coastal resources and what they can do to assist in protection and restoration efforts, this support can be sustained and increased. The Conservancy is authorized to support educational projects and programs for elementary school children relating to the preservation, protection, enhancement, and maintenance of coastal resources. To the extent that appropriate funding sources are available (non–General Fund), the Conservancy will assist government and nonprofit partners in developing high-quality coastal-oriented educational experiences and materials for school children. It will assist nonprofit organizations in providing outreach to low-income, underserved, and inland areas. Additionally, the Conservancy will include public education in the range of its projects. This may include development of interpretive centers or other educational facilities, signs, and displays.

Public Access Goals & Objectives

Goal 1

Develop the Coastal Trail as a major new recreational amenity, tourist attraction, and alternative transportation system, especially in urban areas, and develop networks of inland trails that connect to the coast and parks and provide other recreational opportunities.

STATEWIDE STRATEGY

The Coastal Trail is the Coastal Conservancy's core public-access strategy. The next five years of activity will consist largely of improving existing public accessways and constructing new accessways in, adjacent to, or connecting population centers, including inland waterways that connect to the coast.

OBJECTIVE 1A

Continue to support efforts to obtain consensus and refine the alignment of the Coastal Trail.

STRATEGIES

1. In cooperation with the California Department of Parks and Recreation, the Coastal Commission, local government and affected landowners, determine which alignments of existing trail should be identified as the Coastal Trail.
2. Identify gaps between existing trails and develop specific alignments for those areas. Where gaps are caused by river mouths or harbor entrances, identify feasible methods to close gaps, such as pedestrian and bicycle bridges or ferries.
3. Identify sections of the Coastal Trail that should be wheelchair accessible.
4. Take sea-level rise into consideration when planning alignment.

OUTCOME MEASURES

1. Consensus with the Department of Parks and Recreation and the Coastal Commission on the alignment of the Coastal Trail
2. Identified methods for closing gaps in the Coastal Trail

MONITORING AND TRACKING

1. Develop maps to indicate current Coastal Trail that is useable by the public.

GOAL 1 ▪ OBJECTIVE 1A BASIS

Based on what has been required to date, to develop maps and obtain consensus about particular alignments.

DISTRIBUTION

Statewide

ESTIMATED CONSERVANCY COST

$300,000

FUNDING SOURCES

Propositions 40 and 84
Coastal Access Account
Whale Tail License Plate Fund

OBJECTIVE 1B

Place Coastal Trail signs on approximately 300 miles of existing trails within public and private ownerships.

STRATEGIES

1. Determine locations of all designated publicly accessible trails within the Coastal Trail route.
2. Request authority be delegated to Executive Officer to provide signs and approve grants for Coastal Trail signage up to $40,000.
3. Work with land managers to incorporate these lands into the Coastal Trail and to place signs.

OUTCOME MEASURES

1. Miles of existing trails that become identifiable as part of the Coastal Trail
2. Maps of the Coastal Trail showing these sections

MONITORING AND TRACKING

1. Coastal Trail Working Group and Conservancy staff will monitor the completion of this objective.

GOAL 1 ▪ OBJECTIVE 1B BASIS

Based on estimates in *Completing the California Coastal Trail,* up to 300 miles of existing trails can be designated as part of the Coastal Trail during the planning period.

REGIONAL DISTRIBUTION

South Coast: 100 miles
Central Coast: 100 miles
North Coast: 100 miles

ESTIMATED CONSERVANCY COST

$300,000

FUNDING SOURCES

Propositions 40 and 84
Coastal Access Account
Whale Tail License Plate Fund

OBJECTIVE 1C

Design approximately 94 miles of trails within public and private ownerships.

STRATEGIES

1. Work with land managers to plan new trail segments.
2. Prioritize trail routes within public or nonprofit ownerships where trails can be constructed.
3. Incorporate latest scientific understanding about sea-level rise into design and siting of trails.
4. Identify trail segments that could feasibly accommodate wheelchair riders.

OUTCOME MEASURES

1. Completed plans

MONITORING AND TRACKING

1. Include projects within GIS (Geographical Information Systems) database and report to Coastal Trail Working Group.

GOAL 1 ▪ OBJECTIVE 1C BASIS

Based on analysis in *Completing the California Coastal Trail,* and given current funding and staff resources, up to 94 miles can be added to the Coastal Trail by planning trails within existing rights-of-way.

REGIONAL DISTRIBUTION

South Coast: 24 miles
Central Coast: 50 miles
North Coast: 20 miles

ESTIMATED CONSERVANCY COST

$5,700,000

FUNDING SOURCES

Propositions 40 and 84
Coastal Access Account

OBJECTIVE 1D

Construct approximately 93 miles of trails within public and private ownerships.

STRATEGIES

1. Work with land managers to construct new trail segments.
2. Prioritize trail routes within public or nonprofit ownerships where trails can be constructed.

OUTCOME MEASURES

1. Miles of new trails constructed within existing rights-of-way
2. Miles of new trails constructed that are wheelchair accessible

MONITORING AND TRACKING

1. Include projects within GIS database and report to Coastal Trail Working Group.

GOAL 1 ▪ OBJECTIVE D BASIS

Based on analysis in *Completing the California Coastal Trail,* and given current funding and staff resources, up to 93 miles can be added to the Coastal Trail in the next five years.

REGIONAL DISTRIBUTION

South Coast: 13 miles
Central Coast: 40 miles
North Coast: 40 miles

ESTIMATED CONSERVANCY COST

$26,990,000

FUNDING SOURCES

Propositions 40 and 84
Coastal Access Account

OBJECTIVE 1E

Design approximately 52 miles of regional trails and river parkways along rivers and creeks to connect inland populations to the coast and expand recreational opportunities.

STRATEGIES

1. Provide funding to public agencies and nonprofit organizations to refine plans for inland trails that connect to the coast.
2. Identify inland trails that need wheelchair-accessible facilities.
3. Prioritize trail routes identified in Completing the California Coastal Trail that connect inland populations to the coast.
4. Incorporate predicted alterations in stream flows and channels into siting and design of trails.

OUTCOME MEASURES

1. Completed plans for increased miles of trails connecting inland areas to the Coastal Trail

GOAL 1 ▪ OBJECTIVE 1E BASIS

Based on estimates and analyses of river parkway and urban stream projects by the Conservancy's regional work groups, 52 miles of regional trails and river parkways can be planned over the next five years. Current projects include San Diego River, Santa Ana River, Los Angeles River, Ballona Creek, San Lorenzo River, Carmel River, Russian River, Big River, and Mad River.

REGIONAL DISTRIBUTION

North Coast: 30 miles
Central Coast: 12 miles
South Coast: 10 miles

ESTIMATED CONSERVANCY COST

$7,150,000

FUNDING SOURCES

Proposition 84
Proposition 50 (grants from Resources Agency)
Whale Tail License Plate Fund

OBJECTIVE 1F

Construct approximately 56 miles of regional trails and river parkways along rivers and creeks to connect inland populations to the coast and expand recreational opportunities.

STRATEGIES

1. Provide funding to construct inland trails that connect to the coast and recreational facilities, such as parks, along those trails.
2. Implement plans developed in Objective E.

OUTCOME MEASURES

1. Increased miles of trails connecting inland areas to the Coastal Trail
2. Increased parks along inland rivers and creeks

GOAL 1 ▪ OBJECTIVE 1F BASIS

Based on estimates and analyses of river parkway and urban stream projects by the Conservancy's regional work groups, 56 miles of regional trails and river parkways can be constructed over the next five years. Current projects include San Diego River, Santa Ana River, Los Angeles River, Ballona Creek, Carmel River, San Lorenzo River, Russian River, Big River, and Mad River.

REGIONAL DISTRIBUTION

North Coast: 40 miles
Central Coast: 6 miles
South Coast: 10 miles

ESTIMATED CONSERVANCY COST

$45,700,000

FUNDING SOURCES

Proposition 84
Proposition 50 (grants from Resources Agency)
Whale Tail License Plate Fund

OBJECTIVE 1G

Assist in 20 projects that secure real property or property interests to facilitate the development of the Coastal Trail and inland connecting trails, or for waterfront parks.

STRATEGIES

1. Identify easements or real property that need to be acquired for purposes of constructing trails or waterfront parks, or other public-access facilities.
2. Acquisitions for trail construction should close gaps or provide regional trail connections.
3. Target park-poor areas for land acquisitions for waterfront park development.

OUTCOME MEASURES

1. Additional property available for trail construction or park development

GOAL 1 ▪ OBJECTIVE 1G BASIS

Based on discussions with Conservancy regional managers, up to 20 real estate interests could be secured for the purposes of trail development, parks, or other public-access needs.

REGIONAL DISTRIBUTION

North Coast: 1 miles
Central Coast: 9 miles
South Coast: 10 miles

ESTIMATED CONSERVANCY COST

$9,000,000

Public Access

Goal 2

Develop a system of coastal public accessways, open-space areas, and parks.

STATEWIDE STRATEGY

Open accessways to currently inaccessible areas, acquire or otherwise protect open space and park areas under threat, and provide funds for major reconstruction of existing facilities, including upgrades for wheelchair accessibility.

OBJECTIVE 2A

Develop approximately 11 plans to create or improve waterfront or watershed projects, including but not limited to parks along regional trails, multibenefit pocket parks or projects that demonstrate innovative storm water management strategies.

STRATEGIES

1. Develop and use definition of "underserved community" to prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail.
2. Develop priority projects in coordination with other state and local agencies and non-profit partners.
3. Incorporate latest scientific understanding of sea-level rise into consideration when planning parks and infrastructure.

OUTCOME MEASURES

1. Plans for new or improved parks or projects

GOAL 2 ▪ OBJECTIVE 2A BASIS

Underserved communities are those communities with a higher ratio of residents per acre of parkland than the county or city average. Based on estimates and analyses provided by the Coastal Access Action Plan (1999), the Coastal Commission, *Completing the California Coastal Trail,* the Conservancy's regional managers, and the Southern California Green Visions Project, approximately 11 plans can be developed for recreational multibenefit projects over the next five years.

REGIONAL DISTRIBUTION

South Coast: 5 projects
Central Coast: 4 projects
North Coast: 2 projects

ESTIMATED CONSERVANCY COST

$2,800,000

FUNDING SOURCES

Proposition 84
Whale Tail License Plate Fund

OBJECTIVE 2B

Implement approximately 15 projects to create or enhance waterfront or watershed parks, including but not limited to parks along regional trails, multibenefit pocket parks, or projects that demonstrate innovative storm-water management strategies.

STRATEGIES

1. Prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail.
2. Develop priority projects in coordination with other state and local agencies and non-profit partners.

OUTCOME MEASURES

1. New or improved parks

GOAL 2 ▪ OBJECTIVE 2B BASIS

Based on estimates and analyses provided by Coastal Access Action Plan (1999), the Coastal Commission, *Completing the California Coastal Trail,* the Conservancy's regional managers, and the Southern California Green Visions Project, up to 15 park projects can be implemented over the next five years.

REGIONAL DISTRIBUTION

South Coast: 5 areas
Central Coast: 5 areas
North Coast: 5 areas

ESTIMATED CONSERVANCY COST

$8,100,000

FUNDING SOURCES

Proposition 84
Whale Tail License Plate Fund

OBJECTIVE 2C

Open approximately 17 coastal areas that are currently inaccessible or closed to public use while respecting the rights of nearby landowners and the need to minimize impacts on sensitive natural resources.

STRATEGIES

1. Give funding priority to the development of accessways to beach and coastal areas that are currently inaccessible or closed to public use.
2. Include nearby property owners, local governments, nonprofit partners and resource agencies in planning processes.
3. Fund operations and maintenance costs of opening new accessways, when needed.

OUTCOME MEASURES

1. Public access to areas now closed to the public

MONITORING AND TRACKING

1. Annual usage reports from property managers

GOAL 2 ▪ OBJECTIVE 2C BASIS

Based on estimates and analyses in the Coastal Access Action Plan (1999), Coastal Commission staff, *Completing the California Coastal Trail,* and the Conservancy's regional managers, up to 17 areas can be developed for public use during the planning period

REGIONAL DISTRIBUTION

South Coast: 4 areas
Central Coast: 4 areas
North Coast: 4 areas

ESTIMATED CONSERVANCY COST

$2,600,000

FUNDING SOURCES

Propositions 40 and 84
Coastal Access Account
Whale Tail License Plate Fund

OBJECTIVE 2D

Ensure acceptance of 119 offers to dedicate (OTDs) public access easements before they expire, and work with project partners to open these interests to the public.

STRATEGIES

1. Investigate opportunities for grantees or other project partners to accept OTDs.
2. Where feasible, require acceptance of OTDs as a grant condition.
3. Regularly update list of OTDs that are suitable for acceptance by grantees or other project partners.
4. Accept all OTDs that are in danger of expiring within 90 days.
5. Provide funds and technical assistance to develop facilities to open accepted OTDs for public use.
6. Fund operation and maintenance of accessways derived from OTDs.

OUTCOME MEASURES

1. All OTDs are accepted by grantee, project partner, or the SCC before they expire.
2. OTDs are developed, operated, and maintained.

MONITORING AND TRACKING

1. Add OTD status field to project database.
2. Link OTD and project databases.

GOAL 2 ▪ OBJECTIVE 2D BASIS

The objective of ensuring acceptance of 119 OTDs is based on analysis of offers with expiration dates in the five-year planning period.

REGIONAL DISTRIBUTION

South Coast: 95 OTDs
Central Coast: 21 OTDs
North Coast: 3 OTDs

ESTIMATED CONSERVANCY COST

This involves primarily staff costs. If funds are needed to offset maintenance costs, estimate $100,000.

FUNDING SOURCES

Coastal Access Account
Whale Tail License Plate Fund

OBJECTIVE 2E

Fund 24 projects for new and upgraded facilities, or reconstruction of dilapidated and unsafe facilities to increase and enhance coastal recreational opportunities for residents and visitors.

STRATEGIES

1. Correct dangerous conditions by installing stairs, guardrails, and signs.
2. Fund repairs or reconstruction of facilities more than 20 years old or in serious disrepair.
3. Build new facilities.
4. Assist with facilities that can ease traffic congestion at popular destination points on the coast or inland waterways.
5. Incorporate latest scientific understanding of sea-level rise into consideration when planning facilities.

OUTCOME MEASURES

1. Greater number of recreational facilities
2. Safer conditions at various key locations in the Coastal Zone
3. Marked increases in the structural integrity and expected lifespan of access facilities
4. Less traffic congestion

GOAL 2 ▪ OBJECTIVE 2E BASIS

Based on estimates and analyses in Coastal Access Action Plan (1999) and *Completing the California Coastal Trail,* and additional analysis from the Conservancy's regional program managers, 24 projects can be implemented during the planning period.

REGIONAL DISTRIBUTION

North Coast: 6 projects
Central Coast: 10 projects
South Coast: 8 projects

ESTIMATED CONSERVANCY COST

$11,650,000

FUNDING SOURCES

Proposition 40 and 84
Coastal Access Account
Violation Remediation Account
Whale Tail License Plate

Public Access

Goal 3

Revitalize coastal and inland waterfronts.

STATEWIDE STRATEGY

Focus on areas where economic development is most needed and has the greatest impact, and where there is the most pressure to convert waterfront lands to uses that are not coastal or waterfront-dependent.

OBJECTIVE 3A

Develop approximately eight waterfront restoration plans that encourage and promote public access to developed waterfront areas, accommodate tourism where necessary, promote excellence and innovation in urban design, protect and restore cultural and historic resources, and support commercial and recreational fishing communities.

STRATEGIES

1. Update information on needs/opportunities for waterfront restoration in each region.
2. Solicit proposals and award grants for projects displaying design excellence.
3. Identify and resolve conflicts between different uses in key waterfront areas.
4. In coordination with the Ocean Protection Council, update information regarding specific needs for commercial and recreational fishing support facilities in regional harbors, and inventory opportunities for preserving or enhancing other coast-dependent uses.
5. Incorporate latest predictions about sea-level rise in the design and siting of new facilities.

OUTCOME MEASURES

1. Completed plans

GOAL 3 ▪ OBJECTIVE 3A BASIS

Based on estimates and analyses of needs by regional managers, review of Coastal Access Action Plan and discussions with staff of the California Coastal Commission and the Ocean Protection Council, up to eight plans can be completed in the planning period.

REGIONAL DISTRIBUTION

South Coast: 0 plans
Central Coast: 5 plans
North Coast: 3 plans

ESTIMATED CONSERVANCY COST

$1,650,000

FUNDING SOURCES

Propositions 40 and 84
Whale Tail License Plate Fund

OBJECTIVE 3B

Implement 13 waterfront restoration projects that encourage and promote public access to developed waterfront areas, support commercial and recreational fishing, promote excellence and innovation in urban design, increase wheelchair accessibility, and protect and restore cultural and historic resources

STRATEGIES

1. Restore waterfront facilities and, where possible, leverage funds or seek repayments.
2. Protect and restore coastal cultural and historical resources.
3. Modernize facilities for the fishing industry at such key locations as Crescent City, Humboldt Bay, Noyo Harbor, San Francisco, Half Moon Bay, Monterey, Morro Bay, Port San Luis, Santa Barbara, and San Diego.

4. Provide facilities to accommodate events that increase public use and enjoyment of waterfront areas, including visitor-serving festivals.

OUTCOME MEASURES

1. Increased visitation, tourism, and economic vitality in waterfront areas in each region
2. Completion of projects displaying design excellence
3. Notable improvements in the sustainability of the commercial fishing industry

GOAL 3 ▪ OBJECTIVE 3B BASIS

Based on estimates and analysis of needs by regional managers, review of Coastal Access Action Plan, and discussions with staff of the California Coastal Commission, up to 13 projects can be completed in the planning period.

REGIONAL DISTRIBUTION

South Coast: 3 projects
Central Coast: 5 projects
North Coast: 5 projects

ESTIMATED CONSERVANCY COST

$13,250,000

FUNDING SOURCES

Proposition 84
Coastal Access Account
Whale Tail License Plate Fund

OBJECTIVE 3C

Support the planning, design, or implementation of 15 or more interpretive or educational displays, exhibits, and public events emphasizing coastal, watershed, and ocean-resource education, maritime history, and climate-change impacts.

STRATEGIES

1. Fund plans for environmental education centers.
2. Fund design and content development of high-quality, site-specific interpretive signage and displays.

OUTCOME MEASURES

1. Completed plans
2. Interpretive signage and educational displays that explain global and local environmental issues

GOAL 3 ▪ OBJECTIVE 3C BASIS

Based on estimates from the Conservancy's regional managers, 15 environmental education displays, centers, or events can be planned during the next five years.

REGIONAL DISTRIBUTION

South Coast: 5 designs, displays, exhibits, or events
Central Coast: 5 designs, displays, exhibits, or events
North Coast: 5 designs, displays, exhibits, or events

ESTIMATED CONSERVANCY COST

$1,750,000

FUNDING SOURCES

Proposition 50
Violation Remediation Account
Whale Tail License Plate Fund

OBJECTIVE 3D

Increase education of the public about environmental issues affecting the coast and inland watersheds by constructing or improving 11 regional environmental education centers.

STRATEGIES

1. Fund construction or improvement of environmental education centers.
2. Fund fabrication of site-specific interpretive signage and displays.

OUTCOME MEASURES

1. Constructed or improved centers
2. Interpretive signage and educational displays that explain global and local environmental conditions and issues

GOAL 3 ▪ OBJECTIVE 3D BASIS

Based on estimates from the Conservancy's regional managers, 11 environmental education centers can be built or improved during the next five years.

REGIONAL DISTRIBUTION

South Coast: 3 centers
Central Coast: 5 centers
North Coast: 3 centers

ESTIMATED CONSERVANCY COST

$6,100,000

FUNDING SOURCES

Proposition 50
Violation Remediation Account
Whale Tail License Plate Fund

COASTAL RESOURCES CONSERVATION

Statutory Authorities

NATURAL RESOURCE RESTORATION AND ENHANCEMENT

(Reference: Public Resources Code Sections 31053, 31251, 31251.2)

The Coastal Conservancy undertakes projects to enhance coastal resources that, because of indiscriminate dredging and filling, improper location of improvements, natural or human-induced events, or incompatible land uses, have suffered loss of natural or scenic values. Under this authority, the Conservancy preserves and increases fish and wildlife habitat and other resource values through public actions, including acquisition of resource areas, restoration of degraded sites, and avoidance of incompatible uses.

ACQUISITION OF SIGNIFICANT COASTAL SITES

(Reference: Public Resources Code Sections 31350, 31351)

In cooperation with local governments and other state agencies, the Coastal Conservancy ensures that threatened coastal resource lands are identified and protected in a timely manner.

SOLVING LAND-USE AND DEVELOPMENT CONTROVERSIES

(Reference: Public Resources Code Sections 31052, 31200, 31203)

The Coastal Conservancy undertakes projects for the purpose of restoring areas that, because of scattered ownerships, poor lot layout, inadequate park and open space, incompatible land uses, or other conditions, are adversely affecting the coastal environment or are impeding orderly development. The Conservancy assists local governments to direct new development to appropriate sites through public actions, including transfer of development, lot consolidation and revised subdivision, hazard mitigation, and open-space acquisition financing.

WATERSHED RESTORATION

(Reference: Public Resources Code Section 31220)

In order to improve coastal water quality, the Conservancy may undertake watershed restoration projects and award grants for this purpose in consultation with the State Water Resources Control Board and regional water quality control boards.

OCEAN RESOURCES

(Reference: Public Resources Code Section 31220)

In order to improve and protect coastal and marine habitats, the Conservancy may undertake sediment management and living marine resources protection and restoration projects, and award grants for these projects.

Issues and Priorities

PROTECTION OF RESOURCES AND OPEN LANDS

The primary purpose of California's Coastal Management Program is to protect the scarce and unique resource values of the coast. Competing and incompatible uses continue to threaten these values. Acquisition of land in fee or less-than-fee title is the Coastal Conservancy's primary means to ensure protection of the coast's ecological, scenic, recreational, and cultural values.

The North Coast region is blessed with exceptional natural resources. Because this region is less urbanized than other parts of the state, large, undeveloped properties still exist. Strategic acquisition of fee-title or conservation easements on these resource lands can connect public lands, and provide large, contiguous blocks of habitat and wildlife corridors.

The Central Coast contains some of the largest private landholdings in the Coastal Zone. Opportunities exist to acquire fee or easement interests in these properties to protect wildlife habitat and corridors, connect or expand existing park and recreational lands, and preserve scenic vistas and open space.

There are still many relatively large undeveloped resource properties on the coast and along river corridors in Ventura, Los Angeles, Orange, and San Diego Counties. These properties contain habitat for endangered species, are part of wildlife corridors, or are critical watershed lands. In some areas, these properties straddle the best alignment for completing the Coastal Trail and regional links to the trail.

BIOLOGICAL DIVERSITY

The California coastal region contains a wide diversity of natural plant and animal communities. Globally recognized as unique, many of these communities are severely reduced or degraded due to human activities. A number of species are listed as threatened or endangered. Isolation and fragmentation of habitat is a key reason for species declines. In addition to assembling large habitat areas, the Conservancy will seek to establish and protect corridors among smaller properties. These habitat corridors can help to moderate some of the effects of fragmentation and isolation of properties.

Climate change is predicted to alter habitats and create additional stressors on some species, possibly resulting in additional species being threatened, endangered, or possibly extinct. Protecting, restoring, and enhancing habitat is the primary method that will be used by the Coastal Conservancy to maintain this biological diversity. Particular attention will be paid to protecting critical wildlife corridors that allow for species migration and adaptation to climate changes.

The Conservancy will work with state and federal fish and wildlife agencies, the Coastal Commission, state and regional water quality control boards, and many other public and private organizations to acquire, restore, and enhance scarce habitat areas. To a great extent, the Conservancy's expenditure of funds on particular habitat-related projects will be taken under the advisement of these agencies.

INVASIVE SPECIES are of great concern throughout the coastal region. Invasive species have been shown to be the second greatest threat to biological diversity, second only to habitat loss. The Conservancy has assisted in reducing infestations of Arundo donax (giant reed), an aggressive species that has invaded riparian corridors throughout the state and one of the major threats to riparian habitat in southern California. The Conservancy also helped with the successful eradication of Caulerpa taxifolia from two lagoons in southern California. Unfortunately, new invasive species are a constant reality and threat to coastal resources. The Conservancy must effectively target its resources in addressing these problems. Invasive species experts have concluded that prevention of new invasions is more effective and economically efficient than responding to an invasion. Therefore, the Conservancy will give serious consideration to support prevention projects and programs, including public education and research.

WETLAND LOSSES are of particular concern. California's remaining estuaries, salt and brackish marshes, freshwater wetlands, and seasonal wetlands support large populations of shorebirds, raptors, songbirds, and other wildlife. The estuaries are particularly important as nurseries and spawning grounds for fish and shellfish, including salmon, steelhead, crab, and other species that have traditionally provided the foundation for California's commercial and recreational fisheries. California's wetlands also provide an important function in storing floodwaters, buffering shoreline erosion, and helping to filter pollutants.

Biodiversity generally and wetland functioning in particular will be impacted by climate change. Species will gain or lose range, wetlands will move or even vanish, and other changes will take place. These must be recognized in this plan.

The Southern California Wetland Recovery Project (SCWRP) is a consortium of 18 state and federal resource and regulatory agencies actively working together to protect and restore coastal wetlands and watersheds from Point Conception south to the border with Mexico. The Conservancy will continue to administer the SCWRP and will allocate funding to projects SCWRP identifies as being of high priority.

The Pacific Coast and San Francisco Bay Joint Ventures provide similar guidance for wetland restoration from the Oregon Border through San Mateo County. The Conservancy will actively support and participate in the work of these organizations.

OTHER HABITATS OF CONCERN that the Conservancy will seek to protect or restore include:

- *Beaches and dunes:* California's beaches and remaining dune systems contain unique plant communities, including endangered plants such as Menzies wallflower, beach laiya, and beach spectacle pod, and provide nesting and feeding habitat for several endangered birds, including the western snowy plover and the California least tern.
- *Coastal prairie and scrub:* Coastal prairie habitat, found north of Big Sur, is increasingly rare. Much of the historical coastal prairie, which contained native bunch grasses and herbs, has been converted over time to introduced annual grasses and weedy species. Coastal scrub habitat can be divided

into northern and southern habitat types. Both northern and southern coastal scrub communities are threatened by development along California's coast.

- *Forests:* California's coastal forests can be broken into several different types, including redwood forest, mixed evergreen forest, fire pines and cypresses, and oak woodlands. Less than 88,000 acres of old growth redwood forests remain, the rest having been logged during the last century and a half. Mixed evergreen forests, containing Douglas fir, a variety of oaks, madrones, and Coulter pines have also been heavily logged, and southern oak woodlands are highly threatened by urban development and conversion to vineyards.

Climate Change

Climate change will affect ocean and coastal habitats in a variety of ways, including alteration of river flows, sea-level rise and consequent drowning of shallow-water wetland habitats, increased storm surges, and damage to coastal property. It is also expected to increase inland temperatures and result in migration of terrestrial and marine species. These impacts will affect many Conservancy projects, such as the design elevation for restored wetlands and the location and materials for public accessways near the ocean or waterways. Altered stream flows may affect fish migration, and uplands may not support current species composition. Consideration of these and other climate-change impacts need to be incorporated into decisions about prioritization of expenditures, and into the design and siting of Conservancy-funded infrastructure. The Conservancy will need to support efforts by the Ocean Protection Council (OPC) and others to improve our understanding of impacts of climate change, and to identify tools to mitigate and plan for a range of predicted changes.

Watersheds, Ocean Resources, and Water Quality

Coastal resource problems and solutions often begin upstream. Ownership and development patterns, physical condition, and processes of coastal watersheds, rivers, streams, and other watercourses are often keys to understanding and solving coastal and ocean problems. Water pollution requires beach closures and affects fish and wildlife habitat. Loss of upstream habitat and barriers to fish passage greatly diminish salmon and steelhead populations. Dams have trapped sediment upstream, depriving beaches of sand, and have led to excessive erosion downstream. Urban development, agriculture, and other land uses block the public's ability to reach rivers or use stream corridors as alternative accessways to the ocean.

The Conservancy will continue to use a holistic watershed approach to solving coastal resource problems whenever appropriate. The Conservancy will coordinate its efforts with other local, state, and federal agencies and organizations by working within the governance framework being developed for watershed programs by the Resources Agency and the California Environmental Protection Agency.

The Conservancy's watershed projects will address the following major issues:

SALMON AND STEELHEAD: In the past 30 years salmon and steelhead populations have shown massive declines from their historical numbers, and many have collapsed, largely because of inadequate stream flows, blocked access to historical spawning and rearing areas, and discharge of sediment and debris into watercourses from inappropriate land-use practices. Other contributing factors include loss of riparian canopy, lack of large woody debris recruitment to streams, and loss of estuarine nursery and rearing habitat.

The decline of coastal salmon populations is likely to be exacerbated by climate change. Prolonged droughts, decreasing snow pack, and altered rainfalls are likely to reduce stream flows to levels that no longer sustain anadromous fish.

The Conservancy will focus primarily on reopening historical anadromous fish habitat by removing barriers to fish passage on key rivers, creeks, and tributaries. The Conservancy will continue efforts to remove major barriers such as the Klamath, San Clemente, and Matilija Dams. The Conservancy will also continue to fund projects that remove or retrofit culverts and other smaller barriers on priority streams. In addition, the Conservancy will cooperate with the OPC, public agencies and private entities to identify minimum instream flows necessary to sustain anadromous fish populations at healthy levels.

On the North Coast, the Conservancy will work to implement projects based on the North Coast Watershed Assessment Program,

the 303(d) list of the Water Resources Control Board, salmonid recovery plans, and other watershed-based plans.

On the Central Coast, the Conservancy will fund locally based watershed plans and projects, giving priority to watersheds that support coho salmon and/or steelhead runs, have local stakeholder support, are on the SWRCB 303(d) list for water quality impairment, are targeted in water quality or endangered species recovery plans, and/or contain significant coastal resources. The Conservancy will also focus on developing permit coordination programs and building local capacity.

On the South Coast the Conservancy will continue efforts to restore habitat for southern steelhead by removing fish passage barriers and restoring riparian habitat along important steelhead streams.

RIVER PARKWAYS: River parkways are multipurpose conservation projects focused on the remnant natural landscapes contained in river corridors. In developing river parkway projects, pursuant to Chapters 5.5, 6, and 9 of Division 21, the Conservancy will seek to restore functional river systems, preserve natural habitats, provide public access opportunities, protect open space, and provide sustainable flood control. It will support high-priority projects over the long term to ensure continuity and completion of trail systems to the ocean.

On the South Coast, the Conservancy will continue its efforts to develop parkways along rivers that offer important habitat or recreational opportunities, including the Santa Clara, Ventura, Santa Ana, and San Diego Rivers.

WATER QUALITY: Currently, "non-point" sources of coastal water pollution, such as on-site septic systems and polluted storm-water and agricultural runoff, are the largest causes of coastal water pollution in California (SWRCB and CCC; 2001). Nearly all coastal watersheds in California are considered "impaired" because of one or more contaminants (SWRCB: 303(d) List).

The Conservancy will continue to implement appropriate projects under its purview in furtherance of California's Non–point Source Pollution Control Plan (Program Plan). The Program Plan includes a 15-year timeline, with three short-term five-year plans. The Conservancy will also continue to work with the Coastal Commission to designate critical coastal areas (CCAs) that are most at risk from water pollution and in need of restoration and enhancement.

The Conservancy will continue to support projects that help improve water quality by reducing impacts from non–point source pollution. The Conservancy will continue to work with the Clean Beaches Task Force, the Santa Monica Bay Restoration Commission, and others to advance these projects.

SAND SUPPLY: The natural movement of sediment through coastal watersheds to the shoreline has been altered significantly by human activities. Dams, debris basins, channelized streams and other flood control structures both reduce the volume of sediment in fluvial systems and diminish the ability of rivers and streams to carry sediment to the ocean. Human interference in the natural transport of sediment causes beach erosion and subsequent loss of coastal access, degradation of wetlands, and obstruction of fish passage in coastal waterways.

The Conservancy will seek to complete projects that reestablish the supply of sediment to beaches (including removal of dams) and restore natural channels. It will support efforts to find opportunities to use sediment from debris basins and other sources to replenish beaches.

Preservation of Working Landscapes

Lands that are used to grow agricultural crops, for grazing, dairy operations, or timber production constitute "working landscapes." Throughout the Coastal Zone, these lands, cherished by generations of Californians, play a vital role in maintaining local economies.

With rich soils and a moderate, ocean-influenced climate, coastal agricultural lands support specialty crops, some of which can only be grown on the coast. The per-acre production values of coastal agriculture can be as much as four times those of inland areas. Grazing lands for sheep, cattle, and dairy production are also an important component of coastal agriculture, and an important segment of the North Coast's agricultural economy. The North Coast contains 3.4 million acres of timberlands; half of California's annual timber revenue is derived from Mendocino and Humboldt counties.

The conversion of coastal working landscapes to residential, commercial, and specialized uses, such as golf courses, threatens the

economic viability of remaining working landscapes, and may also reduce wildlife habitat and the scenic quality of the coast. Other factors affecting the viability of working landscapes include: difficulty and cost of meeting new environmental regulations; unreliable water supplies; constrained access to markets; reduction in acreages beyond what will sustain associated processing and transport facilities; and incompatibility of surrounding land uses.

The Conservancy will work through its partnerships to protect working lands by acquiring conservation easements or fee title for the state's most productive and threatened lands. The Conservancy will also fund projects to provide improvement, such as adequate water supplies or improved water storage capacity, necessary to keep threatened lands in production and to strengthen regional agricultural economies. Where appropriate, the Conservancy will also support efforts to improve agricultural practices for the dual purpose of protecting agricultural lands and natural resources.

Coastal Zone Management/ Conflict Resolution

The Coastal Conservancy's jurisdiction encompasses that of both the Coastal Commission and the San Francisco Bay Conservation and Development Commission (BCDC). The regulatory programs of these agencies ensure that state and regional land-use policies are carried out within the San Francisco Bay and coastal regions. This state intervention in land-use decisions has led to intense controversies over the years between developers, environmental groups, local governments, and the state regulatory agencies. The Conservancy was created in part to act as a moderating force in these conflicts. The Conservancy is able to acquire property or use its broad powers, outlook, and authority to devise creative solutions. In some cases, the Conservancy's problem-solving approach can also be used outside of the Coastal Zone.

The Conservancy can also use its powers to assist the Coastal Commission and local jurisdictions to complete local coastal programs (LCPs). In many cases LCPs have not been completed because of ongoing controversies regarding appropriate development for specific subregions within a local jurisdiction. The Conservancy will seek to reduce these conflicts through key property acquisitions and other means.

Coastal Resources Conservation

Goal 4

Acquire significant coastal resource properties.

STATEWIDE STRATEGY

Protect resource lands that: 1) connect existing public and other protected lands to provide large, contiguous blocks; 2) protect habitat and wildlife corridors; 3) support regional plans (e.g., recovery plans for listed species); and 4) preserve scenic vistas and open space.

OBJECTIVE 4A

Protect 25,400 acres of significant coastal and watershed resource properties.

STRATEGIES

1. In consultation with government and nonprofit partners, identify priority resource lands, including critical wildlife corridors.
2. Support efforts to complete and maintain the protected lands GIS database.
3. Regularly meet with national and regional nonprofit organizations, foundations, other local, state, and federal agencies, and real estate brokers to determine appropriate lead agencies for priority acquisitions, and to avoid duplication of effort and ensure awareness of real estate trends and properties likely to be on the market.
4. For each potential acquisition, determine whether fee interest or easements are needed,
5. Identify appropriate entity to acquire and manage real-property interests.

OUTCOME MEASURES

1. Acres protected for landscape-level conservation of natural communities, and scenic or recreational resources

MONITORING AND TRACKING

1. Quantify protection results.

GOAL 4 ▪ OBJECTIVE A BASIS

The objective of 25,400 acres is based on estimates of regional program managers, in consultation with the Wildlife Conservation Board, Department of Fish and Game, Department of Parks and Recreation, Coastal Commission, and nonprofit organizations.

REGIONAL DISTRIBUTION

South Coast: 2,200 ACRES
Central Coast: 8,700 ACRES
North Coast: 14,500 ACRES

ESTIMATED CONSERVANCY COST

$91,550,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund
Future bonds

Coastal Resources Conservation

Goal 5

Restore and enhance biological diversity in coastal watersheds.

STATEWIDE STRATEGY

For identified key regional habitat types, concentrate on restoring systems that are of sufficient size and complexity to help ensure lasting ecological integrity.

OBJECTIVE 5A

Develop 28 plans for the restoration and enhancement of coastal habitats, including coastal wetlands and intertidal areas, stream corridors, dunes, coastal terraces, coastal sage scrub, redwood forest, oak woodlands, Douglas fir forests, and coastal prairie, and for prevention, eradication, or control of invasive species.

STRATEGIES

1. Participate in local and regional strategic planning processes to target most important resources and assess local and regional strategic resource plans.
2. Develop partnerships with nonprofit organizations, local, state, and federal public agencies, and promote public outreach.
3. Develop local capacity to plan and implement resource-enhancement projects.
4. Facilitate resolution of conflicts that impede efforts to conserve coastal resources.
5. Complete planning phases that will lead toward project implementation, including resource enhancement plans, conceptual plan, detailed designs, environmental documentation, and permitting.
6. Fund research of invasive-species prevention strategies and develop prevention programs.
7. Incorporate predicted evolutions in habitat due to climate change when planning restoration and enhancement.

OUTCOME MEASURES

1. Plans completed that incorporate predicted habitat evolutions from climate change
2. Invasive-species prevention programs developed

GOAL 5 ▪ OBJECTIVE 5A BASIS

Estimates of the numbers of plans are based on information from regional program managers, in consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, and nonprofit organizations.

REGIONAL DISTRIBUTION

South Coast: 9 plans
Central Coast: 11 plans
North Coast: 8 plans

ESTIMATED CONSERVANCY COST

$8,600,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 5B

Restore and enhance 6,820 acres of coastal habitats including coastal wetlands and intertidal areas, stream corridors, dunes, coastal sage scrub, coastal terraces, redwood forest, oak woodlands, Douglas fir forests and coastal prairie.

STRATEGIES

1. Implement priority projects.

OUTCOME MEASURES

1. Acres restored or enhanced

GOAL 5 ▪ OBJECTIVE 5B BASIS

Estimates of the numbers of acres based on information from regional program managers, in consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, and nonprofit organizations.

REGIONAL DISTRIBUTION

South Coast: 1,300 restored acres
Central Coast: 4,020 restored acres
North Coast: 1,500 restored acres

ESTIMATED CONSERVANCY COST

$41,875,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 5C

Implement approximately 25 projects to preserve and restore wildlife corridors both between core habitat areas along the coast and from coastal to inland habitat areas.

STRATEGIES

1. Identify core coastal habitat areas.
2. Prioritize and implement projects to preserve or create links between core habitat areas.
3. Implement restoration projects within the habitat corridor.

OUTCOME MEASURES

1. Permanent protection or restoration of important habitat corridors affecting significant populations of various species

GOAL 5 ▪ OBJECTIVE 5C BASIS

Preservation and restoration of 25 habitat corridors is based on estimates from regional program managers in consultation with the Wildlife Conservation Board, Coastal Commission, and nonprofit organizations, including the Missing Linkages Project.

REGIONAL DISTRIBUTION

South Coast: 4 projects
Central Coast: 11 projects
North Coast: 8 projects

ESTIMATED CONSERVANCY COST

$20,000,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 5D

Implement 16 projects that target prevention, control or eradication of non-native invasive species that threaten important coastal habitats.

STRATEGIES

1. Coordinate with local partners to identify and develop strategic projects that are likely to be successful over the long term, including comprehensive, watershed-based approaches and rapid-response efforts.
2. Support public education to prevent the introduction and spread of invasive species.

OUTCOME MEASURES

1. Invasive species controlled or eradicated within targeted projects areas
2. Education materials developed and distributed

GOAL 5 ▪ OBJECTIVE 5D BASIS

Sixteen projects to eradicate non-native species are based on estimates from regional managers in consultation with the Department of Fish and Game, Wildlife Conservation Board, California Biodiversity Council, and nonprofit organizations including the California Invasive Plant Council. Many projects involve removal of *Arundo donax* on various river corridors and removal of terrestrial species, such as pampas grass.

REGIONAL DISTRIBUTION

South Coast: 3 projects
Central Coast: 8 projects
North Coast: 5 projects

ESTIMATED CONSERVANCY COST
$6,100,000

FUNDING SOURCES
Proposition 84
Tax check-off

OBJECTIVE 5E

Implement two projects to support the recovery of the southern sea otter (*Enhydra lutris nereis)* population.

STRATEGIES

1. Support research that will increase understanding of factors that contribute to sea otter mortality, including sources and transport mechanisms of biotoxins, pollutants, and disease agents, and that will clarify relationships between direct and indirect causes of death.
2. Support study of live sea otters, including monitoring their distribution and abundance, and research to increase understanding of their functional biology and development and application of improved instrumentation and tagging methods.
3. Support continuation of programs to salvage and study fresh otter carcasses.
4. Support projects designed to restore or enhance sea otter habitat.
5. Implement management actions, including education and outreach, that promise to help the sea otter population to recover.

OUTCOME MEASURES

1. Number of research/study projects
2. Number of management measures, including education and outreach efforts
3. Increase in otter population
4. Delisting of the southern sea otter as a federally threatened species

MONITORING AND TRACKING

1. Track federal listing status.

FUNDING SOURCES
Proposition 84
Tax check-off

Coastal Resources Conservation

Goal 6

Improve water quality, habitat, and other coastal resources within coastal watersheds and the ocean.

STATEWIDE STRATEGY

Develop and implement projects to protect and restore riparian, coastal, and marine ecosystems, including projects to improve water quality, protect and restore fish and wildlife habitat, implement endangered species recovery plans, and restore coastal wetlands, floodplains, and watershed lands.

OBJECTIVE 6A

Develop 21 plans to preserve and restore coastal watersheds and create river parkways.

STRATEGIES

1. Participate in state watershed coordination processes.
2. Participate in local watershed planning groups.
3. Promote public outreach and community involvement.
4. Fund the development of watershed and river parkway plans.
5. Incorporate predicted alterations in stream flows when developing plans.

OUTCOME MEASURES

1. Plans are developed for high priority watersheds and river parkway projects.

GOAL 6 ▪ OBJECTIVE 6A BASIS

Consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, Department of Parks and Recreation, and nonprofit organizations.

REGIONAL DISTRIBUTION
South Coast: 6 plans
Central Coast: 9 plans
North Coast: 6 plans

ESTIMATED CONSERVANCY COST
$7,150,000

FUNDING SOURCES
Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 6B

Implement 49 projects to preserve and restore coastal watersheds and create river parkways.

STRATEGIES

1. Fund the implementation of projects to preserve and restore coastal watersheds and create river parkways.
2. Promote public outreach and community involvement.

OUTCOME MEASURES

1. Completed projects

GOAL 6 ▪ OBJECTIVE 6B BASIS

Consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, Department of Parks and Recreation, and nonprofit organizations.

REGIONAL DISTRIBUTION
South Coast: 7 projects
Central Coast: 12 projects
North Coast: 30 projects

ESTIMATED CONSERVANCY COST
$15,250,000

FUNDING SOURCES
Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 6C

Develop 112 plans to remove barriers to fish passage and ensure sufficient instream flow to support fish habitat.

STRATEGIES

1. Prioritize barriers for removal based on existing statewide and regional assessments, and conduct additional assessments as needed.
2. Fund the development of plans, designs, permits, and California Environmental Quality Act (CEQA) compliance documents required for the removal of fish barriers.
3. Plans for designs of barrier removal will incorporate predicted stream-flow alterations information.
4. Identify opportunities for securing adequate instream flows in key coastal watersheds.

OUTCOME MEASURES

1. Priorities identified
2. Plans completed

GOAL 6 ▪ OBJECTIVE 6C BASIS

Consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, NOAA Fisheries, Department of Parks and Recreation, and nonprofit organizations.

REGIONAL DISTRIBUTION

South Coast: 2 plans
Central Coast: 10 plans
North Coast: 100 plans

ESTIMATED CONSERVANCY COST

$8,750,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 6D

Implement fish barrier removal projects to open or improve 99 miles of habitat.

STRATEGIES

1. Remove or modify culverts and stream crossings.
2. Construct fishways that restore access.
3. Modify diversions to ensure adequate instream flow.

OUTCOME MEASURES

1. River miles opened to fish
2. Projects completed
3. Presence of fish in previously inaccessible habitat
4. Measurable improvement in instream flow levels

MONITORING AND TRACKING

1. Measure spawning returns.
2. Periodic measurement of instream flows

GOAL 6 ▪ OBJECTIVE 6D BASIS

Consultation with the Wildlife Conservation Board, Coastal Commission, Department of Fish and Game, NOAA Fisheries, Department of Parks and Recreation, and nonprofit organizations.

REGIONAL DISTRIBUTION

South Coast: 18 miles
Central Coast: 51 miles
North Coast: 30 miles

ESTIMATED CONSERVANCY COST

$38,000,000

FUNDING SOURCES

Propositions 40, 50, and 84
Habitat Conservation Fund

OBJECTIVE 6E

Complete approximately 19 plans to improve water quality to benefit coastal ocean resources.

STRATEGIES

1. Plan wetland and riparian projects that improve water quality, where appropriate.
2. Develop plans for projects that reduce impacts of urban runoff to coastal watersheds, beaches, and the ocean.
3. Identify pollution hotspots affecting restoration of coastal ocean resources.
4. Disseminate information and provide funding to address pollution cleanup and prevention, using best-management practices.
5. Work with marine laboratories and other departments to track ocean pollutants.

OUTCOME MEASURES

1. Plans completed
2. A system created to track and monitor ocean pollution

GOAL 6 ▪ OBJECTIVE 6E BASIS

The estimate of 19 plans is based on discussions with the Santa Monica Bay Restoration Project, Coastal Commission, resource conservation districts, and regional water quality control boards.

REGIONAL DISTRIBUTION

South Coast: 8 plans
Central Coast: 9 plans
North Coast: 2 plans

ESTIMATED CONSERVANCY COST

$2,900,000

FUNDING SOURCES

Propositions 40, 50, and 84

OBJECTIVE 6F

Implement 16 projects to improve water quality to benefit coastal resources.

STRATEGIES

1. Implement wetland and riparian projects that improve water quality.
2. Implement projects that reduce impacts of runoff to coastal watersheds, beaches, and the ocean.
3. Promote agricultural practices that reduce erosion, sedimentation, and pollution.
4. Provide funding for projects that address pollution cleanup and prevention, using best-management practices.

OUTCOME MEASURES

1. Measurable water quality improvements in project areas
2. Fewer beach closings and marked improvement in waterfront environments
3. Reduction in agricultural and septic-system pollution

MONITORING AND TRACKING

1. Long-term water quality monitoring by nonprofit organizations, local governments, and regional water quality control boards.

GOAL 6 ▪ OBJECTIVE 6F BASIS

Based on discussion with staff of the Santa Monica Bay Restoration Project, California Coastal Commission, and regional water quality control boards

REGIONAL DISTRIBUTION

South Coast: 5 projects
Central Coast: 9 projects
North Coast: 2 projects

ESTIMATED CONSERVANCY COST

$7,750,000

FUNDING SOURCES

Propositions 40, 50, and 84

OBJECTIVE 6G

Assist in the development of seven projects that constitute regional approaches to the management of shoreline erosion and sediment management.

STRATEGIES

1. Continue to assist in the completion and implementation of the California Sediment Management Master Plan.
2. Assist in the planning and implementation of projects to remove barriers to sediment transport in rivers and streams.
3. Explore opportunities for beneficial reuse of sediment.

OUTCOME MEASURES

1. Measurable increase in natural sediment to a littoral cell
2. Significant increase in sand retention on selected beaches
3. Estimated historical sediment flow reestablished on a river or stream
4. Prevention of erosion

GOAL 6 ▪ OBJECTIVE 6G BASIS

Based on discussions with the Coastal Sediment Management Work Group, sponsored by the Resources Agency and the U.S. Army Corps of Engineers. Projects may be integrated into other ongoing efforts, including removal of dams and experimental placements of sediments into nearshore environments from coastal wetland restoration projects. Projects may also involve additional studies of the nearshore environment and pollution monitoring critical to determining the impacts of beach nourishment projects.

REGIONAL DISTRIBUTION

South Coast: 4 projects
Central Coast: 2 projects

ESTIMATED CONSERVANCY COST

$3,500,000

FUNDING SOURCES

Propositions 40 and 50

Coastal Resources Conservation

Goal 7

Preservation of working landscapes.

STATEWIDE STRATEGY

The top priorities for protection are working lands, including croplands, grazing lands, and working forests within the urban fringe, and/or where there are continuing resource protection/agricultural production conflicts, or threats of subdivision and conversion to other uses.

OBJECTIVE 7A

Acquire approximately 74,070 acres of working-lands conservation easements or fee interests over strategic properties in key coastal watersheds.

STRATEGIES

1. Update/refine identification of strategic agricultural preservation areas and status of agricultural economies in each coastal county.
2. Update/refine identification of strategic timberland areas and status of timber economy in northern coastal counties.
3. Update/refine identification of priority properties in each county.
4. Determine landowner interest and local support.
5. Provide funding for the acquisition of working landscapes.
6. Identify and/or develop new tools (i.e. flood easements) to resolve flooding impacts on agricultural and other lands while enhancing coastal resource habitat.
7. Coordinate with the California Department of Conservation and Wildlife Conservation Board to integrate farmland and timberland preservation and habitat protection.

OUTCOME MEASURES

1. Permanent protection of agricultural productivity and scenic and habitat values associated with priority coastal farmland
2. Permanent protection of working forests and natural resource values associated with priority forestland

MONITORING AND TRACKING

1. Obtain data sufficient to identify projected development that threatens conversion of agricultural lands.
2. Track the number of acres of protected land in the database.
3. Compare protected total/annual acreage to conversion rate in each area if information is readily available.

GOAL 7 ▪ OBJECTIVE 7A BASIS

The goal of 74,070 acres is based on analysis by regional managers of the most critical remaining working lands in each region. Lands to be protected are on the urban/rural boundaries of coastal towns or are otherwise under threat of development or conversion..

REGIONAL DISTRIBUTION

South Coast: 200 acres
Central Coast: 3,870 acres
North Coast: 70,000 acres

ESTIMATED CONSERVANCY COST

$44,000,000
(Most of these lands would be acquired as "significant properties" under Goal 4.)

FUNDING SOURCE

Propositions 40 and 84

OBJECTIVE 7B

Provide funding for 38 plans for projects that foster the long-term viability of coastal working lands, including projects to assist farmers, ranchers, and timber producers to reduce impacts of their operations on wildlife habitat and water quality.

STRATEGIES

1. Investigate and identify significant natural resource areas and waterways that are adversely impacted by operations of working lands.
2. Consult with agencies and nonprofit organizations to identify where planning is needed for restoration or protection of lands, and where there are landowners interested in improving their land use practices.

OUTCOME MEASURES

1. Completion of plans that when implemented will reduce or eliminate impacts of working-land practices.

GOAL 7 ▪ OBJECTIVE 7B BASIS

The goal of 38 plans is based on analysis by regional managers of key needs in each region in consultation with local farm bureaus, Natural Resource Conservation Service, resource conservation districts, California Department of Forestry, Department of Conservation, nonprofit organizations, and farm economists.

REGIONAL DISTRIBUTION

South Coast: 1 plan
Central Coast: 7 plans
North Coast: 30 plans

ESTIMATED CONSERVANCY COST

$2,850,000

OBJECTIVE 7C

Implement approximately 60 projects that foster the long-term viability of coastal working lands, including projects to assist farmers, ranchers, and timber producers to reduce impacts of their operations on wildlife habitat and water quality.

STRATEGIES

1. Fund facilities that increase producers' access to markets.
2. Fund demonstrations of water efficiency, implementation of best-management practices, and other conservation measures.
3. Help resolve conflicts between agricultural productivity and wildlife resources and habitat.
4. Participate in discussions regarding food safety and developing regulations.
5. Develop permit coordination, green certification, and fish-friendly programs through resource conservation districts and nonprofit organizations.
6. Acquire buffer strips along sensitive habitat and watercourses.
7. Provide assistance to farmers through resource conservation districts and nonprofit organizations to reduce erosion and encroachments into streams.
8. Coordinate with regional water quality control boards to help land managers comply with changing regulations (e.g. elimination of farm-waiver programs).

OUTCOME MEASURES

1. Strengthening of, or progress toward, stabilization of local and regional working-land economies

MONITORING AND TRACKING

1. Monitor legislation and regulations affecting coastal agriculture and timberland.

GOAL 7 ▪ OBJECTIVE 7C BASIS

The goal of 60 projects is based on analyses of key needs in each region by regional managers in consultation with local farm bureaus, the Natural Resource Conservation Service, resource conservation districts, California Department of Forestry, Department of Conservation, nonprofit organizations, and farm economists.

REGIONAL DISTRIBUTION

South Coast: 1 projects
Central Coast: 9 projects
North Coast: 50 projects

ESTIMATED CONSERVANCY COST

$6,750,000

FUNDING SOURCES

Propositions 40 and 84
Special Deposit Accounts (Carlsbad funds)

Coastal Resources Conservation

Goal 8

Provide nonregulatory alternatives to reduce conflicts among competing uses in the Coastal Zone.

STATEWIDE STRATEGY

Assist the Coastal Commission, San Francisco Bay Conservation and Development Commission, and local jurisdictions in resolving the most difficult land-use conflicts.

OBJECTIVE 8A

Resolve 6 land-use conflicts stemming from local coastal programs, work toward elimination of "white holes" (areas where there is no certified local coastal program), and participate in habitat-conservation planning.

STRATEGIES

1. Coordinate closely with staff of the Coastal Commission, San Francisco Bay Conservation and Development Commission, and local governments to update and refine baseline information pertaining to problem areas.
2. Communicate with local land-use authorities and others regarding land-use conflicts.
3. Develop plans with local decisionmakers to implement lot consolidations, transfer of development programs, partial acquisitions, or other methods for addressing these issues where appropriate.
4. Work with wildlife agencies to assist in developing and implementing natural communities conservation plans.

OUTCOME MEASURES

1. Within each calendar year and region, focus on the resolution of at least 6 land-use conflicts of the highest priority through acquisition of property interests, redesign of subdivisions, transfer development credit programs, or partial development.

GOAL 8 ▪ OBJECTIVE A BASIS

The goal of resolving six land-use conflicts is based on discussions with staff of the Coastal Commission, San Francisco Bay Conservation and Development Commission (BCDC), and local jurisdictions. This goal overlays other goals. Other goals and objectives will be met to the extent feasible in a manner that resolves various land-use issues within the Coastal Zone and BCDC zones.

REGIONAL DISTRIBUTION

South Coast: 2 resolutions
Central Coast: 3 resolutions
North Coast: 1 resolutions

FUNDING SOURCES

Propositions 40 and 84

SAN FRANCISCO BAY AREA CONSERVANCY PROGRAM

Statutory Authority

Chapter 4.5 of Division 21 recognizes the Bay Area as a region with unique "natural resource and outdoor recreational needs" and the central focus of an "interconnected open-space system of watersheds, natural habitats, scenic areas, agricultural lands, and regional trails." (Reference: Public Resources Code Sections 31160, 31161, 31162, 31163)

The San Francisco Bay Area Conservancy Program addresses the resource and recreational goals of the San Francisco Bay Area, including: improving public access; protecting, restoring, and enhancing natural habitats and related lands; assisting in the implementation of the Coastal Act, the San Francisco Bay Plan, and local government plans; and promoting, assisting, and enhancing projects that provide open space and natural areas that are accessible to urban populations for recreational and educational purposes.

Issues and Priorities

NATURAL RESOURCE RESTORATION AND PROTECTION

WETLANDS: Approximately 20 percent of the Bay Area's tidal marshes, seasonal wetlands, and other wetland habitats remain. The remaining wetlands and adjoining uplands provide habitat critical to the survival of almost 50 endangered and threatened species protected by the federal or state Endangered Species Acts. Landscape-scale acquisitions of San Francisco baylands have occurred over the past decade. While acquisitions of remaining wetlands, particularly seasonal wetlands and uplands adjacent to tidal wetlands, remain important, the Bay Area Program's focus is now the planning and implementation of wetland restoration and enhancement projects. Eradication of introduced species of *Spartina* and hybrids is essential to ensure the success of wetlands restoration projects and is the goal of the Invasive Spartina Project managed by the Conservancy.

The Bay Area Program will continue to work with the San Francisco Bay Joint Venture, a federally chartered consortium of federal, state, and local agencies and private organizations, to assist in the implementation of goals identified in *Restoring the Estuary: An Implementation Strategy for the San Francisco Bay Joint Venture* (2001). The Joint Venture's strategy uses the *Baylands Ecosystem Habitat Goals* (1999) for its scientific basis and includes acreage objectives to protect, restore, and enhance wetland habitats.

The Bay Area Program will continue to support the Subtidal Habitat Goals Project to develop recommendations for restoration, management, and research of the subtidal habitats of San Francisco Bay. The Bay Area Program will also support implementation of these recommendations to help to achieve a net improvement of subtidal ecosystem function. Eelgrass and native oysters are expected to be a major focus of the restoration recommendations. For the purpose of this Strategic Plan, the definition of wetlands is broadened to include subtidal habitats.

UPLAND HABITAT AND CONNECTING CORRIDORS: Habitat conversion, habitat fragmentation, and habitat degradation are the leading causes of biodiversity loss. Protecting wildlife habitat in the Bay Area will be particularly challenging as population is forecasted to increase by over one million people by 2020, to approximately 8.75 million people (Association of Bay Area Governments, 2005). Growth is expected to be concentrated in the north and east bay counties, since other counties have relatively less land available for development.

The Bay Area Program will fund efforts to protect and preserve upland wildlife habitat and connecting corridors with an emphasis on landscape-sized reserves and connections. The program will work with state and federal resource management agencies, the Bay Area Open Space Council, local and regional public agencies, and nonprofit organizations to identify key parcels. The program will also fund and provide technical assistance. In the short term, efforts will be focused on protecting the most threatened and most critical habitat areas.

WATERSHEDS AND STREAMS: Some 75 creeks or rivers drain directly into the San Francisco Estuary. All have been degraded to some degree by urban development and many kinds of pollution. Many creeks now run almost entirely in underground culverts or hard-bottom channels, their functions limited to carrying storm water and non-point pollution to the Bay. Such conditions directly affect fish and wildlife, human health, recreation, and water quality in the San Francisco Bay, as well as the water supply for agriculture and industry.

The Bay Area Program will work with the San Francisco Bay Joint Venture, the Integrated Regional Water Management Program, and others to undertake projects that restore the broad functioning of Bay Area creeks, rivers, and watersheds. Projects that provide multiple benefits and include educational or recreational features will be favored.

PUBLIC ACCESS, RECREATION AND EDUCATION

Within the San Francisco Bay Area, the Conservancy will focus on providing a connected system of public accessways along the coast, San Francisco Bay, and the ridgelines connecting to urban open spaces and public facilities. This will be accomplished by working with the Association of Bay Area Governments, the San Francisco Bay Conservation and Development Commission, the Bay Area Ridge Trail Council, and numerous open space districts, parks departments, land trusts and other nonprofit organizations to plan, fund, and develop the San Francisco Bay Trail, the San Francisco Bay Area Water Trail, the Bay Area Ridge Trail, and other regional trails.

The Bay Area Program will also improve public access by providing related facilities such as interpretive centers, picnic areas, staging areas, interpretive signs, docks and piers, and campgrounds. Public access will also be improved by including wheelchair-accessible or other ADA-compliant elements in Conservancy-funded projects, where feasible.

Urban recreational and educational facilities provide a range of benefits to citizens of the region, especially children. These benefits include economic revitalization and cultural enrichment, recreational and exercise opportunities to promote health and fitness, and interpretation of natural resources and science education. The Conservancy will focus its urban public access, recreation, and education efforts on providing land and facilities that will benefit the largest number of people, reach underserved populations, and provide the greatest opportunity for environmental education.

OPEN SPACE AND AGRICULTURAL PRESERVATION

The San Francisco Bay region has lost significant open-space lands to urbanization. The long-term goal is to protect approximately 2 million acres of open space in the Bay Area. The Bay Area is more than halfway toward meeting this goal, with approximately 1.1 million acres already protected.

A key component of open space in the Bay Area is the region's rangelands and prime, unique, and important farmlands. Scarce and expensive water and energy supplies, conflicts with neighbors over pesticide use, foreign and national competition, and the reduction of agricultural support services all reduce the viability of agriculture. Agricultural lands are in need of protection from conversion to residential and commercial uses. These lands typically provide multiple benefits, including wildlife habitat and connecting corridors, scenic views, open space, and a supply of local agricultural products to people in the Bay Area, reducing the negative impacts of transporting food long distances. The Bay Area Open Space Council and other organizations have identified several areas of important farmland within the region that can be protected through acquisition of easements, as well as large areas of rangelands that can be protected through acquisition of easements or fee title.

The Bay Area Program will work to acquire open space and agricultural conservation easements in key areas to protect the scenic quality of the region and support the continuance of agriculture. To protect local farmlands, the Bay Area Program's enabling legislation may need to be broadened in regard to the protection of agricultural resources. Agricultural lands are referenced in Chapter 4.5, but are not explicitly listed as a goal, although they fall under the category of "open space resources of regional importance."

San Francisco Bay Area Conservancy Program

Goal 9

Maintain and update lists of long-term resource and recreational goals for the San Francisco Bay Area.

REGIONAL STRATEGY

Ensure efficiency and coordination among agencies and organizations in developing project priorities and an effective database.

OBJECTIVE 9A

Maintain and update lists of high-priority areas for the Bay Area Program, including projects that protect and restore natural habitats and other open-space lands of regional significance, and those that improve public access to and around the bay, connecting the ridges, coast, and urban open spaces.

STRATEGIES

1. Contact all major partner organizations every two years to obtain information on their recent accomplishments and current priorities.
2. Complete GIS database of existing projects.
3. Work with partners to identify areas that are underserved by trails, parks, and open space.
4. Support the ability of environmental justice organizations, watershed groups, nongovernmental organizations, and local agencies to adequately develop projects and concepts for consideration as regional priorities.
5. Support assessments and regional planning that help to quantify needs and establish priorities for conservation, restoration, and recreation.
6. Complete the Upland Habitat Goals, Subtidal Goals, and Green Vision projects to identify priority restoration and protection projects.
7. Participate in the Bay Area Open Space Council, the San Francisco Bay Joint Venture, and other regional organizations to determine priority conservation and restoration areas.
8. Work with the Bay Area Ridge Trail Council, the San Francisco Bay Trail Project, and San Francisco Bay Area Water Trail Project partners to identify priorities for completion of regional trails.
9. Develop priorities for agricultural conservation with the California Department of Conservation, resource conservation districts,nonprofit organizations that protect agricultural lands, and local agencies.
10. With local stakeholders and jurisdictions, the San Francisco Bay Regional Water Quality Control Board, Integrated Regional Water Management Program, and others, designate priority areas for watershed and stream restoration that will serve multiple water resource management objectives.
11. Maximize effectiveness in implementing Bay Area Program goals on the coast side of Bay counties.
12. Support assessments that evaluate the effectiveness of Conservancy-funded projects in meeting the Strategic Plan's goals.

OUTCOME MEASURES

1. A biannual set of identified Bay Area Program priority areas and projects
2. Completed and maintained GIS database, including digital layers of completed and in-progress projects

GOAL 9 ▪ OBJECTIVE 9A BASIS

Section 31163(a) requires the Conservancy to cooperate with public and nongovernmental organizations to identify and use long-term resource and outdoor recreational goals to guide the ongoing activities for the San Francisco Bay Area Conservancy Program. The Conservancy will do this by reviewing updated regional and general plans and consulting with staff of agencies, districts, and nongovernmental organizations about updated priorities.

ESTIMATED CONSERVANCY COST

$1,500,000

San Francisco Bay Area Conservancy Program

Goal 10

Protect, restore, and enhance natural habitats and connecting corridors, watersheds, scenic areas, and other open-space resources of regional importance.

REGIONAL STRATEGY

Protect and restore lands of sufficient size or scope, or that are components of landscape efforts, in order to help ensure lasting ecological integrity for key regional habitat types; protect and restore lands that play critical roles in watershed functions and processes; and protect lands that provide important view sheds and critical wildlife corridors.

OBJECTIVE 10A

Protect approximately 3,000 acres of wetland habitat throughout the nine Bay Area counties. For purposes of this objective, wetlands include tidal, managed, riparian, riverine, and subtidal habitats.

STRATEGIES

1. Work with public agencies or nonprofit organizations able and willing to protect, acquire, and manage wetland properties.
2. Identify willing sellers of fee titles or easements, as appropriate, on wetland properties identified as priorities for acquisition.
3. Negotiate and complete acquisition of these properties.
4. Seek matching funds for wetland acquisition projects and support the work of the San Francisco Bay Joint Venture to obtain additional funds.

OUTCOME MEASURES

1. The numerical goal for protection of acres is met on time and is accomplished in a cooperative manner with other agencies and organizations.

GOAL 10 ▪ OBJECTIVE 10A BASIS

Needs and goals for wetland protection are generally derived from the Baylands Ecosystem Habitat Goals report, the San Francisco Bay Joint Venture's Implementation Strategy, and the preliminary work to develop a Subtidal Goals document. Priorities are further refined through consultations with staff from agencies and other experts.

ESTIMATED CONSERVANCY COST

$5,000,000

FUNDING SOURCES

Propositions 12, 40, and 84
Proposition 50 grant funds from Wildlife Conservation Board

OBJECTIVE 10B

Develop plans for restoration or enhancement projects covering approximately 3,500 acres of wetlands. For purposes of this objective, wetlands include tidal, managed, seasonal, riparian, and subtidal habitats.

STRATEGIES

1. Identify governmental and nongovernmental partners to assist in planning and plan review for identified priority wetland areas in need of restoration or enhancement.
2. Initiate and participate in planning efforts for these identified areas collaboratively with partners.
3. Conduct outreach and involve interested parties in restoration or enhancement planning.
4. Apply for and assist partner organizations in obtaining matching funds.
5. Incorporate scientific knowledge about impacts from global climate change in plan designs.

OUTCOME MEASURES

1. Completion of restoration or enhancement studies, plans, and environmental documents needed to implement projects.

GOAL 10 ▪ OBJECTIVE 10B BASIS

Restoration/enhancement plans for 3,500 acres of wetlands is derived from the five-year proportion of the 20-year goals identified in the San Francisco Bay Joint Venture's Implementation Strategy, and the preliminary work to develop a Subtidal Goals document. Priorities further refined through consultations with staff from agencies and other experts.

ESTIMATED CONSERVANCY COST

$5,000,000

FUNDING SOURCES

Propositions 12, 40, and 84
Proposition 50 grant funds from Wildlife Conservation Board

OBJECTIVE 10C

Restore or enhance approximately 10,000 acres of wetland habitat throughout the nine Bay Area counties. For purposes of this objective, wetlands include tidal, managed, seasonal, and subtidal habitats.

STRATEGIES

1. Identify governmental and nonprofit partners to assist in implementing wetland restoration or enhancement plans.
2. Seek matching funds for wetland restoration or enhancement projects, and support the work of the San Francisco Bay Joint Venture to obtain additional funds.
3. Support funding for monitoring that evaluates the effectiveness of Conservancy-funded restoration or enhancement projects in meeting their goals.

OUTCOME MEASURES

1. Implementation of restoration or enhancement plans meeting the acreage goal

MONITORING AND TRACKING

1. Review project monitoring to assess the effectiveness of Conservancy-funded projects.

GOAL 10 ▪ OBJECTIVE 10C BASIS

Protect approximately 20,000 acres of uplands wildlife habitat, connecting corridors, scenic areas, and other open-space resources of regional significance throughout the nine Bay Area counties.

ESTIMATED CONSERVANCY COST

$20,000,000

FUNDING SOURCES

Propositions 12, 40, and 84
Proposition 50 grant funds from Wildlife Conservation Board

OBJECTIVE 10D

Protect approximately 20,000 acres of uplands wildlife habitat, connecting corridors, scenic areas, and other open-space resources of regional significance throughout the nine Bay Area counties.

STRATEGIES

1. Work with public agencies and nonprofit organizations able and willing to acquire and manage upland properties.

2. Identify willing sellers of fee title or easements, as appropriate, on upland properties identified as priorities for acquisition.
3. Negotiate and complete acquisition of these properties.
4. Seek matching funds for acquisition projects and support the work of the Bay Area Open Space Council to obtain additional funds.

OUTCOME MEASURES

1. The numerical goal for acquisition is met on time and is accomplished in a cooperative manner with other agencies and organizations.

GOAL 10 ▪ OBJECTIVE 10D BASIS

Needs and goals for upland acquisition were generally derived from the draft results of the Upland Goals and Green Vision projects of the Bay Area Open Space Council. Priorities were further refined through consultations with staff from agencies, nonprofit organizations, and other experts.

ESTIMATED CONSERVANCY COST

$33,000,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 10E

Develop plans for restoration or enhancement projects covering approximately 5,000 acres of uplands habitat.

STRATEGIES

1. Identify governmental and nonprofit organization partners to assist in planning and plan review for identified priority upland areas in need of restoration or enhancement.
2. Initiate and participate in planning efforts for these identified areas collaboratively with partners.
3. Conduct outreach and involve interested parties in restoration or enhancement planning.
4. Apply for and assist partner organizations in obtaining matching funds.

OUTCOME MEASURES

1. Completion of restoration or enhancement studies, plans, and environmental documents needed to implement projects that meet the acreage goal

GOAL 10 ▪ OBJECTIVE 10E BASIS

Restoration/enhancement plans for 5,000 acres of uplands are generally derived from the draft results of the Upland Goals and Green Vision projects of the Bay Area Open Space Council. Priorities were further refined through consultations with staff from agencies, nonprofit organizations, and other experts.

ESTIMATED CONSERVANCY COST

$1,000,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 10F

Restore or enhance approximately 5,000 acres of uplands habitat throughout the nine Bay Area counties.

STRATEGIES

1. Identify governmental and nonprofit organization partners to assist in implementing upland restoration or enhancement plans.
2. Seek matching funds for uplands restoration or enhancement projects and support the work of the Bay Area Open Space Council to obtain additional funds.
3. Support monitoring that evaluates the effectiveness of Conservancy-funded restoration or enhancement projects in meeting their goals.

OUTCOME MEASURES

1. Implementation of restoration or enhancement plans that meet the acreage goal

GOAL 10 ▪ OBJECTIVE 10F BASIS

Implementation of 5,000 acres of uplands restoration or enhancement is generally derived from the draft results of the Upland Goals and Green Vision projects of the Bay Area Open Space Council. Priorities were further refined through consultations with staff from agencies, nongovernmental organizations, and other experts.

ESTIMATED CONSERVANCY COST

$4,000,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 10G

Develop plans for restoration or enhancement projects covering at least 15 linear miles of riparian or riverine habitat.

STRATEGIES

1. Identify governmental and nonprofit organization partners to assist in planning and plan review for identified priority riparian and riverine areas in need of restoration or enhancement.
2. Initiate and participate in planning efforts for these identified areas collaboratively with partners.
3. Conduct outreach and involve interested parties in restoration or enhancement planning.
4. Apply for and assist partner organizations in obtaining matching funds.

OUTCOME MEASURES

1. Completion of restoration or enhancement studies, plans, and environmental documents needed for implementing projects that meet the mileage goal.

GOAL 10 ▪ OBJECTIVE 10G BASIS

Restoration/enhancement plans for 15 linear miles of riparian or riverine habitat is generally derived from the San Francisco Bay Joint Venture's Implementation Strategy. Priorities were further refined through consultations with staff from agencies and other experts.

ESTIMATED CONSERVANCY COST

$1,500,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 10H

Restore or enhance approximately 10 linear miles of riparian or riverine habitat throughout the nine Bay Area counties.

STRATEGIES

1. Identify governmental and nonprofit partners to assist in implementation of riparian or riverine habitat restoration or enhancement plans.
2. Seek matching funds for riparian or riverine habitat restoration or enhancement projects and support the work of the San Francisco Bay Joint Venture to obtain additional funds.
3. Support monitoring that evaluates the effectiveness of Conservancy-funded restoration or enhancement projects in meeting their goals.

OUTCOME MEASURES

1. Implementation of restoration or enhancement plans that meet the linear mileage goal

GOAL 10 ▪ OBJECTIVE 10H BASIS

The goal of implementing 10 linear miles of riparian or riverine habitat restoration or enhancement is generally derived from the San Francisco Bay Joint Venture's Implementation Strategy. Priorities were further refined through consultations with staff from agencies and other experts.

ESTIMATED CONSERVANCY COST

$2,500,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 10I

Plan 5 projects that protect, restore, or enhance watershed functions and processes for the benefit of wildlife or water quality.

STRATEGIES

1. Identify governmental and nonprofit organization partners to assist in planning and plan review for identified priority watersheds in need of restoration or enhancement.
2. Initiate and participate in planning efforts for these identified areas collaboratively with partners.
3. Conduct outreach and involve interested parties in restoration or enhancement planning.
4. Seek matching funds for watershed restoration or enhancement planning efforts and support the work of the Integrated Regional Water Management Plan's Watershed Functional Area Group to obtain additional funds.

OUTCOME MEASURES

1. Completion of watershed restoration or enhancement studies, plans, and environmental documents needed for project implementation
2. Measure improvements in water quality and wildlife populations

GOAL 10 ▪ OBJECTIVE 10I BASIS

The number of watershed restoration/enhancement plans is generally derived from the Integrated Regional Water Management Plan's Watershed Functional Area Document. Priorities were further refined through consultations with agencies' staff and other experts.

ESTIMATED CONSERVANCY COST
$1,000,000

FUNDING SOURCES
Propositions 40 and 84

OBJECTIVE 10J

Develop 5 plans or studies to prevent, control, or eradicate non-native invasive species that threaten important habitats in the San Francisco Bay Area.

STRATEGIES

1. Coordinate with local partners to identify and develop strategic projects that are likely to be successful over the long term, including comprehensive, watershed-based approaches and rapid-response efforts.
2. Support research into prevention methodologies, efficacy of control or eradication treatments, and development of alternative control or eradication treatment methodologies.
3. Seek matching funds for invasive species prevention, studies, planning, control, and eradication.

OUTCOME MEASURES

1. Completion of invasive species control plans and studies that meet the numerical goal

GOAL 10 ▪ OBJECTIVE 10J BASIS

The number of projects is generally derived from the Draft California State Aquatic Invasive Species Management Plan, lessons learned from past and current Conservancy invasive-species-control projects, and consultations with invasive-species experts.

ESTIMATED CONSERVANCY COST
$1,000,000

FUNDING SOURCES
Propositions 40 and 84
Proposition 50 grant funds from Wildlife Conservation Board

OBJECTIVE 10K

Implement 5 projects or programs to prevent, control, or eradicate non-native invasive species that threaten important habitats in the San Francisco Bay Area.

STRATEGIES

1. Coordinate with local partners to identify and develop strategic projects that are likely to be successful over the long term, including comprehensive, watershed-based approaches and rapid-response efforts.
2. Support prevention programs, including public education, to prevent new introductions of invasive species or the spread of existing infestations.
3. Seek matching funds for invasive species prevention, studies, planning, control, and eradication.

OUTCOME MEASURES

1. Implementation of invasive species projects and programs that meet the numerical goal

GOAL 10 ▪ OBJECTIVE 10K BASIS

The number of projects is derived from the Draft California State Aquatic Invasive Species Management Plan, lessons learned from past and current Conservancy invasive-species-control projects, and consultations with invasive-species experts.

ESTIMATED CONSERVANCY COST
$7,000,000

FUNDING SOURCES
Propositions 40 and 84
Proposition 50 grant funds from Wildlife Conservation Board

San Francisco Bay Area Conservancy Program

Goal 11

Improve public access, recreation, and educational facilities and programs in and around San Francisco Bay, along the coast, the ridgelines, in urban open spaces, and natural areas.

REGIONAL STRATEGY

Ensure completion of major segments of the San Francisco Bay, Ridge, and Water Trail systems, and connectors among other significant regional trails, acquire publicly accessible open-space lands, ensure completion of recreational facilities of regional significance, implement projects, and provide educational projects and programs that engage people in hands-on restoration or trail-building activities.

OBJECTIVE 11A

Develop approximately 25 plans that provide recreational facilities such as picnic and staging areas, docks and piers, campgrounds, parking lots, interpretive signs, and interpretive or educational centers.

STRATEGIES

1. Plan recreation and public-access improvements within projects that also protect and restore habitat, when it can be done without having adverse impacts on environmentally sensitive areas and wildlife.
2. Plan recreation and public-access improvements on newly acquired public lands, minimizing negative impacts to wildlife and habitat.
3. Continuously accept and rank new applications for funding public access and related facilities.
4. Solicit proposals and conduct outreach to partner organizations to develop regionally significant recreational projects.
5. Working with partner organizations, develop plans and designs for new programs and facilities.
6. Work with partner organization to obtain matching funds.

OUTCOME MEASURES

1. Plans for at least 25 new or expanded facilities or programs by the target date

GOAL 11 ▪ OBJECTIVE 11A BASIS

The number of plans listed, 25, is based on consultations with staff of parks agencies and districts, and on estimates of matching funds available from project proponents. Plans include county general plans, East Shore State Park General Plan, City of San Jose's Greenprint for Parks and Facilities, East Bay Regional Park District's Master Plan, the Golden Gate National Parks Association's Long-Range Plan, BCDC's San Francisco Bay Plan, the Strategic Plan for the Santa Clara County Parks and Recreation System, Marin County Open Space District's Strategic Plan, and Sonoma County Agricultural Preservation and Open Space District's *Connecting Communities and the Land: A Long-Range Acquisition Plan*.

ESTIMATED CONSERVANCY COST

$2,500,000

FUNDING SOURCES

Propositions 40, 50, and 84

OBJECTIVE 11B

Implement approximately 20 projects that provide recreational facilities such as picnic and staging areas, docks and piers, campgrounds, parking lots, interpretive signs, and interpretive or educational centers.

STRATEGIES

1. Implement recreation and public-access improvements within projects that also protect and restore habitat, when it can be done without having adverse impacts on environmentally sensitive areas and wildlife.
2. Construct recreation and public-access improvements on newly acquired public lands.
3. Continuously accept and rank new applications for funding public access and related facilities.
4. Solicit proposals and conduct outreach to partner organizations to develop regionally significant recreational projects.
5. Work with partner organization to obtain matching funds.

OUTCOME MEASURES

1. Construction of at least 20 new or expanded facilities or programs by the target date.

GOAL 11 ▪ OBJECTIVE 11B BASIS

The number of projects to be implemented, 20, is based on consultations with staff of parks agencies and districts, on plans listed below, and on estimates of matching funds available from project proponents. Plans include county general plans, East Shore State Park General Plan, City of San Jose's Greenprint for Parks and Facilities, East Bay Regional Park District's Master Plan, Golden Gate National Parks Association's Long-Range Plan, and the San Francisco Bay Plan.

ESTIMATED CONSERVANCY COST

$5,000,000

FUNDING SOURCES

Propositions 40, 50, and 84

OBJECTIVE 11C

Complete 20 projects that increase the amount of land accessible to the public or provide corridors for trails.

STRATEGIES

1. Work with public agencies and nonprofit organizations able and willing to acquire, open and manage properties for public recreation.
2. Identify willing sellers of fee title or public-access easements, as appropriate, on properties identified as priorities for acquisition.
3. Negotiate and complete acquisition of these properties.
4. Seek matching funds for acquisition projects and support the work of the Bay Area Open Space Council to obtain additional funds.

OUTCOME MEASURES

1. The numerical goal for projects that increase accessibility is met on time and is accomplished in a cooperative manner with other agencies and organizations.

GOAL 11 ▪ OBJECTIVE 11C BASIS

The number of projects that increase the amount of land accessible to the public is generally derived from the draft results of the Green Vision Project of the Bay Area Open Space Council. Priorities were further refined through consultations with staff from agencies, nonprofit organizations, and other experts.

ESTIMATED CONSERVANCY COST

$15,000,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11D

Develop plans for approximately 15 miles of the San Francisco Bay Trail.

STRATEGIES

1. Continue assistance and collaboration in trail planning with the Bay Trail Project of the Association of Bay Area Governments.
2. Using the gap analysis developed for the Bay Trail and working with local partners, identify priority areas for additional trail links, and initiate trail planning.
3. Work with partner organizations and the Bay Trail Project to obtain matching funds.
4. Consider available science regarding sea-level rise in siting and designs for Bay Trail infrastructure.

OUTCOME MEASURES

1. Numerical goals for planning Bay Trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11D BASIS

The goal of developing plans for 15 miles of Bay Trail is based on the San Francisco Bay Trail Plan and the gap analysis completed in 2005 and updated in 2007. The analysis involved a GIS-based mapping system to identify the trail gaps and detailed cost estimates for the specific improvements likely to be needed. Bay Trail staff worked closely with local government partners to identify trail gaps.

ESTIMATED CONSERVANCY COST

$2,000,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11E

Construct approximately 30 miles of the San Francisco Bay Trail.

STRATEGIES

1. Continue assistance and collaboration in trail construction with the Bay Trail Project of the Association of Bay Area Governments.
2. Using the gap analysis developed for the Bay Trail, and working with local partners, construct priority trail links.
3. Work with partner organizations to obtain matching funds.

OUTCOME MEASURES

1. Numerical goals for constructing Bay Trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11D BASIS

Completion of 30 miles of Bay Trail is based on the San Francisco Bay Trail Plan and the gap analysis completed in 2005 and updated in 2007. The analysis involved a GIS-based mapping system to identify the trail gaps and detailed cost estimates for the specific improvements likely to be needed. Bay Trail staff worked closely with local government partners to identify trail gaps.

ESTIMATED CONSERVANCY COST

$6,000,000

FUNDING SOURCES

Proposition 84

OBJECTIVE 11F

Plan approximately 50 miles of the Bay Area Ridge Trail.

STRATEGIES

1. Continue assistance and collaboration in trail planning with the Bay Area Ridge Trail Council.
2. Using data developed by the Bay Area Ridge Trail Council, and working with local partners, identify priority areas for additional trail links, and initiate trail planning.
3. Work with partner organizations to obtain matching funds.
4. Work with partner organizations to identify organizations to manage land and public use.

OUTCOME MEASURES

1. Numerical goals for planning Ridge Trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11D BASIS

The goal of developing plans for 50 miles of Ridge Trail is based on consultations with the Bay Area Ridge Trail Council staff and the draft document *400 Miles and Beyond: Completing the Bay Area Ridge Trail.*

ESTIMATED CONSERVANCY COST

$3,500,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11G

Construct approximately 30 miles of the Bay Area Ridge Trail.

STRATEGIES

1. Continue assistance and collaboration in trail construction with the Bay Area Ridge Trail Council.
2. Using data developed by the Bay Area Ridge Trail Council, and working with local partners, construct priority trail segments.
3. Work with partner organizations to obtain matching funds.

OUTCOME MEASURES

1. Numerical goals for constructing Ridge Trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11G BASIS

The goal of completing plans for 30 miles of Ridge Trail is based on consultations with the Bay Area Ridge Trail Council staff and the draft document *400 Miles and Beyond: Completing the Bay Area Ridge Trail.*

ESTIMATED CONSERVANCY COST

$2,000,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11H

Develop five plans for regionally significant public access trails and community connectors, including links between the Bay Trail, Ridge Trail, and Coastal Trail, and links between regional trails and urban communities.

STRATEGIES

1. Continue assistance to and collaboration with the Bay Trail Project and the Bay Area Ridge Trail Council in trail planning.
2. Working with partner agencies and organizations, continue assistance and collaboration in planning significant connector trails that provide important links.
3. Using the data developed by partner organizations, as available, and working with local partners, identify priority areas for additional trail links, and initiate trail planning.
4. Work with partner organizations to obtain matching funds.
5. Work with partner organizations to identify organizations to manage land and public use.

OUTCOME MEASURES

1. Numerical goals for planning trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11H BASIS

The goal of five plans for regionally significant trails is based on projected population growth, needs identified by partner organizations, and needs identified in county and special-district plans.

ESTIMATED CONSERVANCY COST

$500,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 11I

Construct approximately 50 miles of regionally significant public trails and community connectors, including links between the Bay Trail, Ridge Trail, and Coastal Trail, and links between regional trails and urban communities.

STRATEGIES

1. Continue assistance and collaboration in trail construction with the Bay Trail Project and the Ridge Trail Council.
2. Working with partner agencies and organizations, continue assistance and collaboration in constructing significant connector trails that provide important links.
3. Work with partner organizations to obtain matching funds.
4. Work with partner organizations to identify organizations to manage land and public use.

OUTCOME MEASURES

1. Numerical goals for constructing trail miles are met on time.

GOAL 11 ▪ OBJECTIVE 11I BASIS

Construction of 50 miles of regionally significant trails is based on projected population growth, needs identified by partner organizations, and needs identified in county and special-district plans.

ESTIMATED CONSERVANCY COST

$2,500,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11J

Plan approximately 10 launch sites for the San Francisco Bay Area Water Trail.

STRATEGIES

1. Continue assistance and collaboration in trail planning with the San Francisco Bay Conservation and Development Commission (BCDC), Bay Trail Project, California Department of Boating and Waterways, Bay Access, and other partners.
2. Using the San Francisco Bay Area Water Trail Plan, which will be finalized in early 2008, identify priority areas for building or improving launch sites, and initiate detailed planning, including the selection of sites that meet trailhead-designation criteria.
3. Work with partner organizations to obtain matching funds.
4. Work with partner organizations to identify organizations to manage public use of the sites.
5. Work with partners to conduct outreach to Water Trail users on safety, navigation, and wildlife issues.
6. Take scientific knowledge of sea-level rise into consideration in siting and designs for Water Trail infrastructure.

OUTCOME MEASURES

1. Numerical goals for planning of launch sites are met on time.
2. Increase of usage of the Bay by nonmotorized boats, based on estimates of current use.

GOAL 11 ▪ OBJECTIVE 11J BASIS

The goal of planning for 10 Water Trail launch sites is based on the San Francisco Bay Area Water Trail Plan, which will be finalized in early 2008.

ESTIMATED CONSERVANCY COST

$1,000,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 11K

Construct or enhance approximately 35 launch sites for the San Francisco Bay Area Water Trail.

STRATEGIES

1. Continue assistance and collaboration in trail planning with BCDC, Bay Trail Project, California Department of Boating and Waterways, Bay Access, San Francisco Bay Joint Venture, and other partners.
2. Using the San Francisco Bay Area Water Trail Plan, which will be finalized in early 2008, identify priority areas for building or improving launch sites, and initiate construction.
3. Develop a logo for Water Trail informational media (such as website, newsletter, brochures, signs), and a template for Water Trail sign design, construction, and implementation.
4. Install Water Trail signs to identify designated Water Trail sites clearly, promote Water Trail education and stewardship, and increase public awareness of the Water Trail program.
5. Work with partner organizations to obtain matching funds.
6. Work with partner organizations to identify organizations to manage public use.
7. Work with partners to conduct outreach to Water Trail users on safety, navigation, and wildlife issues.

OUTCOME MEASURES

1. Numerical goals for construction of launch sites are met on time.

GOAL 11 ▪ OBJECTIVE 11K BASIS

The goal of constructing and enhancing 35 Water Trail launch sites is based on the San Francisco Bay Area Water Trail Plan, which will be finalized in early 2008.

ESTIMATED CONSERVANCY COST

$3,100,000

FUNDING SOURCES

Propositions 12, 40, and 84

OBJECTIVE 11L

Include wheelchair-accessible or other ADA-compliant elements in approximately 25 Conservancy-funded projects.

STRATEGIES

1. Working with local partners, staff will review all proposals for planning or implementation of recreational features to identify opportunities to include wheelchair-accessible elements or other ADA-compliant elements.
2. Staff may request that partners modify proposals to include improved access and other ADA-compliant elements when appropriate and feasible.

OUTCOME MEASURES

1. At least 25 projects implemented with Conservancy funding will include ADA-compliant elements.

GOAL 11 ▪ OBJECTIVE 11L BASIS

The goal of developing 25 ADA-compliant public access and recreational facility projects is based on discussions with staff of the Bay Trail Project, Bay Area Ridge Trail Council, cities, counties, and special districts regarding opportunities and plans for such projects.

ESTIMATED CONSERVANCY COST

$2,500,000

FUNDING SOURCES

Propositions 40, 50, and 84

OBJECTIVE 11M

Implement approximately 25 projects that create, expand, or improve educational or interpretive programs that are tied to on-the-ground restoration projects or trail construction or enhancement and are available to the urban population of the Bay Area.

STRATEGIES

1. Continue assistance and collaboration in planning and implementation of these projects with local partners.
2. Conduct at least two mini-grant rounds to solicit proposals from partners for projects in this category.
3. Work with the Bay Area Open Space Council, San Francisco Bay Joint Venture, and others to identify successful programs that are currently operating in the region, and encourage partners to use these programs as models in other areas.
4. Seek to combine educational programs with other recreational or access projects that the Bay Program is conducting in urban areas.

OUTCOME MEASURES

1. Twenty-five projects are completed within the five-year target period.

GOAL 11 ▪ OBJECTIVE 11M BASIS

The objective is derived from discussions with local partners regarding the need and capacity for environmental education in the San Francisco Bay Area. These projects are a high priority for the Bay Program because they involve on-the-ground restoration in urban areas where restoration projects can be difficult to rank as high-priority based on resource benefits alone.

ESTIMATED CONSERVANCY COST

$3,000,000

FUNDING SOURCES

Propositions 40 and 84

San Francisco Bay Area Conservancy Program

Goal 12

Protect farmlands, including rangeland, from urban encroachment.

OBJECTIVE 12A

Protect approximately 500 acres of farmland in the nine Bay Area counties.

STRATEGIES

1. Independently, or working with local partners, identify willing sellers of fee titles or easements, as appropriate, on farmland properties identified as priorities for acquisition or protection.
2. Identify prime, important, or unique farmland at risk of conversion to other uses.
3. Negotiate and complete acquisition or protection of these properties.
4. Working with partner organizations, develop and implement restoration and enhancement projects in areas identified as priorities.
5. Seek matching funds for projects and support partner organizations to obtain additional funds.

OUTCOME MEASURES

1. The numerical goals for acquisition are met on time and are accomplished in a cooperative manner with other agencies and organizations.

GOAL 12 ▪ OBJECTIVE 12A BASIS

Protection of 500 acres is an objective derived by evaluating projected loss of farmlands, and by identifying the kinds of farmland that are threatened by urban or suburban encroachment, the level of threat, the capacity of land trusts or other organizations to assist in acquisition or land ownership, and availability of public or private funds. Reports used in the analysis include: *2004–2006 California Farmland Conversion Tables,* 2005 county crop reports, *Acquisition Plan: A Blueprint for Agriculture and Open Space Preservation* (Sonoma County Agricultural and Open Space District), *South Livermore Valley Area Plan,* and *Final Agricultural Conservation Easement Plan for Solano Land Trust.*

ESTIMATED CONSERVANCY COST

$2,500,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 12B

Protect approximately 5,000 acres of rangeland in the nine Bay Area counties.

STRATEGIES

1. Independently, or working with local partners, identify willing sellers of fee titles or easements, as appropriate, on rangeland properties identified as priorities for acquisition or protection.
2. Identify rangeland at risk of conversion to other uses.
3. Negotiate and complete acquisition or protection of these properties.
4. Working with partner organizations, develop and implement restoration and enhancement projects in areas identified as priorities.
5. Seek matching funds for projects, and support partner organizations to obtain additional funds.

OUTCOME MEASURES

1. The numerical goals for protection are met on time and are accomplished in a cooperative manner with other agencies and organizations.

GOAL 12 ▪ OBJECTIVE 12B BASIS

Protection of 5,000 acres is an objective derived by evaluating projected loss of farmlands, identifying the kinds of farmland, level of threat from urban or suburban encroachment, capacity of land trusts or other organizations to assist in acquisition or land ownership, and available public or private funds. Reports used in analysis include: *2004–2006 California Farmland Conversion Tables,* 2005 county crop reports, *Acquisition Plan: A Blueprint for Agriculture and Open Space Preservation* (Sonoma County Agricultural and Open Space District), *South Livermore Valley Area Plan,* and *Final Agricultural Conservation Easement Plan for Solano Land Trust.*

ESTIMATED CONSERVANCY COST

$9,000,000

FUNDING SOURCES

Propositions 40 and 84

OBJECTIVE 12C

Develop or implement three plans or projects that promote conservation technologies and assist farmers and ranchers in complying with best-management practices.

STRATEGIES

1. Using the areas identified as Conservancy priorities for agricultural conservation, work with local partners to identify mutual priority projects that are ready for planning and follow-up projects.
2. With partners, initiate and participate in planning projects and implementing them in these identified areas.
3. Seek matching funds and assist partner organizations to obtain matching funds or grants, as appropriate, which will leverage Conservancy project funds.

OUTCOME MEASURES

1. Completion of plans and projects

GOAL 12 ▪ OBJECTIVE 12C BASIS

This objective is based on discussions with staff of resource conservation districts and local partners about agricultural landowners' interests in participating in planning and implementing projects that support continued agricultural operations and, where possible, improve environmental conditions.

ESTIMATED CONSERVANCY COST

$1,000,000

FUNDING SOURCES

Propositions 40 and 84

OCEAN PROGRAM/ OCEAN PROTECTION COUNCIL

Statutory Authority

(Reference: PRC Sections 321220, 35625, and 35650)

The California Ocean Protection Act (COPA, Public Resources Code Section 35500 et seq.) created the California Ocean Protection Council (OPC) to carry out the following functions:

- Coordinate activities of state agencies to improve the effectiveness of state efforts to protect ocean and coastal resources;
- Establish policies to coordinate the collection and sharing of scientific data related to ocean and coastal resources;
- Identify and recommend to the Legislature changes in state law and policy needed to achieve the goals of COPA; and
- Recommend to the governor and the Legislature actions the State should take to encourage needed changes in federal law and policy.

COPA also created the Ocean Protection Trust Fund. Upon authorization by the OPC, money in the fund may be spent on a wide range of projects that protect or restore ocean and coastal resources.

Rather than create a new administrative department to administer OPC affairs, COPA names the secretary for resources as OPC chair and the executive officer of the Coastal Conservancy as its secretary. Under the direction of the chair, the executive officer is required to administer the OPC, including providing it with staff services. The executive officer is required to administer grants and other expenditures authorized by the OPC, and to arrange meetings, agendas, and other administrative functions.

Subsequent to the passage of COPA, the secretary for resources assigned an assistant secretary to act as executive policy officer for the OPC. The executive policy officer works full-time on OPC issues and takes the lead in prioritizing and recommending actions for administrative, policy, legislative, or funding issues to be considered by the OPC. The executive officer works closely with the executive policy officer on these issues and assigns and directs Conservancy staff to conduct research and analysis relating to OPC issues and to participate in or chair various working groups.

The OPC has designated the executive director of the California Ocean Science Trust (CalOST) to be its science advisor. CalOST is a nonprofit organization created pursuant to the California Ocean Resources Stewardship Act of 2000 to better integrate science into ocean policy and management. Pursuant to the authorizing legislation, a ten-member board of trustees was appointed. The secretary of the California Environmental Protection Agency, the secretary of the California Resources Agency, and the director of finance each appoint one trustee. The secretary for resources receives nominations for the other seven trustees and appoints them as follows: three to represent the California State University and University of California; two to represent ocean and coastal interest groups in California; and two to represent the general public.

Baseline support funding appropriated to the Coastal Conservancy for administration of the OPC may be used to support CalOST's science advising capacity.

In addition to providing a science advisor, the OPC will appoint an advisory panel of distinguished scientists from a wide range of disciplines to consult on specific issues as needed. The science panel will be administered by CalOST and its executive director. Funds in support of OPC may be used for the expenses of this science panel.

Both administrative and programmatic funding for the OPC has been either directly appropriated to the Conservancy or has been transferred to the Conservancy through interagency agreement. Future OPC funding is expected to be appropriated directly to the Conservancy. The executive officer is charged with ensuring the appropriate use of these funds.

Issues and Priorities

The OPC has a strategic plan, "A Vision for Our Ocean and Coast," that is attached as an appendix. Over the next five years, the OPC will focus on governance, research and monitoring, ocean and coastal water quality, physical processes and habitat structure, ocean and coastal ecosystems, and education and outreach. Meeting the specific goals contained in the plan will require a wide range of scientific research, technological development, legislative and policy change, and project development. While much of the responsibility for directing and prioritizing this work will fall on the chair of the OPC and the executive policy officer, a significant commitment of time by the executive officer and multifaceted work by Conservancy staff members will also be needed.

This work will include analysis of specific policies, development of recommendations for the OPC, coordination with other agencies and departments, development and management of contracts and grants, legal review, accounting, and coordination with the executive policy officer, the OPC itself, and project sponsors. It is necessary to ensure that these duties do not conflict with, and are complementary to, the Conservancy's activities and mandates. The executive officer and staff will report regularly to the Conservancy regarding their OPC-related activities.

The Conservancy and its executive officer will undertake the following actions in support of the OPC.

Ocean Protection Council (OPC)

Goal 13

Ensure that OPC staff are effective, efficient, accountable, and coordinate well with other organizations in administering OPC affairs, and that their duties, including those of the executive officer, policy staff, and attorneys, are congruent and not in conflict with their duties to the Conservancy.

OBJECTIVE 13A

Continue to build organizational capacity to carry out OPC initiatives.

STRATEGIES

1. Recruit and maintain competent, highly trained, and motivated staff to work on OPC issues.
2. Provide regular reports to the Conservancy concerning administration of OPC affairs.
3. Develop budget change proposals requesting appropriations to fund OPC priorities and provide administrative support.
4. Provide funding to the Resources Agency to maintain the executive policy officer and related support.
5. Support a science advisor and scientific advisory panel to ensure the use of best scientific knowledge in OPC decisions and the integration of science, policy, and management.

OUTCOME MEASURES

1. A fully functioning staff and sufficient operating and programmatic budget
2. The Coastal Conservancy is fully informed about OPC staff activities
3. Maintenance of a science advisor and development of a science advisory team(s)
4. Demonstrable improvement in the use of science in decision-making

MONITORING AND TRACKING

1. The budget will include line items for OPC administration and programs from funding sources that are not exclusive to the Conservancy.
2. The executive officer will report regularly to the Conservancy concerning OPC staff activities.
3. The science advisor will regularly report to the OPC and make occasional reports to the Conservancy concerning improvements in the use of science in decision-making.
4. Occasional critiques from both scientists and resource managers will be sought in order to determine the effectiveness of integrating science in policy and management decisions.

Ocean Protection Council (OPC)

Goal 14

Ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations, and support compatible economic activities.

OBJECTIVE 14A

Undertake programs, projects, and initiatives that implement the OPC's Strategic Plan.

STRATEGIES

1. Through contracts, grants, interagency agreements, and other means, provide OPC-appropriated funds to undertake programs, projects, studies, resource management, and policy analyses that implement the OPC Strategic Plan.
2. Seek matching funds from other organizations to undertake projects that implement the OPC Strategic Plan.
3. Develop grant solicitations or directly develop projects for all of the above.

OUTCOME MEASURES

1. Completed plans, studies, projects, policy analyses, or improved resource management, that further the goals and objectives of the OPC Strategic Plan.

MONITORING AND TRACKING

1. Conservancy staff of the Ocean Program to provide a yearly update to the OPC and the Conservancy on progress toward meeting strategic plan goals.

ORGANIZATIONAL/ OPERATIONAL ISSUES WORKFORCE AND ADMINISTRATION

Issues and Priorities

Since the passage of four bond measures between 2000 and 2006, the Coastal Conservancy's capital budgets have greatly increased. Staffing levels have not kept pace, nor are they expected to in the next five years. It will be necessary to ensure that current staff is motivated, highly trained, structurally efficient, and provided with efficient and effective procedures that minimize process without sacrificing accountability. To this end, the Conservancy will continue to maximize staff responsibility at all levels and minimize layers of decision making, maintain a culture in which there is strong communication and responsiveness among program, administrative, legal, and management staff, and continue to retain consultants that can respond to project requirements on a short-term, "as required" basis.

The Conservancy will seek to maintain and adjust, as needed, an organizational structure and administrative procedures to meeting fluctuating funding levels, policy directives, programmatic and legal mandates, and to improve management of funds to ensure accountability and proper authorization for all Conservancy expenditures.

INFORMATION TECHNOLOGY

Increased capital budgets have focused attention on the Conservancy and will continue to do so in the future. The Legislature, the administration, and the public require a greater degree of accountability and coordination of project and program expenditures. Information technology is key to ensuring that the Conservancy's program and project expenditures are coordinated with other agencies and are accountable to control agencies and the Legislature. Information technology is also an essential tool for increasing staff efficiency and effectiveness.

The Conservancy will continue to increase its use of information technology to track its program and project expenditures in order to provide a wide range of up-to-date reports to the administration, the Legislature, project partners, and the public. It will also improve efficiency and reduce waste by continuing to standardize, computerize, simplify and enhance access to contracts, forms, and reports.

COMMUNICATIONS

Over the next five years, the Conservancy will participate in hundreds of significant coastal, ocean, and San Francisco Bay Area projects that will have lasting effects on the California environment and economy. The Conservancy will maintain an active communications program to ensure that the Conservancy's role in projects is recognized and to reinforce the values of its programs to core audiences. The Conservancy will continue to increase the effectiveness of its public information program and expand positive recognition of the Conservancy's name. The administration, Legislature, academia, interest groups, and the general public need to be informed of programmatic, strategic, and project planning and development, upcoming opportunities for participation, and of the outcomes of these projects and other decisions. The Legislature and administration also need sufficient information to make public-policy decisions concerning funding for the Coastal Conservancy and changes to its mandate. The Conservancy will also maintain procedures to ensure prompt responses to inquiries from outside the Conservancy and full compliance with the California Public Records Act.

Organizational/Operational Issues

Goal 15

Be increasingly efficient and effective in carrying out programmatic responsibilities.

STATEWIDE STRATEGY

Maintain budgetary and staffing efficiencies while continuing to meet programmatic expectations.

OBJECTIVE 15A

Recruit and maintain a competent, highly trained, and motivated staff.

STRATEGIES

1. Upgrade job classifications to reflect increasing responsibilities, or downgrade as necessary for recruitment and training purposes.
2. Manage employee workloads to ensure the continued high performance of all staff.
3. Provide training programs and support staff attendance to workshops and conferences to ensure that each employee has the skills and knowledge needed to perform at the highest level of productivity.
4. Provide work space and equipment that meets state standards and is designed to maximize comfort, health, productivity, and efficiency, and to reduce work stress and related injuries.
5. Cultivate and develop recruitment strategies that will result in a workforce reflecting the cultural diversity of the State of California within all classifications.
6. Continue to offer challenging assignments and responsibilities to staff at all levels that stretch their abilities, and provide professional development and career advancement opportunities.
7. Continue to offer flexible work schedules to staff, consistent with Governor's Executive Orders, as well as teleworking, carpooling, etc. in order to reduce the number of days that staff are required to commute, thereby reducing employee stress and the Conservancy's carbon footprint.

OUTCOME MEASURES

1. New job classifications, as necessary
2. Greater level of similarity of workload for all employees of the same classification
3. All employees have an opportunity to take annual training that assists in meeting their individual development plans.
4. Periodic ergonomic evaluations of work stations to ensure that each employee has appropriate work space and equipment
5. There is cultural diversity in the workplace throughout all classifications.
6. Classifications are downgraded on an as-needed basis to facilitate recruitment and training, use of training-and-development assignments, assistance for education where feasible, and mentoring of staff to assist in career advancement.
7. Staff who have completed their probationary periods and are performing adequately may work alternate work schedules or partially telework.

MONITORING AND TRACKING

1. Annual individual evaluations and development plans for each employee.
2. Annual review by management to determine success in meeting objectives.

OBJECTIVE 15B

Implement practices that minimize Conservancy's contribution to environmental degradation and consumption of natural resources.

STRATEGIES

1. Work with the Climate Action Team to identify methodology for calculating the Conservancy's carbon footprint, and work to reduce overall footprint.
2. Continue to offer alternative work schedules to staff, consistent with Governor's Executive Orders, as well as teleworking, carpooling, etc. in order to reduce the number of days that staff are required to commute, thereby reducing harmful pollutants and emissions into the environment.
3. Select meeting spaces that are energy-efficient and promote low-carbon transportation options where feasible.
4. Continue to reduce energy use and purchase machines that are energy-efficient and equipped with energy-management settings where possible.
5. Use low-carbon transportation options for work-related purposes where feasible. This includes carpooling, public transit and bicycling, and renting low-carbon vehicles where possible (i.e. hybrids are available as rentals at many airports.)
6. To reduce travel costs, employee stress, time away from the office, and further contributing to emissions into the environment, continue to hold phone conferences whenever feasible and appropriate in place of traveling to meeting locations.
7. Take advantage of other useful operational practices as technological advances increase the quality, fiscal feasibility, and availability of practices that increase staff effectiveness and efficiency and are environmentally sound.
8. Minimize the use of paper.

OUTCOME MEASURES

1. Staff reduces the number of days they commute by private automobile.
2. Meetings are held in energy-efficient spaces and in locations that are accessible by public transportation whenever feasible.
3. Office machines are energy-efficient, and have energy-management settings.
4. The Conservancy participates in all efforts to provide staff with means to utilize public transportation, including subsidies, promotions, and modified schedules to accommodate carpools.
5. The Conservancy has a measurable reduction in carbon emissions.
6. The Conservancy has conference rooms and quiet rooms set up with conferencing phones for the purpose of holding phone conferences.
7. IT staff monitor the availability, quality, and cost of technological advances in the area of various operational office technology and recommend use for the Conservancy as appropriate.

MONITORING AND TRACKING

1. Annual review by management to determine success in meeting objectives
2. Measurements of the Conservancy's carbon footprint.

Organizational/Operational Issues

Goal 16

Improve strategic planning, staff productivity, decision making, coordination with other organizations, and accountability by introducing appropriate technologies.

STATEWIDE STRATEGY

Improve the ability to prepare, utilize, and widely disseminate up-to-date reports and data on Conservancy activities. Deploy necessary technology and procedures to maximize the efficiency and productivity of remote staff.

OBJECTIVE 16A

Maintain and consistently upgrade a project database of Conservancy project information to assist in agency strategic planning, project planning, financial planning, management reporting, and accountability to the Legislature, Resources Agency, control agencies, and the public.

STRATEGIES

1. Staff will update current database with new functions for capturing essential or relevant project information.
2. Project managers input descriptive and quantitative information into project database prior to Board consideration and update annually.
3. Enter historical project information into database as time and budget allow.
4. IT and other staff will employ appropriate technologies.

OUTCOME MEASURES

1. A fully functioning and secure information system that can provide a wide range of reports and data

MONITORING AND TRACKING

1. Periodically meet with a range of parties to ensure that the system can provide the types of reports that may be required.

OBJECTIVE 16B

Develop capability to utilize geographically referenced database technologies (GIS) and other information technology (IT) as tools for project planning, decision making, and reporting.

STRATEGIES

1. Cooperate with and secure technical assistance from other departments/agencies and private contractors for IT services needed to support staff with project and planning needs.
2. Provide semi-annual reports to the Conservancy's management team on current IT use, potential IT applications, staff training needs, and system requirements.
3. Maintain an in-house information technology committee to annually review and evaluate systems, and to recommend priorities and a budget for purchase of new and updated technology.

4. Encourage the sharing of expertise among staff as well as formal training to fully utilize IT.
5. Provide basic mapping capabilities on user desktops for use in meetings and for providing information to management, board members, and the Legislature.

OUTCOME MEASURES

1. Annual recommendations for IT utilization and budget for new purchases
2. The integration of an appropriate level of IT into agency operations
3. Annual improvements in IT capabilities and staff training

MONITORING AND TRACKING

1. Prepare an annual report on accomplishments and unmet objectives.

Organizational/Operational Issues

Goal 17

Ensure that there is an active and effective communications program to inform public policy makers and the general public of the Conservancy's purposes, actions, and accomplishments, and to respond to interested parties' ideas and concerns.

STATEWIDE STRATEGY

Maintain and upgrade all aspects of the Conservancy's communications program.

OBJECTIVE 17A

Reinforce the Conservancy's value to core audiences (Legislature, administration, partners, and the general public).

STRATEGIES

1. Inform media of Conservancy actions.
2. Prepare and place feature stories and letters-to-editors about Conservancy actions, partnerships, and needs.
3. Join partners in media and public relations.
4. Coordinate public relations and legislative advocacy efforts.
5. Provide legislators and their staffs with tours of project sites.
6. Prepare annual reports on Conservancy accomplishments.
7. Upgrade and maintain Conservancy website.
8. Support publication of Coast & Ocean and other print and web materials.

OUTCOME MEASURES

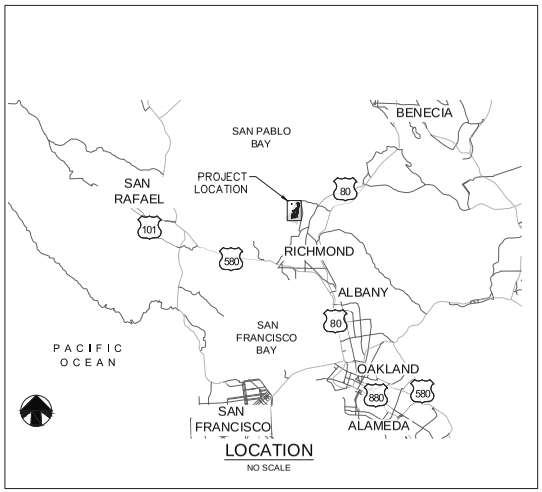
1. Preparation and distribution of news releases, articles, media communications, annual reports, and materials for the Legislature
2. News releases and other communications undertaken with project partners
3. Participation in events related to programs and projects
4. Updated website with links to projects
5. Publication of Coast & Ocean and other print and web materials

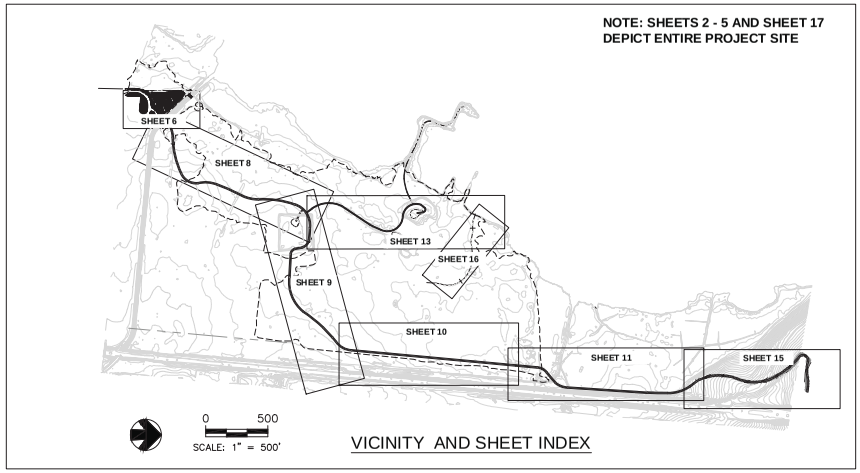
MONITORING AND TRACKING

1. Communications Director and Legislative Coordinator will monitor and track this objective.

BREUNER MARSH RESTORATION AND PUBLIC ACCESS IMPROVEMENT PROJECT

RICHMOND, CALIFORNIA





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15. BAY TRAIL ALIGNMENT LAYOUT 4
16. TIDAL SLOUGH DETAIL
17. PLANTING PLAN

GENERAL NOTES

1. **DESIGN INTENT:** THESE PLANS AND SPECIFICATIONS REPRESENT THE DESIGN INTENT OF QUESTA ENGINEERING CORPORATION (THE ENGINEER), AS APPROVED BY THE OWNER, EAST BAY REGIONAL PARK DISTRICT (EBRPD). THE CONTRACTOR IS RESPONSIBLE FOR ALL ITEMS SHOWN ON THESE PLANS AND SPECIFICATIONS AND SHALL BE RESPONSIBLE FOR ANY DEVIATIONS FROM THESE PLANS AND ASSOCIATED RISK AND EXPENSE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING A COPY OF THE APPROVED PLANS AND SPECIFICATIONS AND ANY ADDENDA AT THE JOB SITE AT ALL TIMES. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY EBRPD OF ANY UNFORESEEN CIRCUMSTANCES OR CONDITIONS THAT WOULD ALTER THESE PLANS AND SPECIFICATIONS FOR APPROVAL OF MODIFICATIONS TO THE INTENDED DESIGN.

2. **COMPOSITE BASE MAP:** THE PROPOSED IMPROVEMENTS SHOWN ON THESE DRAWINGS ARE SUPERIMPOSED ON A BASE MAP. THIS BASE MAP IS COMPILED FROM AN GROUND SURVEYS, AND OTHER DATA AS MADE AVAILABLE TO THE ENGINEER, WHO SHALL NOT BE HELD LIABLE FOR CHANGES, INACCURACIES, OMISSIONS OR OTHER ERRORS ON THESE DOCUMENTS. THE COMPOSITE BASE MAP IS PROVIDED AS AN AID ONLY AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR REVIEWING THESE DOCUMENTS AND INCORPORATING/INTEGRATING ALL CONSTRUCTION AS REQUIRED TO ACCOMMODATE THE SAME.

   NONE OF THE INCLUDED DRAWINGS DEPICT A BOUNDARY SURVEY. BOUNDARY LINES SHOWN ARE APPROXIMATE AND FOR INFORMATIONAL PURPOSES ONLY.

3. **PRECONSTRUCTION MEETING:** A PRECONSTRUCTION MEETING ATTENDED BY THE CONTRACTOR, EBRPD REPRESENTATIVE, AND OTHERS AS APPROPRIATE, WILL BE HELD WITHIN FIFTEEN (15) DAYS OF AWARD OF CONTRACT TO DISCUSS THE WORK. SUBMIT ALL REQUIRED DOCUMENTS, REQUESTS, AND PROPOSALS AT THIS MEETING FOR DISCUSSION.

4. **UTILITIES:** CONTRACTOR SHALL NOTIFY ALL PUBLIC AND PRIVATE UTILITY COMPANIES IN THE PROJECT AREA A MINIMUM OF THREE (3) WORKING DAYS PRIOR TO COMMENCEMENT OF WORK. CONTRACTOR MUST INVESTIGATE AND VERIFY THE LOCATION OF ANY EXISTING UTILITIES WITHIN THE PROJECT AREA, IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO IDENTIFY, LOCATE, AND PROTECT ALL UNDERGROUND UTILITIES. ANY UNDERGROUND UTILITIES SHOWN ON THE PLANS ARE CONSIDERED TENTATIVE AND APPROXIMATIONS AND THEREFORE, NO WARRANTY EXPRESSED OR IMPLIED IS MADE AS TO THE COMPLETENESS OR CORRECTNESS OF THEIR LOCATION. THE UTILITY COMPANIES ARE THOUGHT TO BE MEMBERS OF THE UNDERGROUND SERVICE ALERT (U.S.A.) ON-CALL PROGRAM. THE CONTRACTOR SHALL NOTIFY U.S.A. 72-HOURS IN ADVANCE OF PERFORMING EXCAVATION WORK AT 811 FROM 7:00 AM TO 5:00 PM, MONDAY THROUGH FRIDAY. EXISTING PUBLIC UTILITIES SHALL BE KEPT IN SERVICE AT ALL TIMES. UTILITIES THAT INTERFERE WITH THE WORK TO BE PERFORMED SHALL BE PROTECTED AS REQUIRED BY EBRPD AND ALL OTHER AFFECTED ENTITIES.

5. **RESOURCE PROTECTION:** THE CONTRACTOR IS ADVISED OF THE PRESENCE OF SENSITIVE RESOURCES LOCATED NEAR PROJECT WORK AREAS. THE TRAIL ALIGNMENT, FENCING, STAGING AREAS AND ALL OTHER PROJECT FACILITIES HAVE BEEN CAREFULLY LOCATED TO AVOID PHYSICAL DISTURBANCE OF SENSITIVE RESOURCES. THE LIMITS OF WORK ARE SHOWN ON THE DRAWINGS. ALL CONTRACTOR ACTIVITIES, INCLUDING, BUT NOT LIMITED TO, CONSTRUCTION ACTIVITIES, VEHICLE MAINTENANCE, AND MATERIALS AND EQUIPMENT STORAGE AND STAGING, MUST BE STRICTLY CONFINED TO THE WORK AREAS SHOWN ON THE DRAWINGS. THE LIMITS OF WORK WILL BE CAREFULLY LOCATED IN THE FIELD BY THE CONTRACTOR AND ENGINEER OF RECORD, AND ALL WORK LIMIT AREAS WILL BE PROTECTED BY STRAW WATTLES, CONSTRUCTION BARRIER FENCING, OR SILT FENCING AS SHOWN ON THE DRAWINGS.

   EBRPD WILL PROVIDE A QUALIFIED BIOLOGICAL MONITOR THAT WILL INITIALLY REVIEW SITE CONSTRUCTION PROTOCOLS WITH ALL CONSTRUCTION CONTRACTOR EMPLOYEES AT A PRE-CONSTRUCTION MEETING THAT WILL BE SPECIFICALLY HELD ON RESOURCE PROTECTION. EACH EMPLOYEE ASSIGNED TO THIS PROJECT MUST PARTICIPATE IN THIS PRE-CONSTRUCTION MEETING AND DISCUSSION OF ADJACENT SENSITIVE RESOURCES, AND SIGN A STATEMENT INDICATING THAT THEY HAVE READ AND UNDERSTOOD THE PROTOCOLS AND AGREE TO ADHERE TO THEM. SIGNIFICANT BREACHES OF PROTOCOL AND FAILURE TO ADEQUATELY PROVIDE THE DEGREE OF RESOURCE PROTECTION REQUIRED BY THIS PROJECT WILL RESULT IN THE ISSUANCE OF A STOP WORK ORDER BY THE ENGINEER OR BY THE BIOLOGICAL MONITOR.

   EBRPD PROVIDED BIOLOGICAL MONITOR WILL CAREFULLY INSPECT ALL WORK AREAS FOR THE PRESENCE OF WILDLIFE PRIOR TO INSTALLATION OF PROTECTIVE BARRIER FENCING AND FIELD FENCING, AND PRIOR TO INITIATION OF CONSTRUCTION EACH DAY. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY PENALTIES AND ALL REPAIRS AND MITIGATIONS IMPOSED DUE TO BREACH OF PROTOCOL AND UNAUTHORIZED INTRUSION INTO SENSITIVE RESOURCE AREAS.

6. **JOB SITE CONDITIONS, TRAFFIC CONTROL AND CONTRACTOR RESPONSIBILITY:** CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION, INCLUDING THE SAFETY OF ALL PERSONS AND PROPERTY, TRAFFIC CONTROL, ACCESS TO AND FROM ADJOINING DRIVEWAYS AND STREETS, AND ANY LANE CLOSURES. THE CONTRACTOR SHALL DEFEND, INDEMNIFY, AND HOLD EBRPD AND THE ENGINEER (QUESTA ENGINEERING CORPORATION) HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPT FROM LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF EBRPD OR THE ENGINEER. CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING CONSTRUCTION, INCLUDING SAFETY OF PERSONS AND PROPERTY. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

   ALL WORK SHALL BE IN COMPLIANCE WITH APPLICABLE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) STANDARDS AS SET FORTH BY THE FEDERAL DEPARTMENT OF LABOR AND/OR THE STATE OF CALIFORNIA.

   ALL TRAFFIC CONTROL SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE CALTRANS MANUAL OF TRAFFIC CONTROLS FOR CONSTRUCTION AND MAINTENANCE OF WORK ZONES. ALL SIGNS SHALL BE APPROPRIATELY CONSTRUCTED WITH REFLECTIVE MATERIAL ON A BACKING OF METAL OR FABRIC (NO WOOD OR PLASTIC ALLOWED) AND SHALL BE MAINTAINED THROUGHOUT CONSTRUCTION TO PROVIDE PROPER VISIBILITY, PER SECTION 12 OF THE CALTRANS SPECIAL PROVISIONS.

   THE CONTRACTOR SHALL MAINTAIN REASONABLE ACCESS TO ALL ROADWAYS DURING CONSTRUCTION

7. **MISCELLANEOUS:** WRITTEN DIMENSIONS ALWAYS TAKE PRECEDENCE OVER SCALED DIMENSIONS IF THERE IS A CONFLICT. THE CONTRACTOR SHALL CONTACT EBRPD TO OBTAIN ADDITIONAL CLARIFICATION. NO DEVIATION OR SUBSTITUTION SHALL BE ALLOWED WITHOUT OBTAINING PRIOR WRITTEN APPROVAL FROM EBRPD AND THE ENGINEER.

SURVEY NOTES

8. TO BE ADDED ON FUTURE REVISION.

ABBREVIATIONS

"T	= TREE (APPROX. ø @ BREAST HEIGHT)	GP	= GATE POST
AP	= ANGLE POINT	GR	= GROUND ELEVATION
AB	= AGGREGATE BASE	MHW	= MEAN HIGH WATER
BO	= BOTTOM OF	MLW	= MEAN LOW WATER
BOL	= BOLLARD	P	= PAVEMENT
BRC	= BACK OF ROLL CURB	S.	= SIGN
CONC	= CONCRETE	SF	= SQUARE FEET
CY	= CUBIC YARDS	SWL	= SWALE
DL	= DAYLIGHT	T	= TOP OF SLOPE
EL	= ELEVATION	t	= TOE OF SLOPE
EP	= EDGE OF PAVEMENT	TB	= TOP OF BERM
F	= FENCE	TO	= TOP OF
FL	= FLOW LINE	TOC	= TOP OF CONCRETE
GB	= GRADE BREAK	TW	= TOP OF WALL
GL	= GUTTER LIP	WLK	= WALK

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NOT FOR CONSTRUCTION

BEFORE EXCAVATING
CALL U.S.A.
UNDERGROUND SERVICE ALERT
AT 811
TWO WORKING DAYS BEFORE ALL
PLANNED WORK OPERATIONS

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EAST BAY REGIONAL PARK DISTRICT
2950 PERALTA OAKS COURT, OAKLAND, CA 94605 WWW.EBPARKS.ORG 888-327-2757

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scale: AS NOTED
drawn: JM
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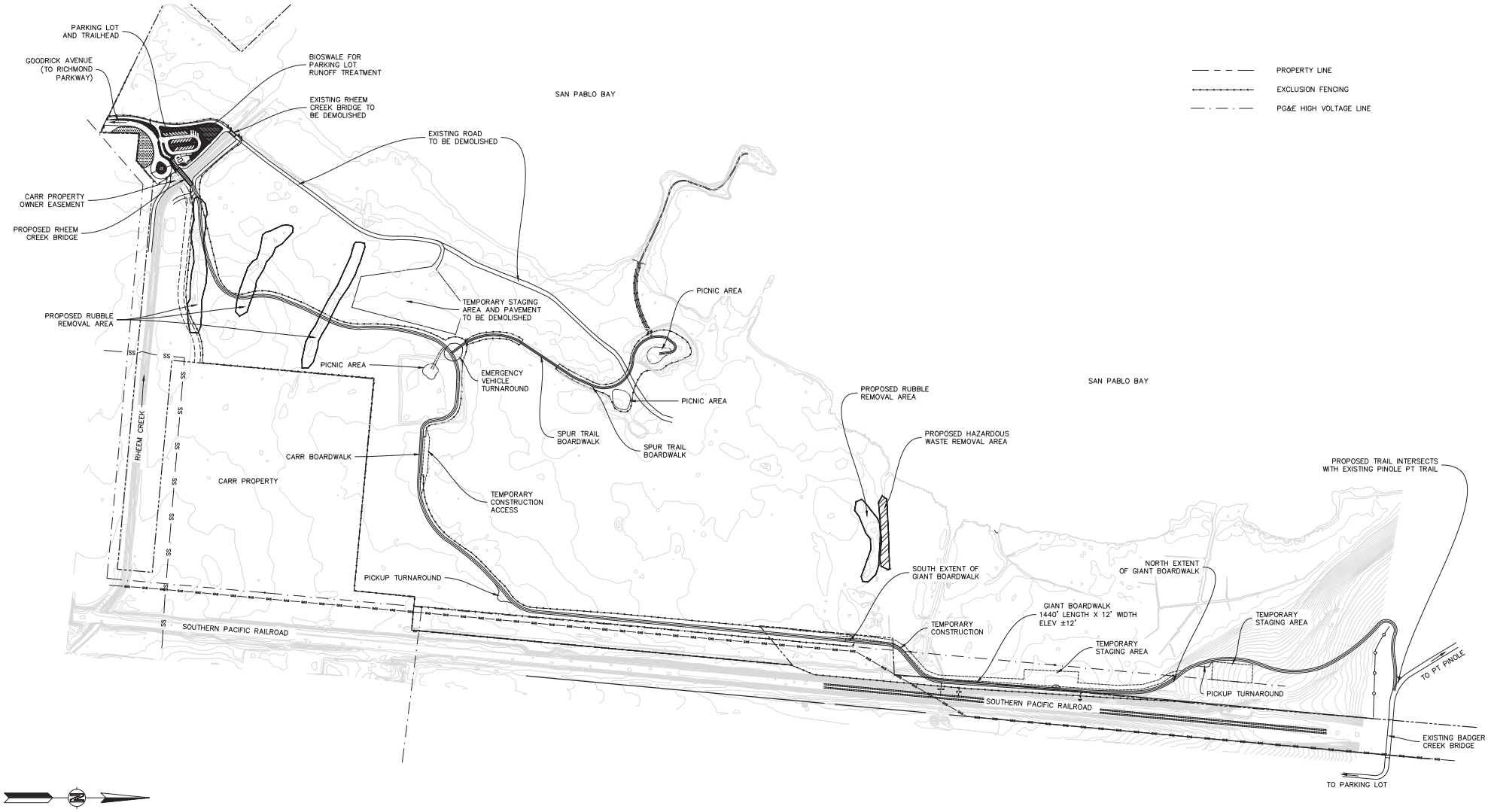
date: 2012-11-1

TITLE SHEET
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA
PROJECT NO. 1200077
CONTRACT NO.

SHEET NO. 1
OF : 17



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SITE PLAN
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077

CONTRACT NO.

SHEET NO. 2
OF : 17

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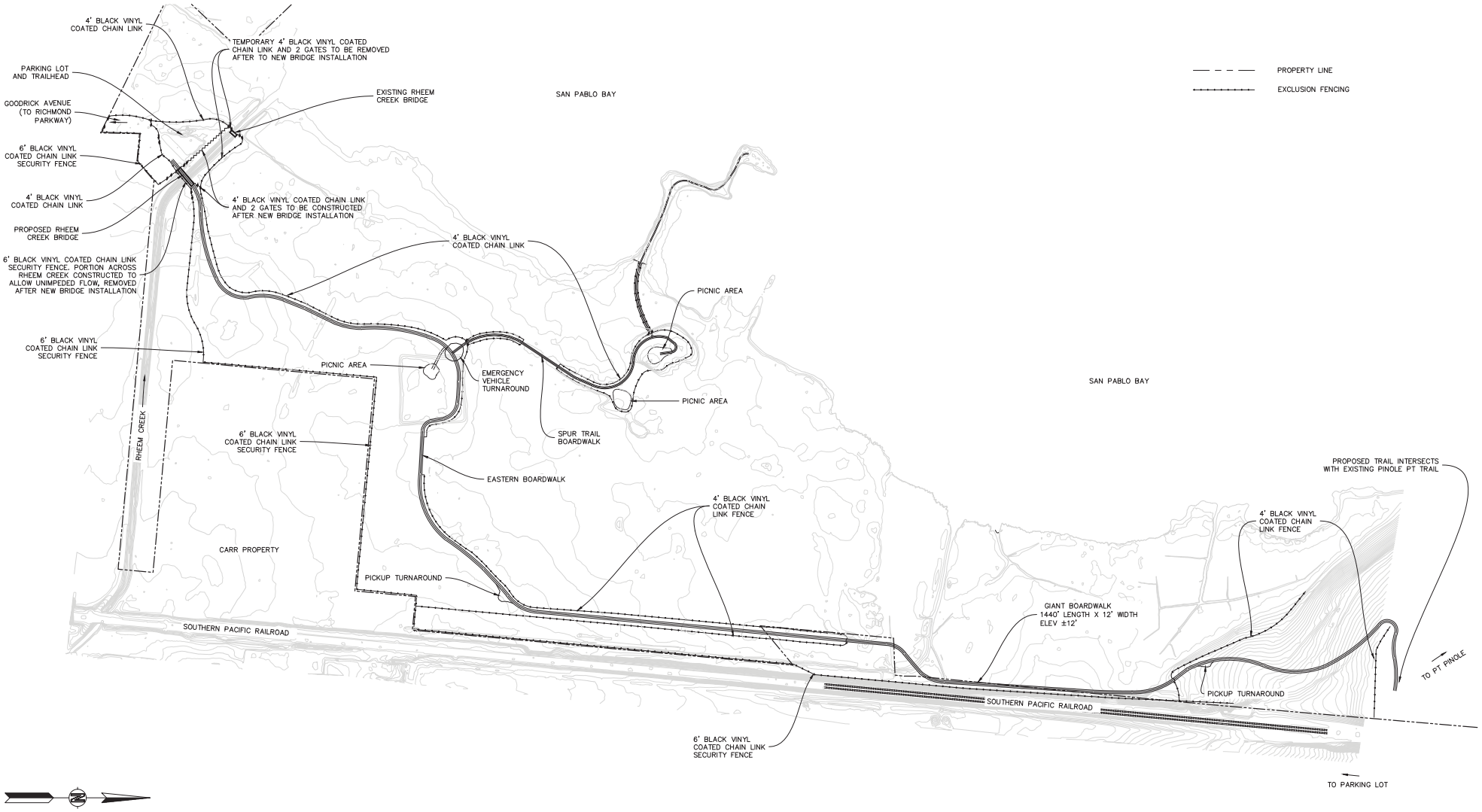

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FENCING PLAN
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RICHMOND, CA

PROJECT NO. 1200077

CONTRACT NO.

SHEET NO. 2B
OF : 17

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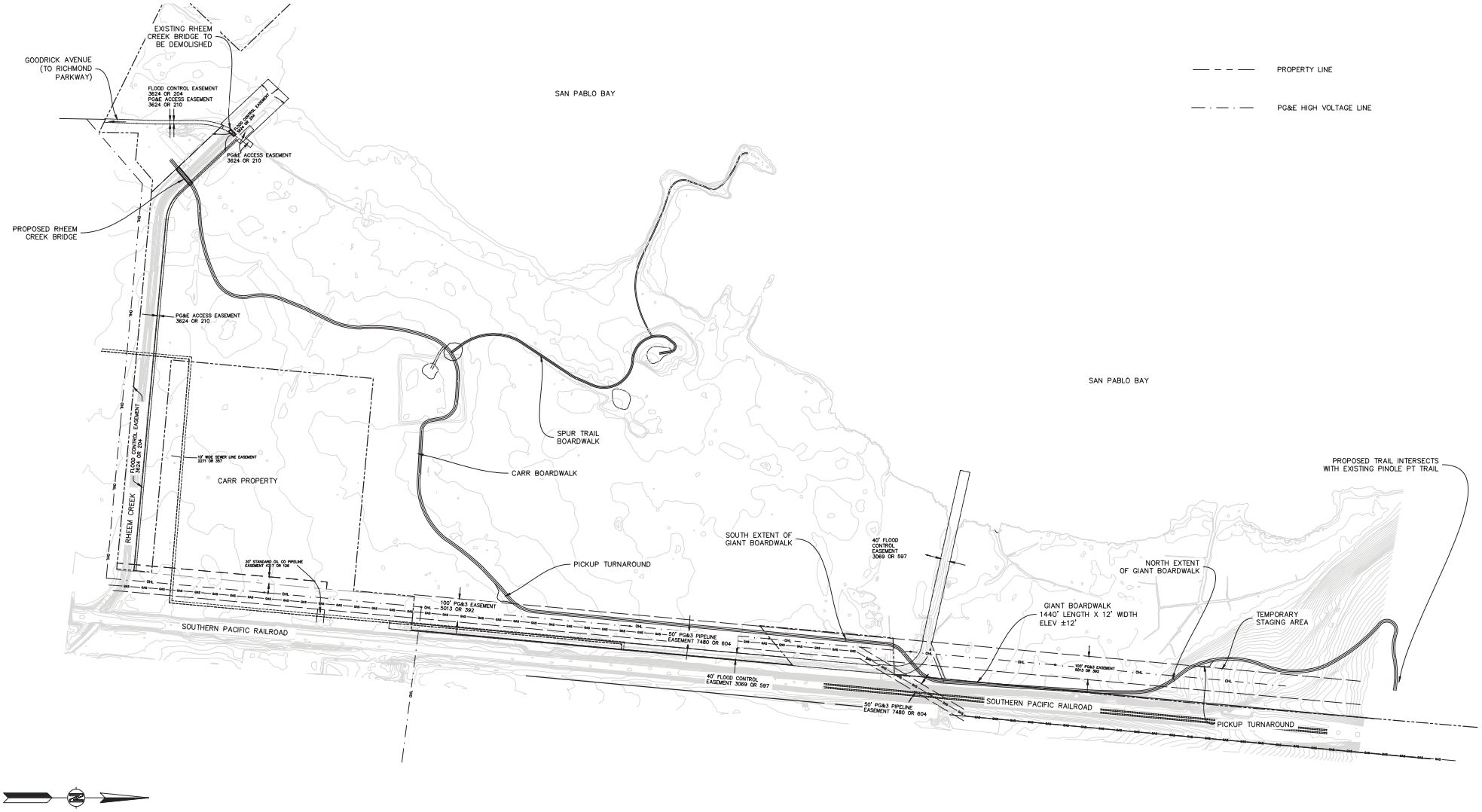

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EASEMENTS AND UTILIITES
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077

CONTRACT NO.

SHEET NO. 3
OF : 17

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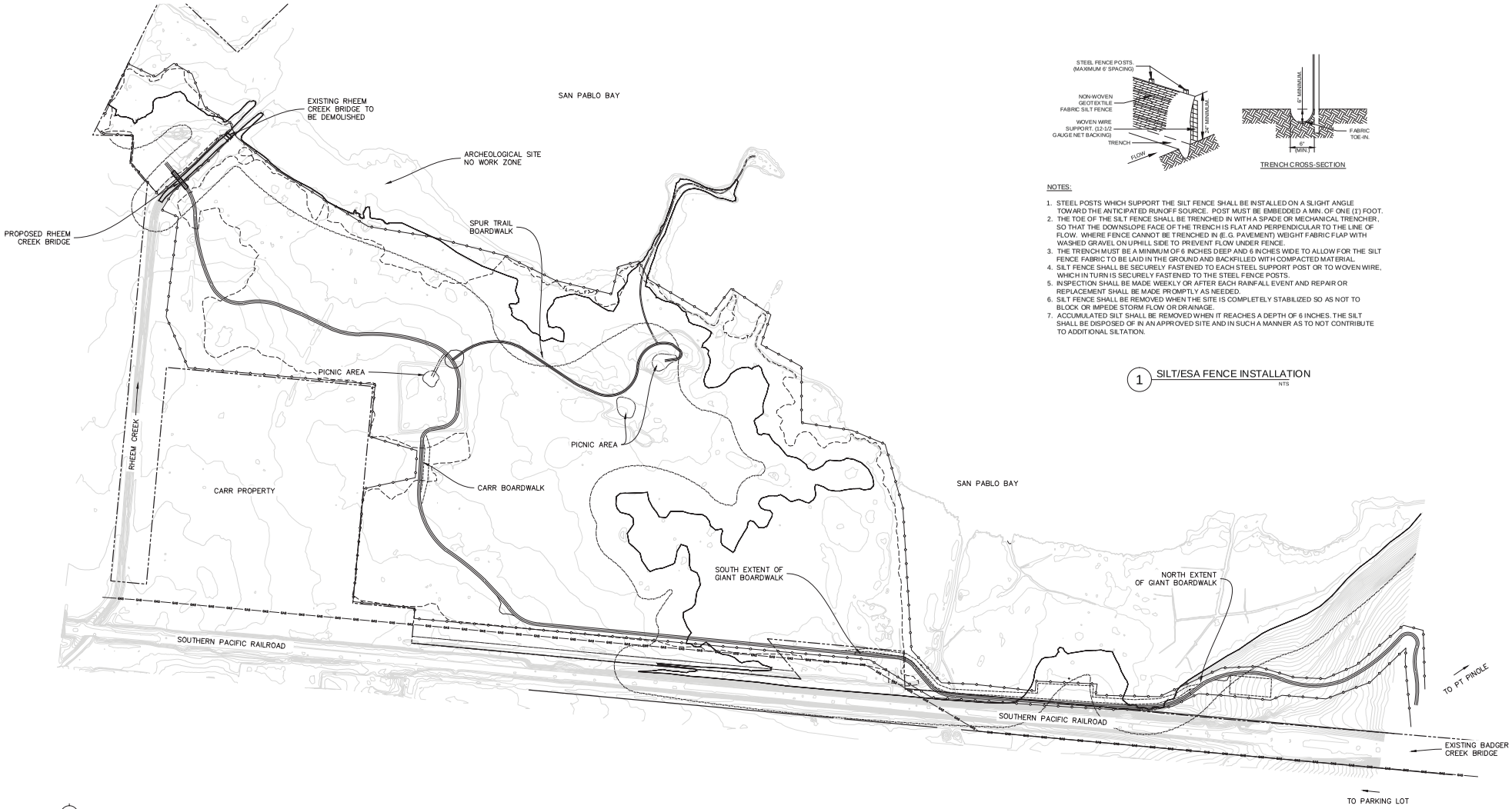

TRENCH CROSS-SECTION

NOTES:

1. STEEL POSTS WHICH SUPPORT THE SILT FENCE SHALL BE INSTALLED ON A SLIGHT ANGLE TOWARD THE ANTICIPATED RUNOFF SOURCE. POST MUST BE EMBEDDED A MIN. OF ONE (1') FOOT.
2. THE TOE OF THE SILT FENCE SHALL BE TRENCHED IN WITH A SPADE OR MECHANICAL TRENCHER, SO THAT THE DOWNSLOPE FACE OF THE TRENCH IS FLAT AND PERPENDICULAR TO THE LINE OF FLOW. WHERE FENCE CANNOT BE TRENCHED IN (E.G. PAVEMENT) WEIGHT FABRIC FLAP WITH WASHED GRAVEL ON UPHILL SIDE TO PREVENT FLOW UNDER FENCE.
3. THE TRENCH MUST BE A MINIMUM OF 6 INCHES DEEP AND 6 INCHES WIDE TO ALLOW FOR THE SILT FENCE FABRIC TO BE LAID IN THE GROUND AND BACKFILLED WITH COMPACTED MATERIAL.
4. SILT FENCE SHALL BE SECURELY FASTENED TO EACH STEEL SUPPORT POST OR TO WOVEN WIRE, WHICH IN TURN IS SECURELY FASTENED TO THE STEEL FENCE POSTS.
5. INSPECTION SHALL BE MADE WEEKLY OR AFTER EACH RAINFALL EVENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. SILT FENCE SHALL BE REMOVED WHEN THE SITE IS COMPLETELY STABILIZED SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
7. ACCUMULATED SILT SHALL BE REMOVED WHEN IT REACHES A DEPTH OF 6 INCHES. THE SILT SHALL BE DISPOSED OF IN AN APPROVED SITE AND IN SUCH A MANNER AS TO NOT CONTRIBUTE TO ADDITIONAL SILTATION.

1 SILT/ESA FENCE INSTALLATION
NTS

GRAPHIC SCALE
0 100 200 400
(IN FEET)
1 inch = 200 ft.

SILT FENCE/ESA PROTECTION/LIMIT OF WORK
BCDC SHORELINE: 8' ELEVATION (NAVD88)
BCDC 100' SHORELINE BAND
EXTENT OF GRADING FOR WETLAND RESTORATION

60% DESIGN
NOT FOR CONSTRUCTION

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EAST BAY REGIONAL PARK DISTRICT
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ENVIRONMENTAL PROTECTION
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
CONTRACT NO.

SHEET NO. 4
OF : 17

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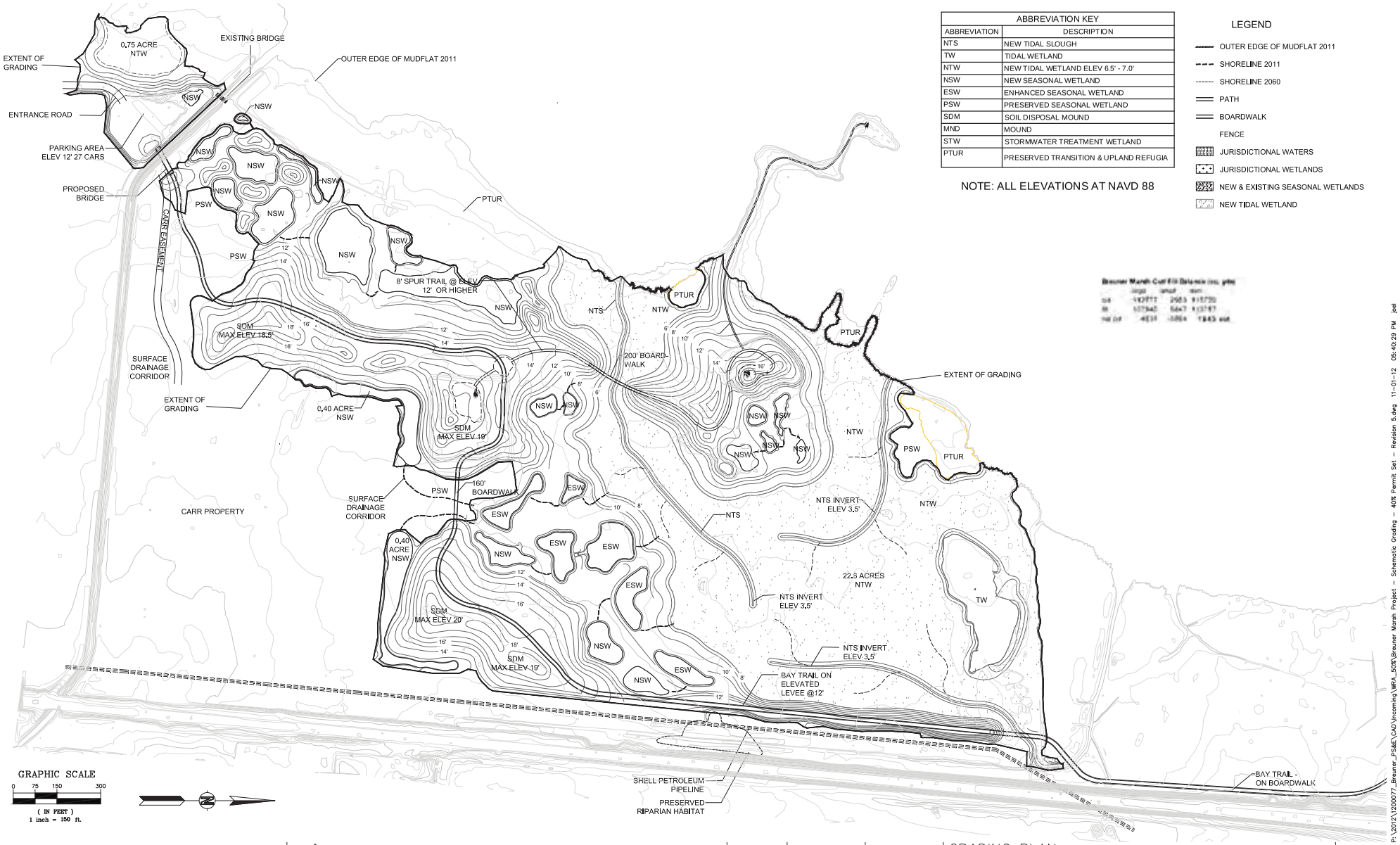

ABBREVIATION KEY	
ABBREVIATION	DESCRIPTION
NTS	NEW TIDAL SLOUGH
TW	TIDAL WETLAND
NTW	NEW TIDAL WETLAND ELEV 6.5' - 7.0'
NSW	NEW SEASONAL WETLAND
ESW	ENHANCED SEASONAL WETLAND
PSW	PRESERVED SEASONAL WETLAND
SDM	SOIL DISPOSAL MOUND
MND	MOUND
STW	STORMWATER TREATMENT WETLAND
PTUR	PRESERVED TRANSITION & UPLAND REFUGIA

NOTE: ALL ELEVATIONS AT NAVD 88

LEGEND

- OUTER EDGE OF MUDFLAT 2011
- SHORELINE 2011
- SHORELINE 2060
- PATH
- BOARDWALK
- FENCE
- JURISDICTIONAL WATERS
- JURISDICTIONAL WETLANDS
- NEW & EXISTING SEASONAL WETLANDS
- NEW TIDAL WETLAND

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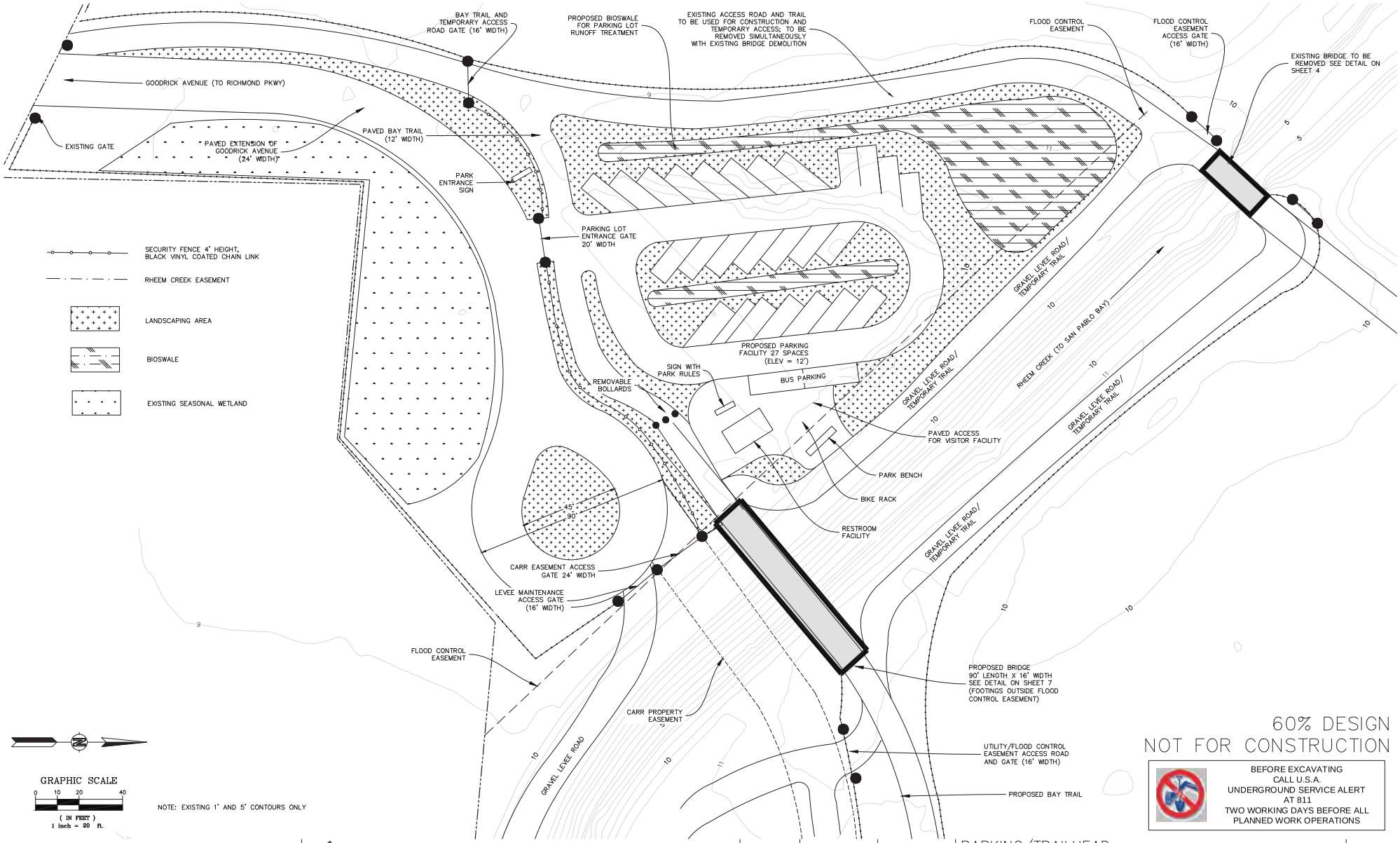
GRADING PLAN
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO.1200077
CONTRACT NO.

SHEET NO. 5
OF : 17



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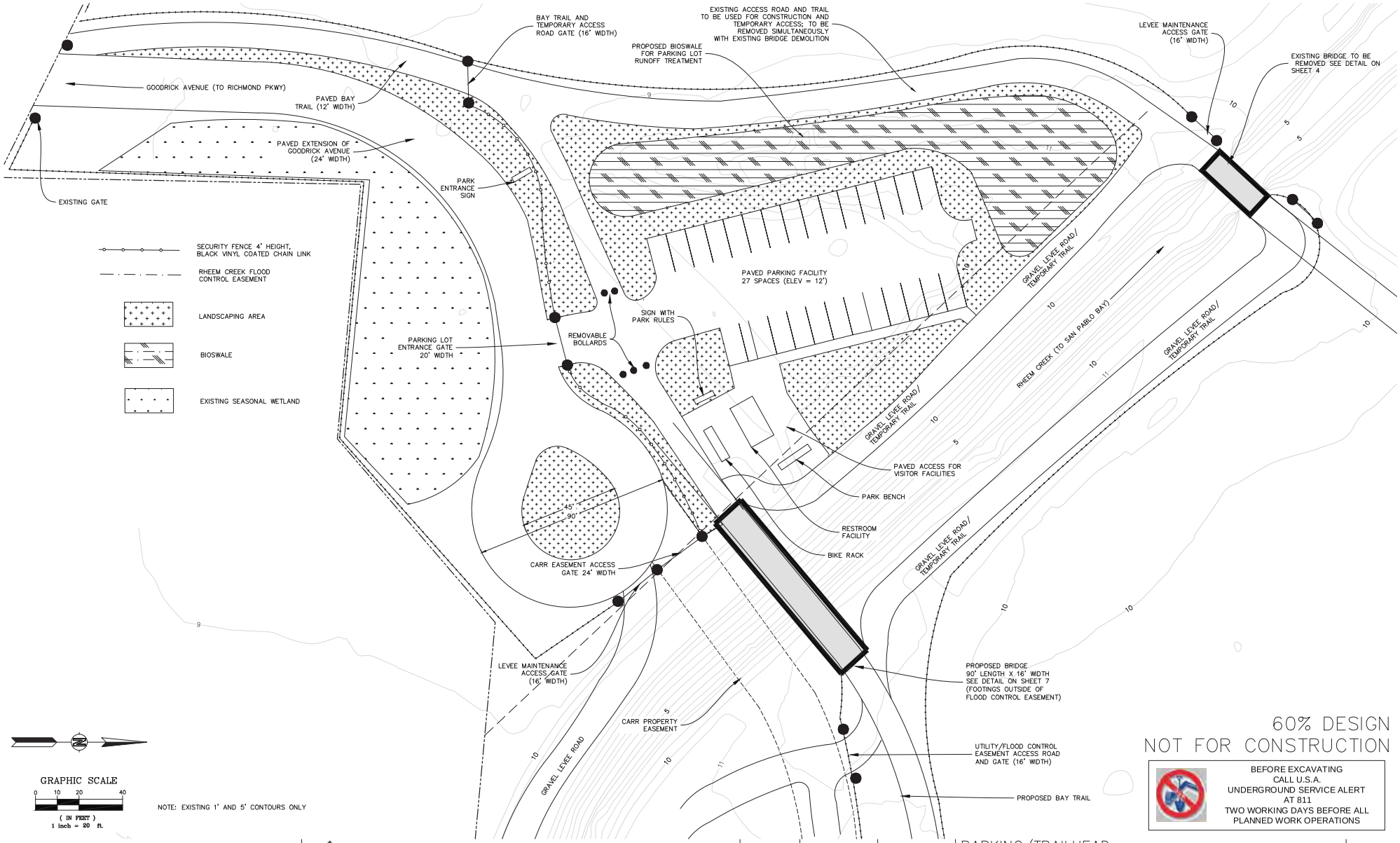
PARKING/TRAILHEAD
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
CONTRACT NO.

SHEET NO. 6
OF : 17



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PARKING/TRAILHEAD
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RICHMOND, CA

PROJECT NO. 1200077
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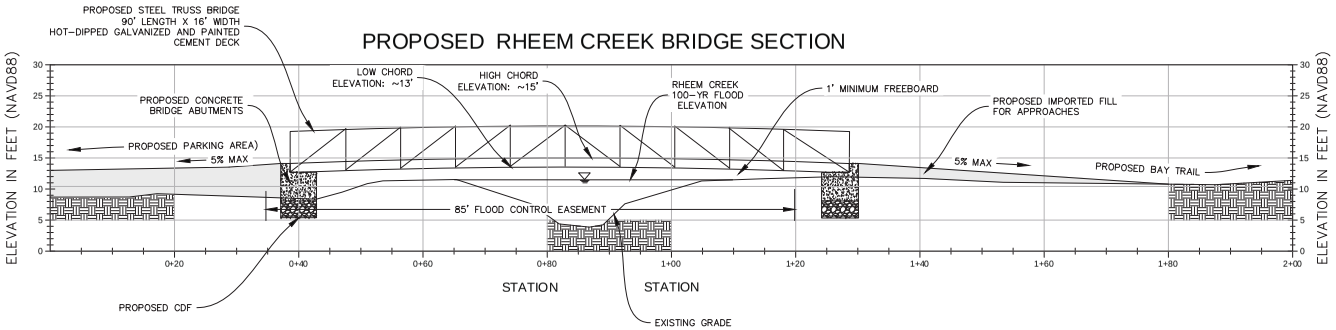
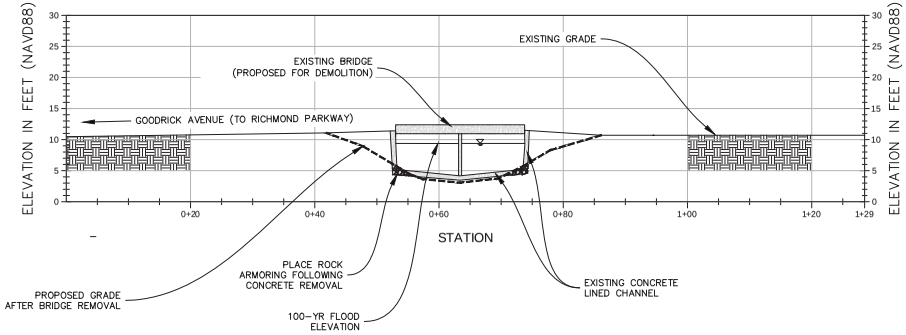
SHEET NO. 6B
OF : 17

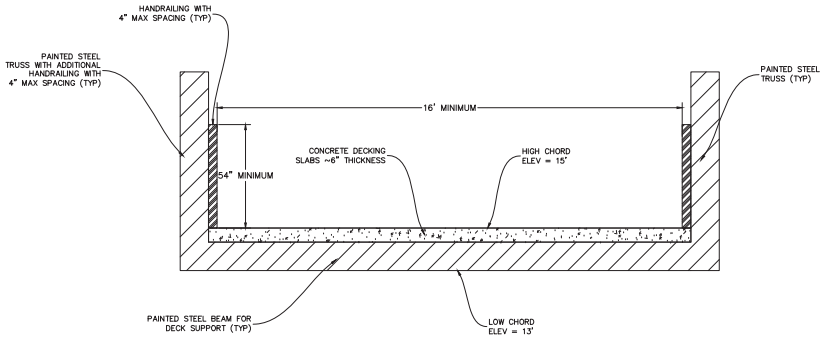
PROPOSED RHEEM CREEK BRIDGE SECTION



EXISTING RHEEM CREEK BRIDGE SECTION



PROPOSED BRIDGE SECTION



HYDROLOGIC INFORMATION	
100-YEAR MAXIMUM FLOW	1080 CFS
100-YEAR FLOW ELEVATION AT EXISTING BRIDGE	9.4 FT
100-YEAR FLOW DEPTH AT PROPOSED BRIDGE	11.5 FT

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GRAPHIC SCALE
0 4 8 16
(IN FEET)
1 inch = 8 ft.

REVISIONS

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PARKING/TRAILHEAD
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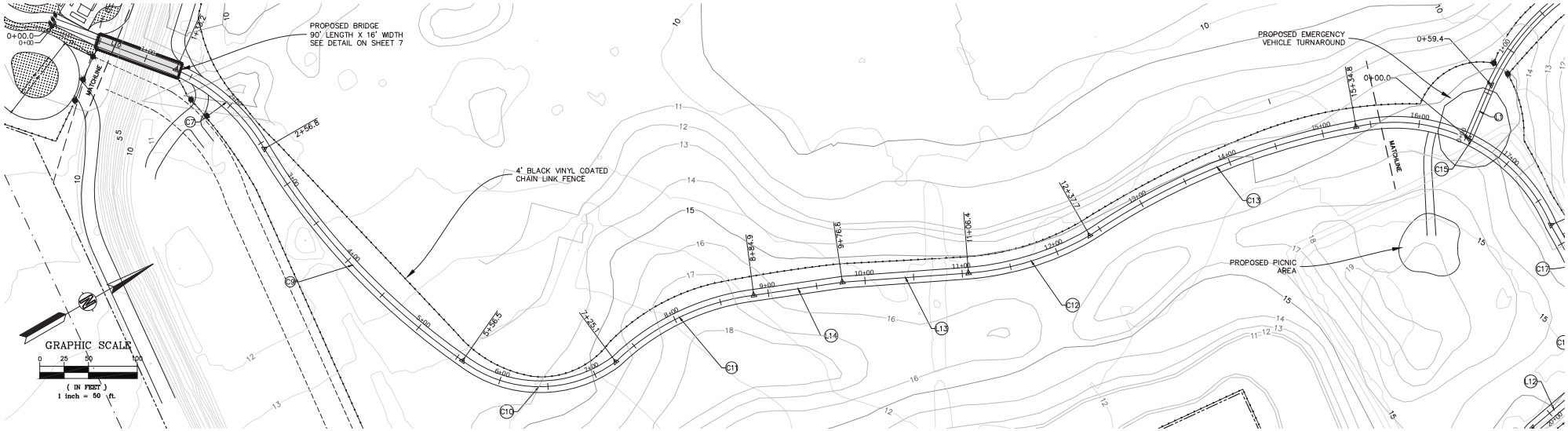
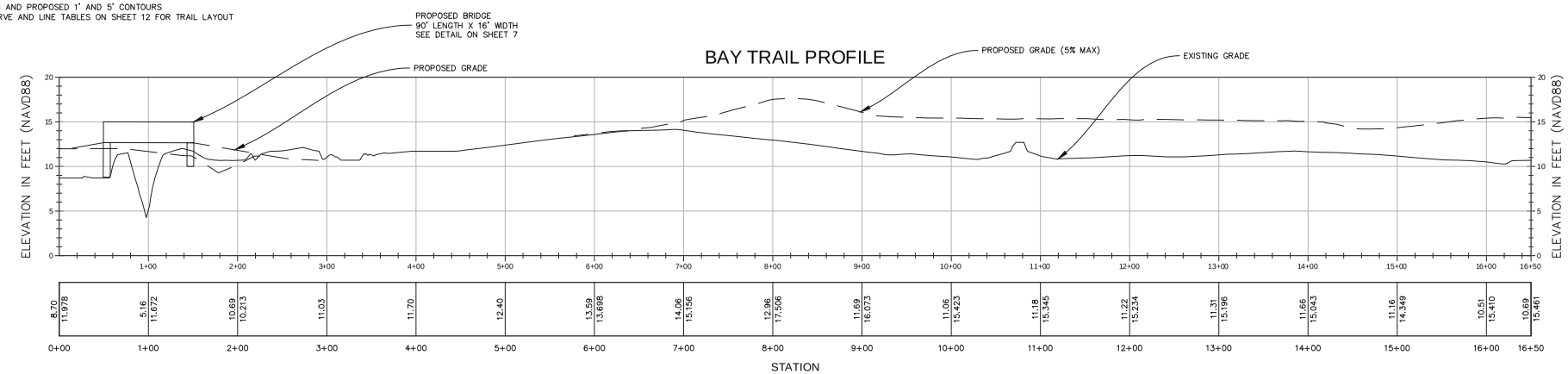


NOTES:
1) EXISTING AND PROPOSED 1' AND 5' CONTOURS
2) SEE CURVE AND LINE TABLES ON SHEET 12 FOR TRAIL LAYOUT



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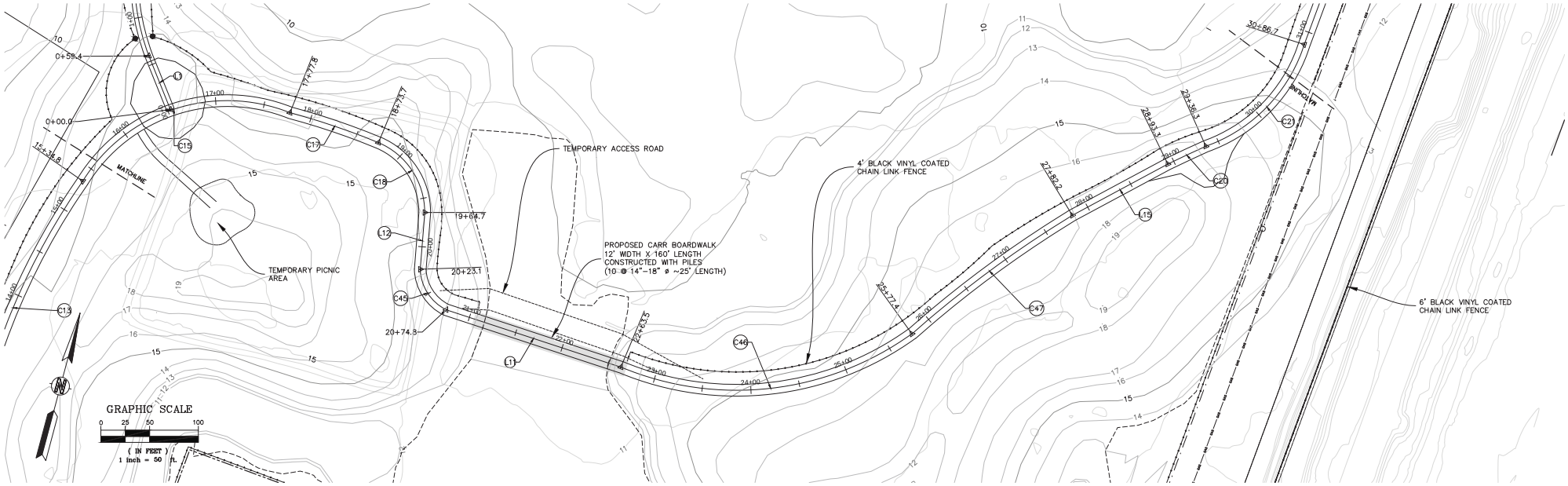
BAY TRAIL SEGMENT 1
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

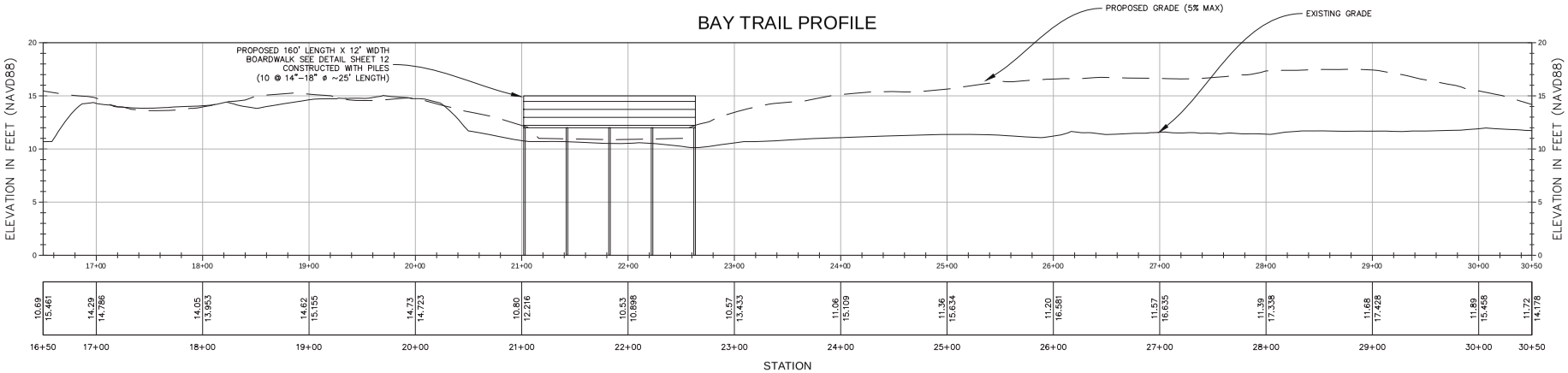
PROJECT NO. 1200077
CONTRACT NO.

SHEET NO. 8
OF : 17



NOTE: EXISTING AND PROPOSED 1' AND 5' CONTOURS

BAY TRAIL PROFILE



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BAY TRAIL SEGMENT 2
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
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OF : 17

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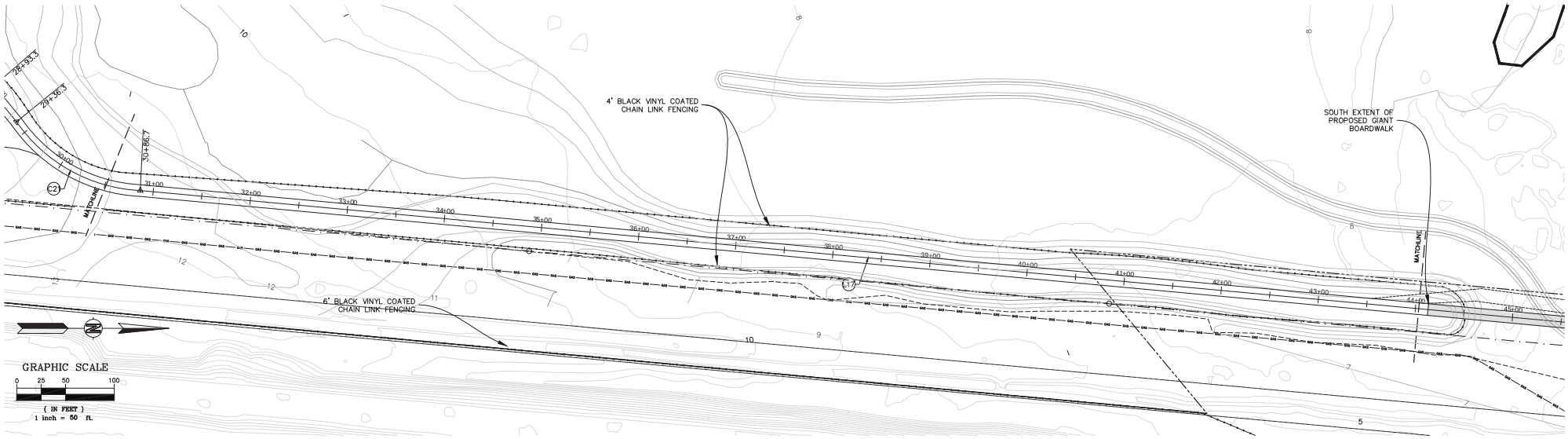
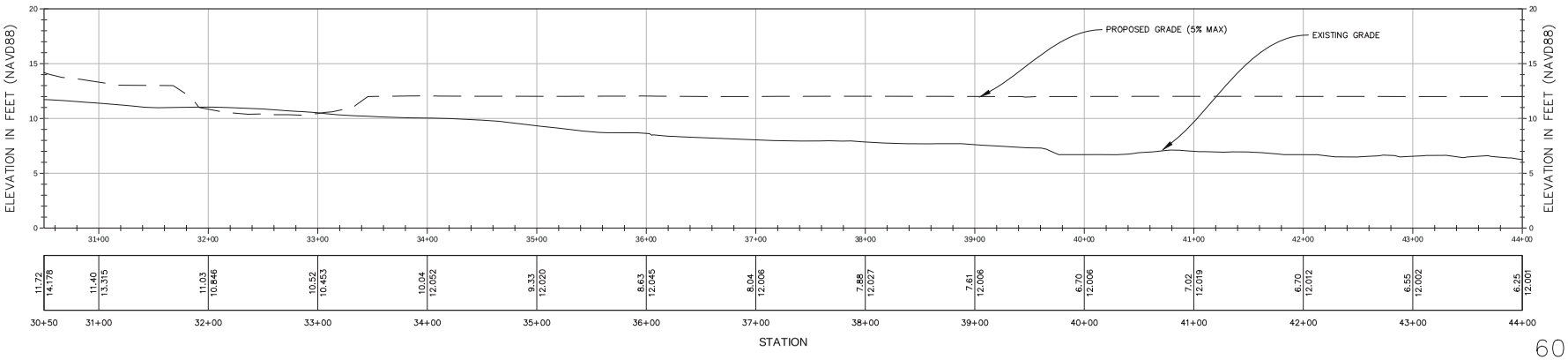


NOTE: EXISTING 1' AND 5' CONTOURS ONLY

BAY TRAIL PROFILE



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BAY TRAIL SEGMENT 3
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
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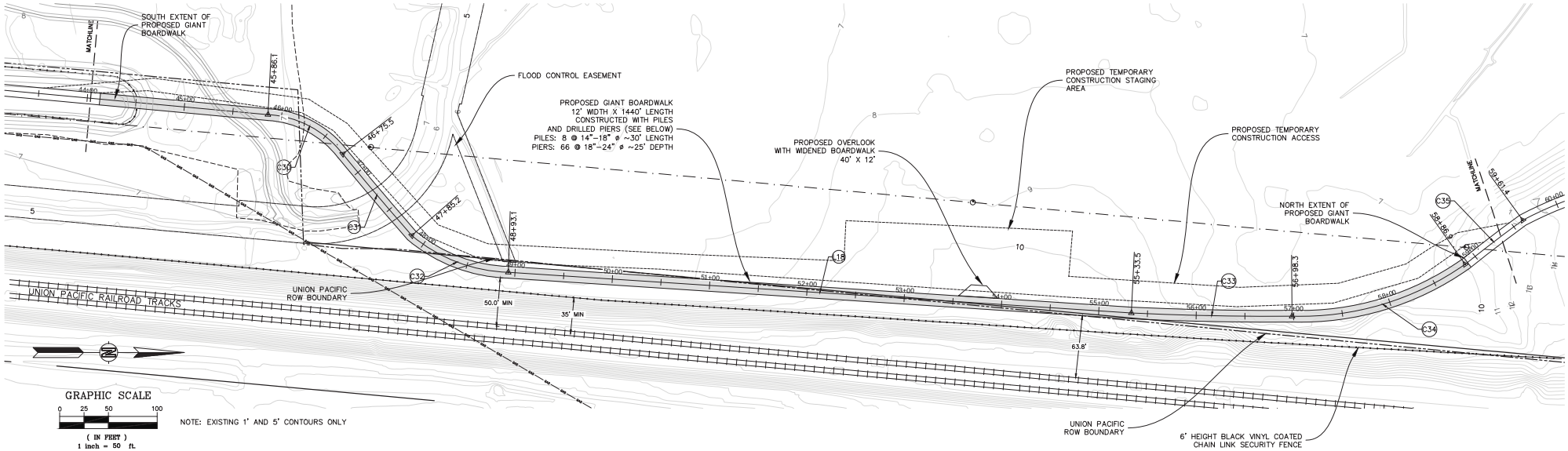
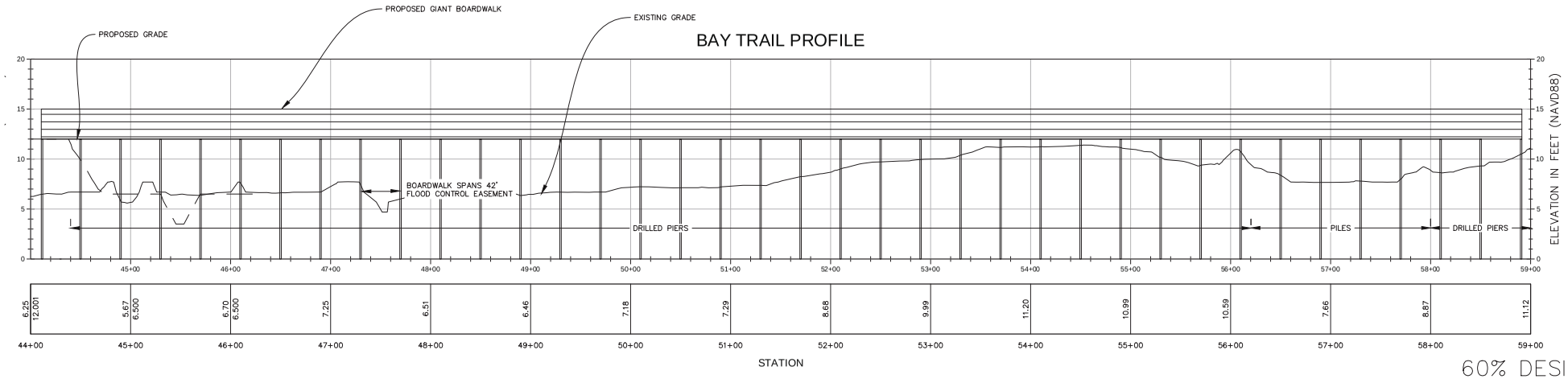
SHEET NO. 10
OF : 17





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GIANT BOARDWALK
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
CONTRACT NO.

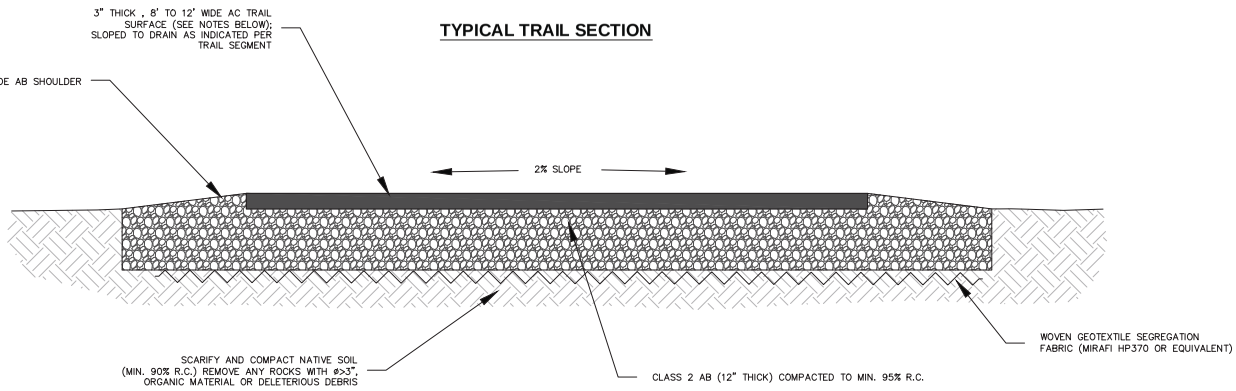
SHEET NO. 11
OF : 17

LINE TABLE				
LINE	LENGTH	BEARING	START (N,E)	END (N,E)
L10	133.18	N50° 22' 10.91"E	(2184476.58,6024236.42)	(2184561.53,6024338.99)
L11	188.63	S86° 49' 32.01"E	(2185549.31,6025388.90)	(2185538.86,6025577.24)
L12	58.42	S10° 25' 55.72"E	(2185639.99,6025341.93)	(2185582.54,6025352.51)
L13	129.62	N25° 52' 06.12"E	(2185044.40,6024869.42)	(2185161.03,6024925.98)
L14	91.92	N21° 38' 52.76"E	(2184958.97,6024835.52)	(2185044.40,6024869.42)
L15	111.09	N46° 46' 19.40"E	(2185809.05,6025984.23)	(2185885.14,6026065.17)
L17	1499.39	N05° 16' 32.74"E	(2186039.75,6026168.64)	(2187532.79,6026306.51)
L18	640.37	N03° 44' 15.59"E	(2187779.28,6026468.31)	(2188418.29,6026510.06)
L1	59.36	N36° 54' 02.78"W	(2185674.32,6025062.67)	(2185721.79,6025027.03)
L2	265.79	N33° 37' 19.32"E	(2185963.46,6025009.79)	(2186184.78,6025156.96)
L3	70.59	N23° 31' 04.28"E	(2186211.30,6025171.40)	(2186276.02,6025199.57)
L4	39.97	N38° 30' 18.72"E	(2186596.18,6024996.98)	(2186627.46,6025021.87)
L5	48.76	S08° 08' 19.39"E	(2186613.41,6025057.82)	(2186565.14,6025064.72)

CURVE TABLE					
CURVE	RADIUS	LENGTH	CHORD BEARING	START (N,E)	END (N,E)
C7	195	123.65	N71° 49' 55.53"E	(2184561.53,6024338.99)	(2184599.44,6024454.51)
C9	716	299.69	N76° 55' 06.52"E	(2184599.44,6024454.51)	(2184666.78,6024744.30)
C10	131	168.55	N30° 23' 52.29"E	(2184666.78,6024744.30)	(2184802.31,6024823.81)
C11	250	159.80	N04° 16' 18.57"E	(2184802.31,6024823.81)	(2184958.97,6024835.52)
C12	297	131.24	N12° 45' 44.95"E	(2185161.03,6024925.98)	(2185288.00,6024954.74)
C13	708	297.14	N07° 48' 24.55"E	(2185288.00,6024954.74)	(2185580.23,6024994.80)
C15	174	243.03	N56° 43' 53.97"E	(2185580.23,6024994.80)	(2185703.00,6025181.93)
C17	728	95.87	S86° 18' 49.62"E	(2185703.00,6025181.93)	(2185696.84,6025277.53)
C18	78	91.03	S48° 34' 04.28"E	(2185696.84,6025277.53)	(2185639.99,6025341.93)
C20	1361	43.08	N49° 56' 49.93"E	(2185885.14,6026065.17)	(2185912.85,6026098.14)
C21	164	150.40	N29° 03' 14.40"E	(2185912.85,6026098.14)	(2186039.75,6026168.64)
C30	103	89.42	N27° 47' 38.05"E	(2187532.79,6026306.51)	(2187609.43,6026346.91)
C31	3382	109.61	N49° 43' 53.19"E	(2187609.43,6026346.91)	(2187680.28,6026430.54)
C32	162	107.95	N20° 52' 54.72"E	(2187680.28,6026430.54)	(2187779.28,6026468.31)
C33	2992	164.86	N01° 09' 11.88"E	(2188418.29,6026510.06)	(2188583.09,6026513.37)
C34	292	188.57	N16° 41' 56.80"W	(2188583.09,6026513.37)	(2188760.59,6026460.12)
C35	1463	74.54	N37° 27' 07.56"W	(2188760.59,6026460.12)	(2188819.76,6026414.80)
C36	386	336.87	N02° 52' 49.17"W	(2188819.76,6026414.80)	(2189145.60,6026398.41)
C37	356	265.85	N01° 04' 11.19"E	(2189145.60,6026398.41)	(2189405.26,6026403.26)
C41	722	298.91	N37° 14' 10.31"W	(2189405.26,6026403.26)	(2189641.54,6026223.67)

CURVE TABLE					
CURVE	RADIUS	LENGTH	CHORD BEARING	START (N,E)	END (N,E)
C42	40	113.96	N27° 48' 02.71"E	(2189641.54,6026223.67)	(2189712.20,6026260.93)
C43	200	104.37	S86° 28' 49.15"E	(2189712.20,6026260.93)	(2189705.87,6026363.93)
C44	387	143.14	N89° 26' 38.40"E	(2189705.87,6026363.93)	(2189707.25,6026506.25)
C45	48	51.71	S47° 36' 10.19"E	(2185582.54,6025352.51)	(2185549.31,6025388.90)
C46	308	313.88	N68° 29' 12.62"E	(2185538.86,6025577.24)	(2185649.05,6025856.79)
C47	1162	204.82	N38° 32' 20.13"E	(2185649.05,6025856.79)	(2185809.05,6025984.23)
C1	232	254.97	N04° 04' 52.49"W	(2185721.79,6025027.03)	(2185963.46,6025009.79)
C2	171	30.24	N28° 34' 11.80"E	(2186184.78,6025156.96)	(2186211.30,6025171.40)
C4	123	245.58	N32° 05' 46.83"W	(2186276.02,6025199.57)	(2186451.35,6025089.60)
C5	110	197.56	N32° 35' 51.25"W	(2186451.35,6025089.60)	(2186596.18,6024996.98)
C6	21	48.31	S68° 39' 33.14"E	(2186627.46,6025021.87)	(2186613.41,6025057.82)

TYPICAL TRAIL SECTION



NOTE:
1) 4" THICK AC ON BAY TRAIL FROM STA 0+00 TO STA X+XX AND INCLUDING TURNAROUNDS
ALL OTHER AC CONSTRUCTED WITH 3" THICKNESS
2) BAY TRAIL 12' WIDTH WITH 2' SHOULDERS; SPUR TRAIL 8' WIDTH WITH 2' SHOULDERS

60% DESIGN
NOT FOR CONSTRUCTION

BEFORE EXCAVATING
CALL U.S.A.
UNDERGROUND SERVICE ALERT
AT 811
TWO WORKING DAYS BEFORE ALL
PLANNED WORK OPERATIONS

P:\2012\1200077_Breuner_PS&E\CAD\Model\1200077_Breuner_60%_Design_2012-10-31.dwg 11-15-12 03:13:02 PM jpel

REVISIONS | DATE

EAST BAY REGIONAL PARK DISTRICT
2950 PERALTA OAKS COURT, OAKLAND, CA 94605 WWW.EBPARKS.ORG 888-327-2757

APPROVED
design:
operations:

SURVEY
drawn :
job no. :
dwg :
ascii :
field file :
field bk :

scale: AS NOTED
drawn: JM
checked:
date: 2012-11-1

GIANT BOARDWALK TRAIL SECTION AND TABLES
BREUNER MARSH RESTORATION AND PUBLIC ACCESS PROJECT
RICHMOND, CA

PROJECT NO. 1200077
CONTRACT NO.

SHEET NO. 12
OF : 17

EXHIBIT "A"

A non-exclusive easement and right of way for ingress and egress and the installation, operation, maintenance, repair and replacement of public utilities in, over and under a strip of land 20 feet in width along the southerly side of Crothers Road as said road is shown on that map filed for record in Book 416 of maps at page 38, Santa Clara County Records, State of California and more clearly described as follows:

Beginning at the northwest corner of Parcel "A" said point also lying on the southerly line of Crothers Road and as shown on the above mentioned map; thence S37°37'E, 21.22 feet to the beginning of a tangent curve to the left having a radius of 280.00 feet, a central angle of 30°40'00" and an arc length of 149.87 feet; thence S68°17'00"E, 37.51 feet to the beginning of a tangent curve to the right having a radius of 283.05 feet, a central angle of 18°31'00" and an arc length of 91.48 feet to a point of compound curve from which the radial point bears S40°14'00"W 104.33 feet; thence continuing southeasterly along said curve having a radius of 104.33 feet, a central angle of 20°37'40" and an arc length of 37.56 feet to the northeast corner of Parcel "A" said point also lying on the southerly line of Crothers Road; thence leaving said line S32°33'00W 22.92 feet; thence through a curve to the northwest from which the radial point bears S62°44'34"W 331.03 feet having a radius of 331.03 feet, a central angle of 1°52'54" and an arc length of 10.87 feet to a point of compound curve from which the radial point bears S60°51'40"W 84.33 feet; thence continuing northwesterly along said curve having a radius of 84.33 feet, a central angle of 20°37'40" and an arc length of 30.36 feet to a point of compound curve from which the radial point bears S40°14'00"W 263.05 feet; thence continuing northwesterly along said curve having a radius of 263.05 feet, a central angle of 18°31'00" and an arc length of 85.01 feet; thence N68°17'00"W 37.51 feet; thence through a tangent curve to the right having a radius of 300.00 feet, a central angle of 30°40'00" and an arc length of 160.57 feet; thence N37°37'W 10.81 feet to the westerly line of Parcel A; thence N24°53'30"E 22.55 feet to the POINT OF BEGINNING for the herein described 20 foot strip of land.

Containing approximately 6,729 square feet.

Attached hereto is a plat labeled EXHIBIT "B" and by this reference made a part thereof.

The bearing of the monument line of Crothers Road, as shown on the record of survey recorded in Book 416 of Maps at page 38, S49°46'E, was used as the basis of bearing for this description.

END OF DESCRIPTION

This description was prepared by _____
David Alvarez
P.L.S. 4050

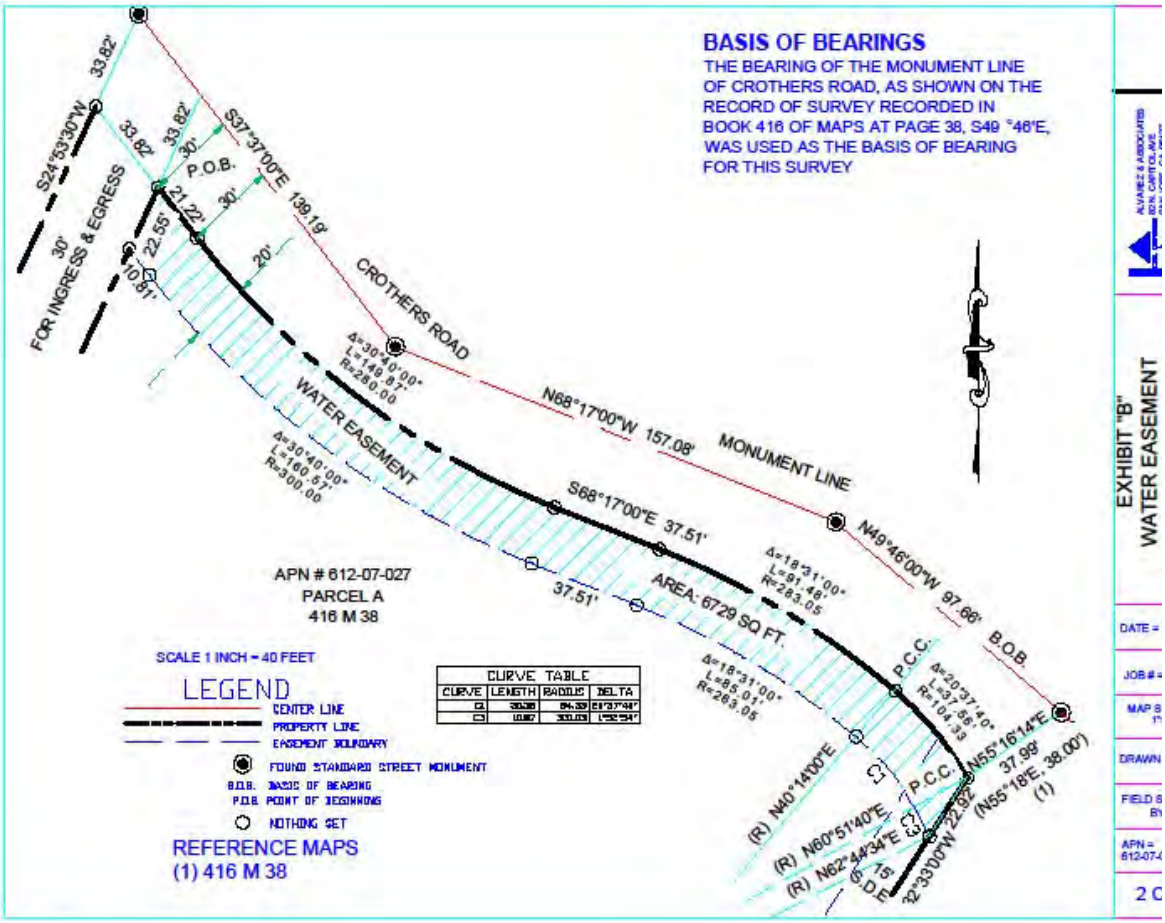

BASIS OF BEARINGS
THE BEARING OF THE MONUMENT LINE OF CROTHERS ROAD, AS SHOWN ON THE RECORD OF SURVEY RECORDED IN BOOK 416 OF MAPS AT PAGE 38, S49 °46'E, WAS USED AS THE BASIS OF BEARING FOR THIS SURVEY
S24°53'30"W
33.82'
33.82'
33.82'
30'
P.O.B.
30'
S37°37'00"E 139.19'
21.22'
22.55'
10.81'
20'
30' FOR INGRESS & EGRESS
CROTHERS ROAD
Δ=30°40'00"
L=149.87'
R=280.00
WATER EASEMENT
Δ=30°40'00"
L=160.57'
R=300.00
N68°17'00"W 157.08'
MONUMENT LINE
S68°17'00"E 37.51'
37.51'
AREA: 6729 SQ FT.
Δ=18°31'00"
L=91.46'
R=283.05
N49°46'00"W 97.66'
B.O.B.
APN # 612-07-027
PARCEL A
416 M 38
Δ=18°31'00"
L=85.01'
R=263.05
P.C.C.
Δ=20°37'40"
L=37.56'
R=104.33
SCALE 1 INCH = 40 FEET
LEGEND
CENTER LINE
PROPERTY LINE
EASEMENT BOUNDARY
FOUND STANDARD STREET MONUMENT
B.O.B. BASIS OF BEARING
P.O.B. POINT OF BEGINNING
NOTHING SET
REFERENCE MAPS
(1) 416 M 38
CURVE TABLE
CURVE | LENGTH | RADIUS | DELTA
C2 | 30.00 | 84.39 | 20°37'40"
C3 | 10.00 | 301.03 | 1°52'34"
(R) N40°14'00"E
(R) N60°51'40"E
(R) N62°44'34"E
P.C.C.
N55°16'14"E
37.99'
(N55°18'E 38.00')
(1)
22.82'
S22°33'00"W
EXHIBIT "B"
WATER EASEMENT
DATE =
JOB # =
MAP S
DRAWN
FIELD S
BY
APN =
612-07-
2 C

EXHIBIT "A"

A non-exclusive easement and right of way for ingress and egress and the installation, operation, maintenance, repair and replacement of public utilities in, over and under a strip of land 25 feet in width along the southerly side of Crothers Road as said road is shown on that map filed for record in Book 387 of maps at page 39, Santa Clara County Records, State of California and more clearly described as follows:

Beginning at the northeasterly corner of Parcel 2, as said Parcel 2 is shown on the attached EXHIBIT "B", said point also lying on the southerly line of Crothers Road and as described in the deed filed for record as Document Number 16086880; thence from said point of beginning S46°54'08"W 25.07 feet along the northeasterly line of said parcel 2; thence leaving said line N38°46'00"W 33.34 feet to a tangent curve to the right having a radius of 325.00 feet, a central angle of 2°25'00" and an arc length of 13.71 feet; thence N36°21'00"W 82.43 feet to the beginning of a tangent curve to the right having a radius of 225.00 feet, a central angle of 19°40'00" and an arc length of 77.23 feet; thence N16°41'00"W 37.39 feet; thence through a tangent curve to the left having a radius of 326.03 feet, a central angle of 10°14'43" and an arc length of 58.30 feet to the northwesterly line of Parcel 2 from which the radial point bears S63°04'17"W 326.03 feet; thence along said northwesterly line N32°22'30"E 28.72 feet to a point on curve on the southerly line of Crothers Road from which the radial point bears S60°40'40"W 351.03 feet; thence continuing southeasterly along a curve having a radius of 351.03 feet, a central angle of 12°38'20" and an arc length of 77.43 feet; thence S16°41'00"E 37.39 feet to a tangent curve to the left having a radius of 200.00 feet, a central angle of 19°40'00" and an arc length of 68.65 feet; thence S36°21'00"E 82.43 feet; thence through a tangent curve to the left having a radius of 300.00 feet, a central angle of 2°25'00" and an arc length of 12.65 feet; thence S38°46'00"E 31.45 feet to the POINT OF BEGINNING for the herein described 25 foot strip of land.

Containing approximately 7,656 square feet.

Attached hereto is a plat labeled EXHIBIT "B" and by this reference made a part thereof.

The bearing of the monument line of Crothers Road, as shown on the Record of Survey recorded in Book 387 of Maps at page 39, S38°46'E, was used as the basis of bearing for this description.

END OF DESCRIPTION

This description was prepared by _____
David Alvarez
P.L.S. 4050

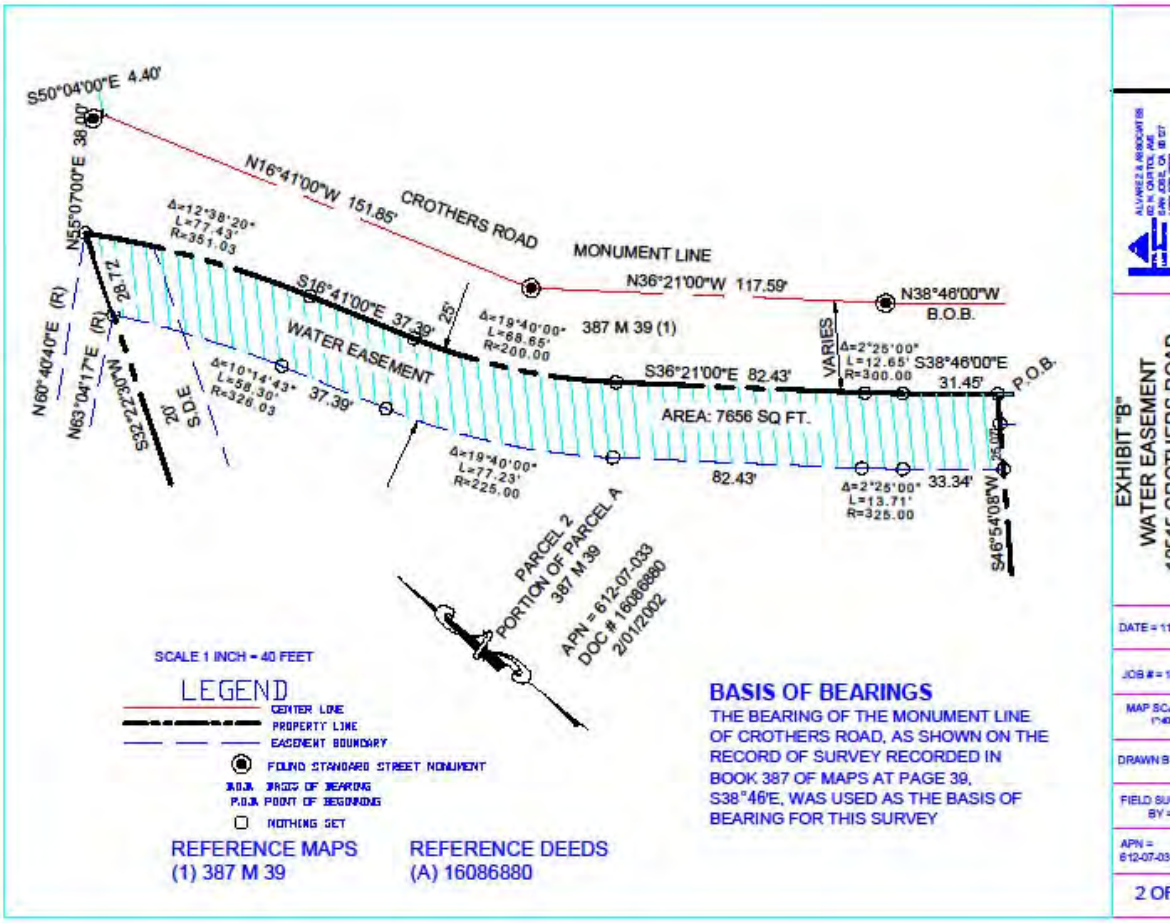

S50°04'00"E 4.40'
N55°07'00"E 38.00'
N16°41'00"W 151.85'
CROTHERS ROAD
MONUMENT LINE
N36°21'00"W 117.59'
N38°46'00"W
B.O.B.
Δ=12°38'20"
L=77.43'
R=351.03
S16°41'00"E 37.39'
25'
Δ=19°40'00"
L=68.65'
R=200.00
387 M 39 (1)
WATER EASEMENT
VARIES
Δ=2°25'00"
L=12.65'
R=300.00
S38°46'00"E
31.45'
P.O.B.
S36°21'00"E 82.43'
N60°40'40"E (R)
N63°04'17"E (R)
28.72'
S32°22'30"W
20' S.D.E.
Δ=10°14'43"
L=58.30'
R=326.03
37.39'
AREA: 7656 SQ FT.
Δ=19°40'00"
L=77.23'
R=225.00
82.43'
Δ=2°25'00"
L=13.71'
R=325.00
33.34'
S46°54'08"W
PARCEL 2
PORTION OF PARCEL A
387 M 39
APN = 612-07-033
DOC # 16086880
2/01/2002
SCALE 1 INCH = 40 FEET
LEGEND
CENTER LINE
PROPERTY LINE
EASEMENT BOUNDARY
FOUND STANDARD STREET MONUMENT
B.O.B. BASIS OF BEARING
P.O.B. POINT OF BEGINNING
NOTHING SET
REFERENCE MAPS
(1) 387 M 39
REFERENCE DEEDS
(A) 16086880
BASIS OF BEARINGS
THE BEARING OF THE MONUMENT LINE OF CROTHERS ROAD, AS SHOWN ON THE RECORD OF SURVEY RECORDED IN BOOK 387 OF MAPS AT PAGE 39, S38°46'E, WAS USED AS THE BASIS OF BEARING FOR THIS SURVEY
EXHIBIT "B"
WATER EASEMENT
DATE =
JOB # =
MAP SC
DRAWN B
FIELD SU
BY
APN =
612-07-03
2 OF

EXHIBIT "A"

A non-exclusive easement and right of way for ingress and egress and the installation, operation, maintenance, repair and replacement of public utilities in, over and under a strip of land 10 feet in width along the southerly side of Crothers Road as said road is shown on that map filed for record in Book 387 of maps at page 39, Santa Clara County Records, State of California and more clearly described as follows:

Beginning at the northwest corner of Parcel 3 as said parcel is described in the deed filed for record as Document Number 20615653, Records of Santa Clara County, State of California and as shown on the attached EXHIBIT "B"; said point also lying on the southerly line of Crothers Road; thence from said Point of Beginning S38°46'00"E 120.15 feet to a tangent curve to the left having a radius of 300 feet, a central angle of 4°21'00" and an arc length of 22.78 feet; thence S43°07'00"E 187.47 feet to the northeast corner of Parcel 3; thence leaving the southerly line of Crothers Road S87°31'00"W 41.88 feet along the northeasterly line of Parcel 3; thence S42°30'00"W 25.00 along the easterly line of Parcel 3; thence leaving said easterly line N47°30'00W 5.00 feet; thence N42°30'00" 25.00 feet; thence N2°30'00"W 34.05 feet; thence N43°07'00"W 129.37 feet to a tangent curve to the right having a radius of 310.00 feet, a central angle of 4°21'00" and an arc length of 23.54 feet; thence N38°46'00" 119.39 feet to the westerly line of Parcel 3; thence along said westerly line N46°54'08"E 10.03 feet the POINT OF BEGINNING.

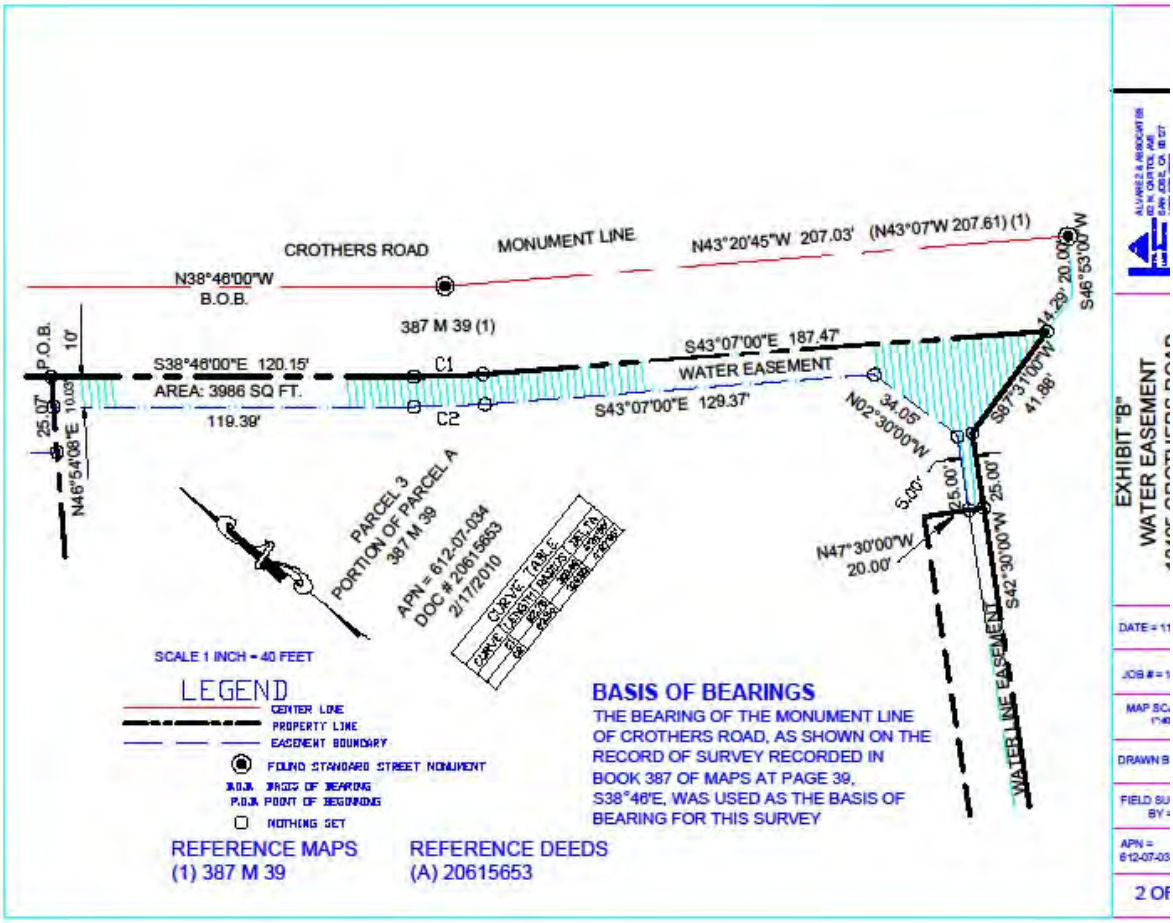
Containing approximately 3,986 square feet.

Attached hereto is a plat labeled EXHIBIT "B" and by this reference made a part thereof

The bearing of the monument line of Crothers Road, as shown on the Record of Survey recorded in Book 387 of Maps at page 39, S38°46'E, was used as the basis of bearing for this description.

END OF DESCRIPTION

This description was prepared by _____
David Alvarez
P.L.S. 4050


CROTHERS ROAD
MONUMENT LINE
N43°20'45"W 207.03' (N43°07'W 207.61) (1)
N38°46'00"W
B.O.B.
387 M 39 (1)
S43°07'00"E 187.47'
S38°46'00"E 120.15'
C1
WATER EASEMENT
AREA: 3986 SQ FT.
119.39'
C2
S43°07'00"E 129.37'
P.O.B.
10'
25.07'
10.03'
N46°54'08"E
14.29'
20.00'
S46°53'00"W
S87°31'00"W
41.88'
N02°30'00"W
34.05'
5.00'
25.00'
25.00'
N47°30'00"W
20.00'
S42°30'00"W
WATER LINE EASEMENT
PARCEL 3
PORTION OF PARCEL A
387 M 39
APN = 612-07-034
DOC # 20615653
2/17/2010
SCALE 1 INCH = 40 FEET
LEGEND
CENTER LINE
PROPERTY LINE
EASEMENT BOUNDARY
FOUND STANDARD STREET MONUMENT
B.O.B. BASIS OF BEARING
P.O.B. POINT OF BEGINNING
NOTHING SET
BASIS OF BEARINGS
THE BEARING OF THE MONUMENT LINE OF CROTHERS ROAD, AS SHOWN ON THE RECORD OF SURVEY RECORDED IN BOOK 387 OF MAPS AT PAGE 39, S38°46'E, WAS USED AS THE BASIS OF BEARING FOR THIS SURVEY
REFERENCE MAPS
(1) 387 M 39
REFERENCE DEEDS
(A) 20615653
EXHIBIT "B"
WATER EASEMENT

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY
WATER TANK AND PIPELINE REPLACEMENT PROJECT

COUNTY OF SANTA CLARA
General Construction Specifications

GENERAL CONDITIONS

1. ALL CONSTRUCTION WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE SOILS AND/OR GEOTECHNICAL REPORTS PREPARED BY MURRAY ENGINEERS AND DATED MAY 2011 AND OCTOBER 2009. THIS REPORT IS SUPPLEMENTED BY: 1) THESE PLANS AND SPECIFICATIONS, 2) THE COUNTY OF SANTA CLARA STANDARD DETAILS. 3) THE COUNTY OF SANTA CLARA STANDARD SPECS, 4) STATE OF CALIFORNIA STANDARD DETAILS, 5) STATE OF CALIFORNIA STANDARD SPECIFICATIONS. IN THE EVENT OF CONFLICT THE FORMER SHALL TAKE PRECEDENCE OVER THE LATTER. THE PERFORMANCE AND COMPLETION OF ALL WORK MUST BE TO THE SATISFACTION OF THE COUNTY.
2. DEVELOPER IS RESPONSIBLE FOR INSTALLATION OF THE IMPROVEMENTS SHOWN ON THESE PLANS AND HE OR HIS SUCCESSOR PROPERTY OWNERS ARE RESPONSIBLE FOR THEIR CONTINUED MAINTENANCE.
3. DEVELOPER SHALL BE RESPONSIBLE FOR CORRECTION OF ANY ERRORS OR OMISSIONS IN THESE PLANS. THE COUNTY SHALL BE AUTHORIZED TO REQUIRE DISCONTINUANCE OF ANY WORK AND SUCH CORRECTION AND MODIFICATION OF PLANS AS MAY BE NECESSARY TO COMPLY WITH COUNTY STANDARDS OR CONDITIONS OF DEVELOPMENT APPROVAL.
4. DEVELOPER SHALL OBTAIN ENCROACHMENT PERMITS FROM THE SANTA CLARA VALLEY WATER DISTRICT AND CALIFORNIA DEPARTMENT OF TRANSPORTATION WHERE NEEDED. COPIES OF THESE PERMITS SHALL BE KEPT AT THE JOB SITE FOR REVIEW BY THE COUNTY'S INSPECTOR.
5. THIS PLAN AUTHORIZES THE REMOVAL OF ONLY THOSE TREES WITH TRUNK DIAMETERS GREATER THAN 12 INCHES MEASURED 4.5 FEET ABOVE THE GROUND THAT ARE SHOWN TO BE REMOVED UNLESS AN AMENDED PLAN IS APPROVED OR A SEPARATE TREE REMOVAL PERMIT IS OBTAINED FROM THE PLANNING OFFICE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ENSURE THAT REMOVAL OF ADDITIONAL TREES HAS BEEN PERMITTED.
6. CONTRACTOR SHALL PROVIDE ADEQUATE DUST CONTROL AS REQUIRED BY THE COUNTY INSPECTOR.
7. ALL PERSONS MUST COMPLY WITH SECTION 4442 OF THE PUBLIC RESOURCES CODE AND SECTION 13005 OF THE HEALTH AND SAFETY CODE RELATING TO THE USE OF SPARK ARRESTERS.
8. UPON DISCOVERING OR UNEARTHING ANY BURIAL SITE AS EVIDENCED BY HUMAN SKELETAL REMAINS OR ARTIFACTS, THE PERSON MAKING SUCH DISCOVERY SHALL IMMEDIATELY NOTIFY THE COUNTY CORONER AT (408) 454-2520 AND LAND DEVELOPMENT ENGINEERING OFFICE AT (408) 299-5730. NO FURTHER DISTURBANCE OF THE SITE MAY BE MADE EXCEPT AS AUTHORIZED BY THE LAND DEVELOPMENT OFFICE IN ACCORD WITH PROVISIONS OF THIS ORDINANCE (COUNTY ORDINANCE CODE SECTION B6-18).
9. THESE PLANS ARE FOR THE WORK DESCRIBED IN THE SCOPE OF WORK ONLY.
10. ANY DEVIATION FROM THESE APPROVED PLANS SHALL BE RE-APPROVED IN WRITING BY THE COUNTY ENGINEER PRIOR TO CONSTRUCTION.

CONSTRUCTION STAKING

1. THE DEVELOPER'S ENGINEER IS RESPONSIBLE FOR THE INITIAL PLACEMENT AND REPLACEMENT OF CONSTRUCTION GRADE STAKES. THE STAKES ARE TO BE ADEQUATELY IDENTIFIED, LOCATED, STABILIZED, ETC. FOR THE CONVENIENCE OF CONTRACTORS. LATERAL OFFSET OF STAKES SET FOR CURBS AND GUTTERS SHALL NOT EXCEED 2 1/2 FEET FROM BACK OF CURB.
2. ANY PROPERTY LINE STAKES OR ROAD MONUMENTS DISTURBED DURING CONSTRUCTION SHALL BE REPLACED BY DEVELOPER'S ENGINEER AND LICENSED LAND SURVEYOR.
3. PROPERTY LINE STAKING MUST BE PERFORMED BY THE PROJECT ENGINEER OR LAND SURVEYOR TO ESTABLISH OR RE-ESTABLISH THE PROJECT BOUNDARY AND SHALL BE INSPECTED BY THE COUNTY INSPECTOR PRIOR TO THE BEGINNING OF THE WORK.
4. PROPER CONSTRUCTION STAKES SHALL BE SET IN THE FIELD BY THE PROJECT ENGINEER OR LAND SURVEYOR AND VERIFIED BY THE COUNTY INSPECTOR PRIOR TO THE COMMENCEMENT OF GRADING.

CONSTRUCTION INSPECTION

1. CONTRACTOR SHALL NOTIFY PERMIT INSPECTION UNIT, SANTA CLARA COUNTY PRIOR TO COMMENCING WORK AND FOR FINAL INSPECTION OF WORK AND SITE.
2. THE COUNTY REQUIRES A MINIMUM OF 24 HOURS ADVANCE NOTICE FOR GENERAL INSPECTION, 48 HOURS FOR ASPHALT CONCRETE INSPECTION.
3. INSPECTION BY SANTA CLARA COUNTY SHALL BE LIMITED TO INSPECTION OF MATERIALS AND PROCESSES OF CONSTRUCTION TO OBSERVE THEIR COMPLIANCE WITH PLANS & SPECIFICATIONS BUT DOES NOT INCLUDE RESPONSIBILITY FOR THE SUPERINTENDENT OF CONSTRUCTION, SITE CONDITIONS, EQUIPMENT OR PERSONNEL. CONTRACTOR SHALL NOTIFY THE COUNTY LAND DEVELOPMENT INSPECTOR AT PHONE (408) 299-6868 AT LEAST 24 HOURS PRIOR TO COMMENCING WORK AND FOR FINAL INSPECTION OF WORK AND SITE.
4. DEVELOPER AND/OR HIS AUTHORIZED REPRESENTATIVE MUST SUBMIT WRITTEN REQUEST FOR FINAL INSPECTION AND ACCEPTANCE. SAID REQUEST SHALL BE DIRECTED TO THE INSPECTION OFFICE NOTED ON THE PERMIT FORM.
5. THE CONTRACTOR SHALL PROVIDE TO THE COUNTY CONSTRUCTION INSPECTOR WITH PAD ELEVATION AND LOCATION CERTIFICATES, PREPARED BY THE PROJECT ENGINEER OR LAND SURVEYOR, PRIOR COMMENCEMENT OF THE BUILDING FOUNDATION.

SITE PREPARATION (CLEARING AND GRUBBING)

1. EXISTING TREES AUTHORIZED FOR REMOVAL, ROOTS, AND FOREIGN MATERIAL IN AREAS TO BE IMPROVED WILL BE REMOVED TO AN AUTHORIZED DISPOSAL SITE AS FOLLOWS:
   A) TO A MINIMUM DEPTH OF TWO FEET BELOW THE FINISHED GRADE OF PROPOSED ROADWAYS (EITHER PRIVATE OR TO BE DEDICATED TO PUBLIC USE)
   B) FROM AREAS AFFECTED BY THE PROPOSED GRADING EXCEPT WHERE NOTED ON THE PLANS.
2. IT SHALL BE THE RESPONSIBILITY OF THE DEVELOPER TO MOVE OR RELOCATE UTILITY POLES AND OTHER OBSTRUCTIONS IN THE WAY OF CONSTRUCTION.

UTILITY LOCATION, TRENCHING & BACKFILL

1. CONTRACTOR SHALL NOTIFY USA (UNDERGROUND SERVICE ALERT) AT 1-800-277-2600 A MINIMUM OF 24 HOURS BEFORE BEGINNING UNDERGROUND WORK FOR VERIFICATION OF THE LOCATION OF UNDERGROUND UTILITIES.
2. ACCURATE VERIFICATION AS TO SIZE, LOCATION, AND DEPTH OF EXISTING UNDERGROUND CONDUITS OR FACILITIES SHALL BE THE INDIVIDUAL CONTRACTORS RESPONSIBILITY. PLAN LOCATIONS ARE APPROXIMATE AND FOR GENERAL INFORMATION ONLY.
3. ALL UNDERGROUND INSTALLATIONS SHALL BE IN PLACE AND THE TRENCH BACKFILLED AND COMPACTED BEFORE PLACING AGGREGATE BASE MATERIAL OR SURFACE STRUCTURES. SURFACING MAY BE DONE IF THE UTILITY COMPANY CONCERNED INDICATES BY LETTER THAT IT WILL BORE. UNLESS SPECIFICALLY AUTHORIZED BY THE COUNTY, GAS AND WATER MAINS SHALL BE INSTALLED OUTSIDE THE PAVED AREAS.
4. TRENCH BACKFILL IN EXISTING PAVEMENT AREAS SHALL BE SAND MATERIAL IN ACCORDANCE WITH THE APPLICABLE PROVISIONS OF THE STATE SPECIFICATIONS. THE STRUCTURAL SECTION FOR TRENCH REPLACEMENT SHALL CONSIST OF NOT LESS THAN 12 INCHES OF APPROVED AGGREGATE BASE MATERIAL COMPACTED TO A RELATIVE COMPACTION OF AT LEAST 95% AND 4 INCHES OF HOT ASPHALT CONCRETE PLACED IN TWO LIFTS. TRENCH RESTORATION FOR HIGHER TYPE PAVEMENTS SHALL BE MADE IN KIND OR AS DIRECTED BY THE COUNTY.
5. TRENCH BACKFILL IN NEW CONSTRUCTION AREAS SHALL BE SAND MATERIAL COMPACTED TO A RELATIVE COMPACTION OF AT LEAST 90%. THE REQUIREMENT FOR SELECT MATERIAL MAY BE WAIVED BY COUNTY IF THE NATIVE SOIL IS SUITABLE FOR USE AS TRENCH BACKFILL BUT THE COMPACTION REQUIREMENTS WILL NOT BE THEREBY WAIVED.
6. BACKFILL AND TRENCH RESTORATION REQUIREMENTS SHALL APPLY AS MINIMUM STANDARDS TO ALL UNDERGROUND FACILITIES INSTALLED BY OTHER FIRMS OR PUBLIC AGENCIES.

GRADING

1. EXCAVATED MATERIAL SHALL BE PLACED IN THE FILL AREAS DESIGNATED OR SHALL BE HAULED AWAY FROM THE SITE. WHERE FILL MATERIAL IS TO BE PLACED ON NATURAL GROUND, IS SHALL BE STRIPPED OF ALL VEGETATION. TO ACHIEVE A PROPER BOND WITH THE FILL MATERIAL, THE SURFACE OF THE GROUND SHALL BE SCARIFIED TO DEPTH OF 6" BEFORE FILL IS PLACED. WHERE NATURAL GROUND IS STEEPER THAN 5:1, IT SHALL BE BENCHED AND THE FILL KEYED IN TO ACHIEVE STABILITY. WHERE NEW FILL IS TO BE PLACED ON EXISTING FILL THE EXISTING FILL SHALL BE REMOVED UNTIL MATERIAL COMPACTED TO 90% RELATIVE COMPACTION IS EXPOSED. THEN THE NEW FILL MATERIAL SHALL BE PLACED AS PER THESE CONSTRUCTION NOTES. FILL MATERIAL SHALL BE PLACED IN UNIFORM LIFTS NOT EXCEEDING 6" IN UNCOMPACTED THICKNESS. BEFORE COMPACTION BEGINS, THE FILL SHALL BE BROUGHT TO A WATER CONTENT THAT WILL PERMIT PROPER COMPACTION BY EITHER 1) AERATING THE FILL IF IT IS TOO WET OR 2) MOISTENING THE FILL WITH WATER IF IT IS TOO DRY. EACH LIFT SHALL BE THOROUGHLY MIXED BEFORE COMPACTION TO ENSURE A UNIFORM DISTRIBUTION OF MOISTURE.

GRADING (CONTINUED)

2. SURPLUS EARTH FILL MATERIAL SHALL BE PLACED IN A SINGLE (8" MAX) THICK LAYER COMPACTED TO WITHSTAND WEATHERING IN THE AREA(S) DELINEATED ON THE PLAN.
3. NO ORGANIC MATERIAL SHALL BE PLACED IN ANY FILL. NO TREES SHALL BE REMOVED OUTSIDE OF CUT, FILL OR ROADWAY AREAS.
4. THE UPPER 6" OF SUBGRADE BELOW DRIVEWAY ACCESS ROAD OR PARKING AREA SHALL BE COMPACTED TO 95% OF MAXIMUM DENSITY.
5. MAXIMUM CUT SLOPE SHALL BE 2 HORIZONTAL TO 1 VERTICAL. MAXIMUM FILL SLOPE SHALL 2 HORIZONTAL TO 1 VERTICAL.

ESTIMATED VOLUME OF CUT	APPROX. 83	CUBIC YARDS
FILL	0	CUBIC YARDS
MAXIMUM DEPTH OF CUT	5.5	FEET
FILL	0	FEET

NOTE: FILL VOLUMES INCLUDE 10% SHRINKAGE.
EXCESS MATERIAL SHALL BE OFF HAULED TO A COUNTY APPROVED DUMP SITE.

6. NOTIFY SOILS ENGINEER TWO (2) DAYS PRIOR TO COMMENCEMENT OF ANY GRADING WORK TO COORDINATE THE WORK IN THE FIELD.
7. ALL MATERIALS FOR FILL SHOULD BE APPROVED BY THE SOILS ENGINEER BEFORE IT IS BROUGHT TO THE SITE.
8. THE UPPER 6" OF THE SUBGRADE SOIL SHALL BE SCARIFIED, MOISTURE CONDITIONED AND COMPACTED TO A MINIMUM RELATIVE COMPACTION OF 95%
9. ALL AGGREGATE BASE MATERIAL SHALL BE COMPACTED TO A MINIMUM 95% RELATIVE COMPACTION.
10. THE GEOTECHNICAL PLAN REVIEW LETTER MUST BE REVIEWED AND APPROVED BY THE COUNTY GEOLOGIST PRIOR TO FINAL APPROVAL BY THE COUNTY ENGINEER FOR BUILDING OCCUPANCY.
11. THE PROJECT GEOTECHNICAL ENGINEER SHALL PERFORM COMPACTION TESTING AND PRESENT THE RESULTS TO THE COUNTY ENGINEERING INSPECTOR PRIOR TO THE CONSTRUCTION OF ANY PAVED AREA.

AIR QUALITY, LANDSCAPING AND EROSION CONTROL

1. WATER ALL ACTIVE CONSTRUCTION AREAS AT LEAST TWICE DAILY.
2. COVER ALL TRUCKS HAULING SOIL, SAND, AND OTHER LOOSE MATERIALS OR REQUIRE ALL TRUCKS TO MAINTAIN AT LEAST TWO FEET OF FREEBOARD.
3. PAVE, APPLY WATER THREE TIMES DAILY, OR APPLY (NON-TOXIC) SOIL STABILIZERS ON ALL UNPAVED ACCESS ROADS, PARKING AREAS AND STAGING AREAS AT CONSTRUCTION SITES.
4. SWEEP DAILY (WITH WATER SWEEPERS) ALL PAVED ACCESS ROADS, PARKING AREAS AND STAGING AREAS AT CONSTRUCTION SITES. THE USE OF DRY POWDER SWEEPING IS PROHIBITED.
5. SWEEP STREETS DAILY (WITH WATER SWEEPERS) IF VISIBLE SOIL MATERIAL IS CARRIED ONTO ADJACENT PUBLIC STREETS. THE USE OF DRY POWDER SWEEPING IS PROHIBITED.
6. ALL CONSTRUCTION VEHICLES, EQUIPMENT AND DELIVERY TRUCKS SHALL HAVE A MAXIMUM IDLING TIME OF 5 MINUTES (AS REQUIRED BY THE CALIFORNIA AIRBORNE TOXIC CONTROL MEASURE TITLE 13, SECTION 2485 OF CALIFORNIA CODE OF REGULATIONS (CCR)). ENGINES SHALL BE SHUT OFF IF CONSTRUCTION REQUIRES LONGER IDLING TIME UNLESS NECESSARY FOR PROPER OPERATION OF THE VEHICLE.
7. ALL VEHICLE SPEEDS ON UNPAVED ROADS SHALL BE LIMITED TO 15 MILES PER HOUR.
8. ALL CONSTRUCTION EQUIPMENT SHALL BE MAINTAINED AND PROPERLY TUNED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS. ALL EQUIPMENT SHALL BE CHECKED BY A CERTIFIED MECHANIC AND DETERMINED TO BE RUNNING IN PROPER CONDITION PRIOR TO OPERATION.
9. POST A SIGN THAT IS AT LEAST 32 SQUARE FEET MINIMUM 2 INCHES LETTER HEIGHT VISIBLE NEAR THE ENTRANCE OF CONSTRUCTION SITE THAT IDENTIFIES THE FOLLOWING REQUIREMENTS. OBTAIN ENCROACHMENT PERMIT FOR SIGN FROM ROADS DEPARTMENT OR OTHER APPLICABLE AGENCY IF REQUIRED.
   A. 15 MILES PER HOUR (MPH) SPEED LIMIT
   B. 5 MINUTES MAXIMUM IDLING TIME OF VEHICLES
   C. TELEPHONE NUMBER TO CONTACT THE BAY AREA AIR QUALITY MANAGEMENT DISTRICT REGARDING DUST COMPLAINTS. NOTE PHONE NUMBER OF THE BAY AREA AIR QUALITY MANAGEMENT DISTRICT AIR POLLUTION COMPLAIN HOTLINE OF 1-800-334-6367.
10. ALL FILL SLOPES SHALL BE COMPACTED AND LEFT IN A SMOOTH AND FIRM CONDITION CAPABLE OF WITHSTANDING WEATHERING.
11. ALL EXPOSED DISTURBED AREAS SHALL BE SEEDED WITH BROME SEED SPREAD AT THE RATE OF 5 LB. PER 1000 SQUARE FEET (OR APPROVED EQUAL). SEEDING AND WATERING SHALL BE MAINTAINED AS REQUIRED TO ENSURE GROWTH.
12. ALL DITCHES SHALL BE LINED PER COUNTY STANDARD SD8.
13. ALL STORM DRAINAGE STRUCTURES SHALL BE INSTALLED WITH EFFECTIVE ENTRANCE & OUTFALL EROSION CONTROLS E.G. SACKED CONCRETE RIP-RAP. ENERGY DISSIPATERS SHALL BE INSTALLED AT ALL DITCH OUTFALLS. WHERE OUTFALLS ARE NOT INTO AN EXISTING CREEK OR WATER COURSE, RUNOFF SHALL BE RELEASED TO SHEET FLOW.
14. THIS PLAN AUTHORIZES THE REMOVAL OF ONLY THOSE TREES WITH TRUNK DIAMETERS GREATER THAN 12 INCHES MEASURED 4.5 FEET ABOVE THE GROUND WHICH ARE SHOWN TO BE REMOVED. ANY OTHER SUCH TREES ARE NOT TO BE REMOVED UNLESS AMENDED PLAN IS APPROVED OR A SEPARATE TREE REMOVAL PERMIT IS OBTAINED FROM THE PLANNING OFFICE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ENSURE THAT THE REMOVAL OF ADDITIONAL TREES HAS BEEN PERMITTED.
15. PRIOR TO GRADING COMPLETION AND RELEASE OF THE BOND, ALL GRADED AREAS SHALL BE RESEEDED IN CONFORMANCE WITH THE COUNTY GRADING ORDINANCE TO MINIMIZE THE VISUAL IMPACTS OF THE GRADE SLOPES AND REDUCE THE POTENTIAL FOR EROSION OF THE SUBJECT SITE.
16. PERMANENT LANDSCAPING SHOWN ON THE ATTACHED LANDSCAPE PLAN MUST BE INSTALLED AND FIELD APPROVED BY THE COUNTY PLANNING OFFICE PRIOR TO FINAL APPROVAL BY THE COUNTY ENGINEER, AND FINAL OCCUPANCY RELEASE BY THE BUILDING INSPECTION OFFICE.
17. THE OWNER SHALL PREPARE AND PRESENT A WINTERIZATION REPORT TO THE COUNTY INSPECTOR FOR REVIEW PRIOR TO OCTOBER 15TH OF EVERY YEAR.

RETAINING WALLS

1. REINFORCED CONCRETE AND CONCRETE MASONRY UNIT RETAINING WALLS SHALL HAVE FOUNDATION AND REINFORCEMENT INSPECTED BY THE COUNTY ENGINEERING INSPECTOR AND ENGINEER OF RECORD PRIOR TO POURING THE FOUNDATION AND FORMING THE WALL.
2. SEGMENTAL BLOCK RETAINING WALLS SHALL HAVE FOUNDATION AND REINFORCEMENT INSPECTED BY THE COUNTY ENGINEERING INSPECTOR.

STORM DRAINAGE

1. DEVELOPER IS RESPONSIBLE FOR ALL NECESSARY DRAINAGE FACILITIES WHETHER SHOWN ON THE PLANS OR NOT AND HE OR HIS SUCCESSOR PROPERTY OWNERS ARE RESPONSIBLE FOR THE ADEQUACY AND CONTINUED MAINTENANCE OF THESE FACILITIES IN A MANNER WHICH WILL PRECLUDE ANY HAZARD TO LIFE, HEALTH, OR DAMAGE TO ADJOINING PROPERTY.
2. DROP INLETS SHALL BE COUNTY STANDARD TYPE 5 UNLESS OTHERWISE NOTED ON THE PLANS. THE DEVELOPER'S ENGINEER SHALL BE RESPONSIBLE FOR THE PROPER LOCATION OF DROP INLETS. WHERE STREET PROFILE GRADE EXCEEDS 6% DROP INLETS SHALL BE SET AT 500 ANGLE CURB LINE TO ACCEPT WATER OR AS SHOWN ON THE PLANS.
3. WHERE CULVERTS ARE INSTALLED THE DEVELOPER SHALL BE RESPONSIBLE FOR GRADING THE OUTLET DITCH TO DRAIN TO AN EXISTING SWALE OR TO AN OPEN AREA FOR SHEET FLOW.
4. UPON INSTALLATION OF DRIVEWAY CONNECTIONS, PROPERTY OWNERS SHALL PROVIDE FOR THE UNINTERRUPTED FLOW OF WATER IN ROADSIDE DITCHES.
5. THE COUNTY ENGINEERING INSPECTOR SHALL INSPECT UNDERGROUND DRAINAGE IMPROVEMENTS PRIOR TO BACKFILL.

PORTLAND CEMENT CONCRETE

1. CONCRETE USED FOR STRUCTURAL PURPOSES SHALL BE CLASS "A" (6 SACK PER CUBIC YARD) AS SPECIFIED IN THE STATE STANDARD SPECIFICATIONS. CONCRETE PLACED MUST DEVELOP A MINIMUM STRENGTH FACTOR OF 2800 PSI IN A SEVEN-DAY PERIOD. THE CONCRETE MIX DESIGN SHALL BE UNDER THE CONTINUAL CONTROL OF THE COUNTY INSPECTOR.

GEOTECHNICAL INSPECTION

ALL EARTHWORK AND SITE DRAINAGE, INCLUDING ROUGH TANK SITE GRADING, SPREAD FOOTING AND DRILLED PIER FOUNDATION EXCAVATIONS, PLACEMENT AND COMPACTION OF ENGINEERED FILL, TRENCH BACKFILL, RETAINING WALL DRAINAGE AND BACKFILL, AND FINAL SURFACE DRAINAGE INSTALLATION SHOULD BE PERFORMED IN ACCORDANCE WITH THE GEOTECHNICAL LETTERS PREPARED BY MURRAY ENGINEERS, INC., DATED OCTOBER 15, 2009 (CROTHERS ROAD) AND MAY 18, 2011 (BON VISTA COURT). MURRAY ENGINEERS, INC. SHOULD BE PROVIDED AT LEAST 48 HOURS ADVANCE NOTIFICATION (650-559-9980) OF ANY EARTHWORK OPERATIONS AND SHOULD BE PRESENT TO OBSERVE AND TEST, AS NECESSARY, THE EARTHWORK AND FOUNDATION INSTALLATION PHASES OF THE PROJECT.

AS-BUILT PLANS STATEMENT

THIS IS A TRUE COPY OF THE AS-BUILT PLANS. THERE (___ WERE) (___ WERE NOT) MINOR FIELD CHANGES - MARKED WITH THE SYMBOL (^). THERE (___ WERE) (___ WERE NOT) PLAN REVISIONS INDICATING SIGNIFICANT CHANGES REVIEWED BY THE COUNTY ENGINEER AND MARKED WITH THE SYMBOL .

DATE _____ SIGNATURE

NOTE: THIS STATEMENT IS TO BE SIGNED BY THE PERSON AUTHORIZED BY THE COUNTY ENGINEER TO PERFORM THE INSPECTION WORK. A REPRODUCIBLE COPY OF THE AS-BUILT PLANS MUST BE FURNISHED TO THE COUNTY ENGINEER AFTER CONSTRUCTION.

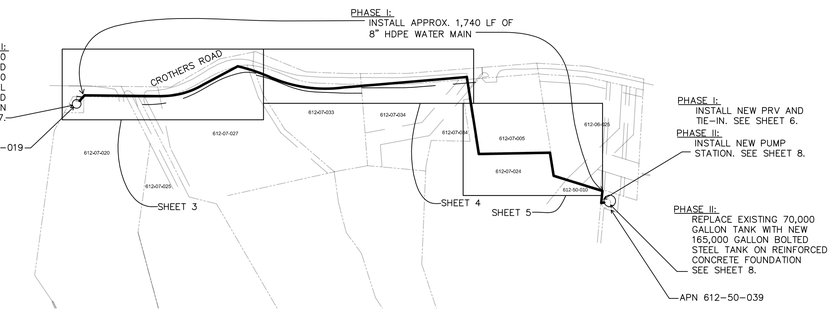
1. A CONSTRUCTION OBSERVATION LETTER FROM THE RESPONSIBLE GEOTECHNICAL ENGINEER DETAILING CONSTRUCTION OBSERVATIONS AND CERTIFYING THAT THE WORK WAS DONE IN ACCORDANCE WITH THE RECOMMENDATIONS IN THE GEOTECHNICAL REPORTS SHALL BE SUBMITTED PRIOR TO THE GRADING COMPLETION AND RELEASE OF THE BOND.

CONSTRUCTION / ENCROACHMENT / GRADING PERMIT

PERMIT(S) NO.:_____

FILE(S) NO.:_____

ISSUED BY:_____ DATE:
LAND DEVELOPMENT ENGINEERING & SURVEYING
DEVELOPMENT SERVICES OFFICE
COUNTY OF SANTA CLARA



PLAN VIEW
SCALE: 1"=200'

LEGEND

- THRUST BLOCK
- FIRE HYDRANT (F.H.)
- GATE VALVE (G.V)
- AIR RELEASE VALVE (A.R.V.)
- BLOW-OFF (B.O)
- STANDARD SERVICE
- PROPERTY LINE
- (E) EXISTING

SCOPE AND ORDER OF WORK

PHASE I:

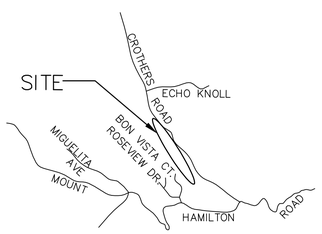
1. REMOVE CROTHERS ROAD TANK SITE FENCING.
2. INSTALL AND DISINFECT TEMPORARY STORAGE ADJACENT TO CROTHERS ROAD TANK SITE.
3. CONNECT TEMPORARY TANKS TO EXISTING PIPING.
4. MOVE PUMP FROM EXISTING TANK INTO TEMPORARY AND RECONNECT.
5. REMOVE EXISTING CROTHERS TANK, FOUNDATION, AND TWO TREES.
6. GRADE PAD FOR NEW TANK AND CONSTRUCT RETAINING WALL.
7. CONSTRUCT NEW REINFORCECED CONCRETE PIER AND RINGWALL TANK FOUNDATION.
8. INSTALL NEW BOLTED STEEL TANK AND CONNECTING PIPING.
9. COMPACT BASE ROCK SURFACING AROUND TANK
10. INSTALL NEW SITE FENCING.
11. CLEARING AND MINOR GRADING OF PIPELINE ROUTE.
12. INSTALL NEW WATER MAIN. KEEP EXISTING MAIN IN SERVICE.
13. INSTALL PRV ON GRADE AT BON VISTA SITE AND TIE-IN TO EXISTING PIPING.
14. INSTALL TEMPORARY BYPASS PIPELINE AT BON VISTA FOR USE OF OLD PUMP DURING CONSTRUCTION OF PHASE II.
15. DISINFECTION AND LEAKAGE TESTING OF NEW CROTHERS TANK AND PIPELINE.
16. UPON PASSING BAC-T SAMPLING, PUT NEW TANK, PIPELINE, AND PRV INTO SERVICE.
17. REINSTALL BOOSTER PUMP IN CROTHERS TANK AND RECONNECT ELECTRICAL AND CONTROLS.
17. IF THE ADDITIONAL STORAGE IS NOT REQUIRED BY THE FIRE MARSHAL FOR PHASE II, REMOVE TEMPORARY STORAGE AND RESTORE SITE TO PREEXISTING CONDITION.
18. SEED DISTURBED AREAS PER COUNTY REQUIREMENTS.

PHASE II:

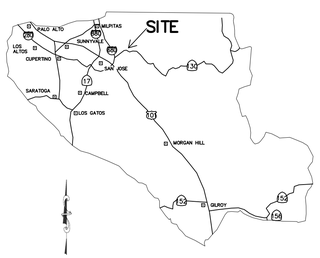
1. REMOVE EXISTING BON VISTA TANK, FOUNDATION, AND FENCING.
2. MINOR GRADING OF SITE; REMOVE TWO TREES.
3. INSTALL UNDER-TANK PIPING.
4. INSTALL DRAIN PIPE AND CONDUIT FOR PUMP STATION ELECTRICAL
5. CONSTRUCT REINFORCED CONCRETE FOUNDATION
6. INSTALL NEW BOLTED STEEL TANK.
7. INSTALL TANK INLET, OUTLET AND DRAIN/OVERFLOW CONNECTING PIPING
8. DISINFECTION AND LEAKAGE TESTING OF NEW TANK.
9. UPON PASSING BAC-T TESTS, PUT TANK INTO SERVICE AND CLOSE VALVE AT PRV.
10. CONSTRUCT NEW PUMP STATION AND REMOVE TEMPORARY BYPASS PIPING TO PROPERTY LINE. CAP ENDS OF 2-EA. 2" PIPES AT PROPERTY LINE AND DOWNSTREAM OF 2 (E) METERS. ABANDON IN PLACE. ALSO CUT AND CAP (E) 2" PIPES AT CROTHERS TANK AND AT TIE-ACROSS AND ABANDON IN PLACE.
11. COMPACT NEW BASE ROCK SURFACING
12. INSTALL SITE FENCING.
13. RESTORE DISTURBED AREAS TO ORIGINAL CONDITION.
14. SEED DISTURBED AREAS PER COUNTY REQUIREMENTS.

INTENT OF PROJECT:

1. REPLACE TWO EXISTING AGING, LEAKING, NON-SEISMIC REDWOOD WATER STORAGE TANKS WITH SEISMICALLY DESIGNED STEEL WATER STORAGE TANKS MEETING CURRENT AWWA STANDARDS AND CALIFORNIA PUBLIC HEALTH DEPARTMENT REQUIREMENTS.
2. INCREASE STORAGE CAPACITY TO PROVIDE ADDITIONAL FIRE SUPPRESSION WATER TO THE EXISTING RESIDENCES IN THE ROSEVIEW HEIGHTS DEVELOPMENT, AND TO PROVIDE FIRE SUPPRESSION WATER TO A PORTION OF THE EXISTING RESIDENCES ON CROTHERS ROAD WHERE THERE IS CURRENTLY NONE.
3. IMPROVE FLOW CAPACITY AND RELIABILITY OF EXISTING DISTRIBUTION PIPING ALONG CROTHERS ROAD TO ALLOW INSTALLATION OF ONE FIRE HYDRANT ON CROTHERS ROAD, AND TO IMPROVE REDUNDANCY IN THE WATER SYSTEM: TO ALLOW ADEQUATE FIRE SUPPRESSION AND DOMESTIC WATER TO FLOW TO THE ROSEVIEW HEIGHTS DEVELOPMENT FROM THE UPPER PRESSURE ZONE (CROTHERS TANK) THROUGH A PRV WHEN THE BON VISTA TANK NEEDS TO BE REMOVED FROM SERVICE FOR REPLACEMENT, CLEANING, OR MAINTENANCE.



VICINITY MAP
NTS



COUNTY LOCATION MAP

ISSUED FOR REVIEW/PERMITTING
NOT FOR CONSTRUCTION

COUNTY OF SANTA CLARA DEPT. OF ROADS AND AIRPORTS
ISSUED BY: _____ DATE: _____
ENCROACHMENT PERMIT NO. _____

COUNTY OF SANTA CLARA
LAND DEVELOPMENT ENGINEERING & SURVEYING
CONSTRUCTION PERMIT NO. _____
GRADING PERMIT NO. _____
ISSUED BY: _____ DATE: _____

ENGINEER'S STATEMENT

I HEARBY STATE THAT THESE PLANS ARE IN COMPLIANCE WITH ADOPTED COUNTY STANDARDS, THE APPROVED TENTATIVE MAP (OR PLAN) AND CONDITIONS OF APPROVAL PERTAINING THERETO DATED FILE(S) NO.

DATE _____ SIGNATURE _____ R.C.E. NO. _____ EXPIRATION DATE _____

COUNTY ENGINEER'S NOTE

ISSUANCE OF A PERMIT AUTHORIZING CONSTRUCTION DOES NOT RELEASE THE DEVELOPER, PERMITTEE OF ENGINEER FROM RESPONSIBILITY FOR THE CORRECTION OF ERRORS OR OMISSIONS CONTAINED IN THE PLANS. IF, DURING THE COURSE OF CONSTRUCTION, THE PUBLIC INTEREST REQUIRES A MODIFICATION OF (OR DEPARTURE FROM) THE SPECIFICATIONS OF THE PLANS, THE COUNTY SHALL HAVE THE AUTHORITY TO REQUIRE THE SUSPENSION OF WORK, AND THE NECESSARY MODIFICATION OR DEPARTURE AND TO SPECIFY THE MANNER IN WHICH THE SAME IS TO BE MADE.

DATE _____ _____
R.C.E. NO. EXPIRATION DATE

SHEET INDEX

1	SANTA CLARA COUNTY STANDARD COVER SHEET
2	SPECIFICATIONS
3	PHASE I: PIPELINE PLAN AND PROFILE
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5	PHASE I: PIPELINE PLAN AND PROFILE
6	PHASE I: BON VISTA PRV AND TIE-IN
7	PHASE I: CROTHERS TANK
8	PHASE II: BON VISTA TANK, SITE PIPING, AND PUMP STATION
9	DETAILS

Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. J ◦ SAN JOSE ◦ CALIFORNIA 95129 ◦ (408) 257-9252

Revision 1	Date	APN	Sheet 1 of 9
Revision 2	Date	Co. File	
Revision 3	Date		

PLAN #____
SHEET ____ OF ____

REVISED 3-7-2011

APPLICANT: ROAD: COUNTY FILE NO.:

GENERAL CONSTRUCTION SPECIFICATIONS

1. ALL MATERIALS & WORK SHALL CONFORM TO THESE APPROVED PROJECT PLANS, LOCAL CITY OR COUNTY JURISDICTIONAL REQUIREMENTS, AND THE CURRENT STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS AND DETAILS. IN CASE OF CONFLICT, THE ORDER OF PRIORITY SHALL COINCIDE WITH THE ORDER AS LISTED ABOVE.

2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF THE LOCATION AND THE PROTECTION OF ALL EXISTING UTILITIES AND UNDERGROUND STRUCTURES IN THE FIELD. LOCATIONS SHOWN ON THE PLANS ARE APPROXIMATE AND FOR GENERAL INFORMATION PURPOSES ONLY.

3. THE CONTRACTOR SHALL NOTIFY ALL UTILITIES A MINIMUM OF 48 HOURS PRIOR TO EXCAVATION NEAR THEIR FACILITIES BY CALLING UNDERGROUND SERVICE ALERT AT 800-642-2444 TOLL FREE.

4. DUST CONTROL AND PROTECTION OF VEGETATION SHALL BE PROVIDED BY THE CONTRACTOR AS REQUIRED BY THE DISTRICT, CITY, COUNTY, OR ENGINEER.

5. THE CONTRACTOR SHALL REMEDY ANY DEFECTS IN THE WORK AND PAY FOR ANY DAMAGE TO OTHER WORK RESULTING THEREFROM WHICH SHALL APPEAR WITHIN A PERIOD OF ONE (1) YEAR FROM THE DATE OF FINAL ACCEPTANCE OF THE WORK.

6. CONTRACTOR SHALL CLEANUP AND RESTORE THE SITE AFTER CONSTRUCTION. CONTRACTOR SHALL LEAVE SITE IN A CONDITION EQUAL TO OR BETTER THAN THAT WHICH WAS ORIGINALLY FOUND.

7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL PERMITS AS REQUIRED.

8. CONTRACTOR SHALL BE SOLELY AND COMPLETELY RESPONSIBLE FOR WORKING CONDITIONS AT THE JOB SITE, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY DURING PERFORMANCE OF THE WORK. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY, AND SHALL NOT BE LIMITED TO WORK HOURS. ALL WORK DONE AND MATERIALS AND EQUIPMENT TRANSPORTED, HANDLED, STORED, OR INSTALLED SHALL BE DONE IN CONFORMANCE WITH THE APPLICABLE ORDERS, RULES, AND REGULATIONS OF THE STATE OF CALIFORNIA, DIVISION OF INDUSTRIAL SAFETY, OSHA, AND WITH ALL OTHER STATE, COUNTY OR GOVERNING OR UTILITY AGENCY REQUIREMENTS.

9. CONTRACTOR SHALL PROVIDE SUBMITTALS ON ALL FURNISHED MATERIALS. NO PORTION OF THE WORK SHALL BE PERFORMED UNTIL THE RESPECTIVE SUBMITTAL HAS BEEN STAMPED "APPROVED" BY THE ENGINEER. ALLOW 10 WORKING DAYS MINIMUM FOR INITIAL REVIEW. BY SUBMITTING, THE CONTRACTOR REPRESENTS THAT THE CONTRACTOR HAS DETERMINED AND VERIFIED MATERIALS, FIELD MEASUREMENTS, AND FIELD CONSTRUCTION CRITERIA RELATED THERETO. SUBMIT THE NUMBER OF COPIES THE CONTRACTOR REQUIRES TO BE RETURNED PLUS THREE. THREE COPIES WILL BE RETAINED BY THE ENGINEER. MARK EACH COPY TO CLEARLY SHOW APPLICABLE CHOICES AND OPTIONS.

10. THE CONTRACTOR SHALL MARK UP ONE SET OF REPRODUCIBLE PRINTS OF THE PLANS TO SHOW THE AS-BUILT CONDITIONS. THIS MARKED SET OF PRINTS SHALL INCLUDE ALL THE INFORMATION SHOWN ON THE CONTRACT SET OF PLANS AND A RECORD OF ALL DEVIATIONS, MODIFICATIONS, OR CHANGES FROM THOSE PLANS, HOWEVER MINOR, WHICH WERE INCORPORATED INTO THE WORK, AND ALL ADDITIONAL WORK NOT PREVIOUSLY SHOWN ON THE PLANS.

11. CONTRACTOR SHALL MAINTAIN THIRD PARTY LIABILITY AND PROPERTY DAMAGE INSURANCE IN THE AMOUNT OF $1,000,000 PER OCCURRENCE, $2,000,000 AGGREGATE, AND THE MWC AND BINKLEY ASSOCIATES SHALL BE NAMED AS ADDITIONAL INSUREDS. THE CONTRACTOR SHALL ALSO MAINTAIN WORKER'S COMPENSATION INSURANCE WITH A LIMIT NOT LESS THAN $1,000,000. CERTIFICATES SHALL BE SUBMITTED TO RHMWC FOR APPROVAL PRIOR TO THE START OF CONSTRUCTION.

12. RHMWC MUST PROVIDE CONTINUITY OF SUPPLY OF DOMESTIC AND FIRE PROTECTION WATER TO ALL PORTIONS OF ITS SERVICE AREA DURING CONSTRUCTION. THE CONTRACTOR WILL CONTACT THE RHMWC PRIOR TO OPERATING ANY VALVES OR CONTROL EQUIPMENT. THE CONTRACTOR WILL ALSO CONTACT THE RHMWC PRIOR TO CONNECTING, DISCONNECTING OR MODIFYING ANY RHMWC FACILITIES. RHMWC WILL COOPERATE WITH THE CONTRACTOR TO THE MAXIMUM EXTENT POSSIBLE WITH THE UNDERSTANDING WATER SERVICE CONTINUITY DURING CONSTRUCTION IS A REQUIREMENT OF THE PROJECT. CONTRACTOR SHALL PROVIDE MINIMUM 24 HOUR ADVANCE NOTIFICATION TO RHMWC BEFORE STARTING ANY PORTION OF THE WORK.

13. CONTRACTOR WILL ARRANGE A STAGING AREA WITH RHMWC PRIOR TO THE START OF CONSTRUCTION. CONTRACTOR WILL CLEAN UP STAGING AREA AFTER COMPLETION AND ACCEPTANCE OF CONSTRUCTION. CONTRACTOR SHALL LEAVE THE STAGING AREA IN A CONDITION EQUAL TO OR BETTER THAN IT WAS ORIGINALLY.

14. RHMWC WILL NEGOTIATE WITH ADJACENT PROPERTY OWNER FOR ACCESS TO THE BON VISTA TANK SITE FOR CONSTRUCTION PURPOSES. CONTRACTOR WILL BE NOTIFIED OF THE DETAILS OF THE TEMPORARY ACCESS. CONTRACTOR SHALL LEAVE THE ACCESS ROUTE IN A CONDITION EQUAL TO OR BETTER THAN THE ORIGINAL CONDITION, INCLUDING SEEDING NATIVE DROUGHT TOLERANT GRASSES AND PLANTING SHRUBS AS REQUIRED.

PIPE INSTALLATION, DISINFECTION AND TESTING

1. ALL PIPING SHALL BE INSTALLED AND JOINED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

2. ALL TEES, ELBOWS AND DEAD ENDS SHALL BE BLOCKED WITH CONCRETE AGAINST UNDISTURBED SOIL PER THE STANDARD THRUST BLOCK DETAILS. GATE VALVES, REDUCERS, VERTICAL BENDS AND SPECIAL FITTINGS SHALL BE BLOCKED AS SHOWN ON THESE PLANS.

3. PRESSURE AND LEAKAGE TESTS SHALL BE PERFORMED ON ALL PIPING. PRESSURE AND LEAKAGE TESTING OF POLYVINYL CHLORIDE MAINS SHALL BE PERFORMED IN ACCORDANCE WITH AWWA STANDARD C-605, AND DUCTILE IRON MAINS IN ACCORDANCE WITH AWWA STANDARD C-600. ALLOWABLE LEAKAGE SHALL BE THE MINIMUM SPECIFIED IN THE LATEST AWWA STANDARDS. NO LEAKAGE IS ALLOWED FOR HDPE PIPE. PRESSURE AND LEAKAGE TESTING SHALL BE OBSERVED BY THE ENGINEER. CONTRACTOR SHALL PROVIDE MINIMUM TWO WORKING DAYS ADVANCE NOTICE. CONCRETE THRUST BLOCKS SHALL CURE FOR 7 DAYS BEFORE PRESSURIZATION OF MAINS. ALL FITTINGS AND SERVICE SADDLES ON HDPE PIPE SHALL BE LEFT EXPOSED FOR VISUAL INSPECTION DURING PRESSURE AND LEAKAGE TESTING.

4. FLUSHING OF THE MAINS AND LATERALS SHALL BE PERFORMED AS DIRECTED BY THE ENGINEER.

5. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONSTRUCT A WATER PIPING SYSTEM CAPABLE OF PASSING PRESSURE, LEAKAGE AND DISINFECTION TESTS. IT IS ALSO THE CONTRACTOR'S RESPONSIBILITY TO PREVENT THE CONSUMPTION OF WATER FOR ANY AND ALL USES FROM UNSTERILE PIPING EITHER BY THEIR WORKMEN, SUB-CONTRACTORS, OR OTHER PERSON.

6. THE END OF THE WATER MAIN SHALL BE PLUGGED NIGHTLY WITH A WATER TIGHT PLUG. GROUND WATER SHALL NOT BE ALLOWED TO ENTER THE PIPE AT ANY TIME.

7. ALL PIPELINE MATERIALS SHALL BE FREE OF FOREIGN MATERIAL WHEN INSTALLED AND SHALL REMAIN CLEAN DURING INSTALLATION. ALL FOREIGN MATERIAL SHALL BE REMOVED OR SWABBED FROM THE INTERIOR OF THE PIPE AS NECESSARY.

8. ALL FITTINGS SHALL BE MECHANICAL JOINT DUCTILE IRON CASTINGS CONFORMING TO THE APPLICABLE REQUIREMENTS OF AWWA STANDARD C153 FOR THREE HUNDRED FIFTY (350) PSI WORKING PRESSURE, UNLESS OTHERWISE SHOWN ON THESE PLANS. MANUFACTURER'S CERTIFICATES SHOWING CONFORMANCE WITH THIS SPECIFICATION SHALL BE DELIVERED TO THE ENGINEER WITH EACH SHIPMENT OF MATERIALS DELIVERED TO THE JOB SITE. BOLTS AND NUTS FOR FLANGED JOINTS SHALL BE STAINLESS STEEL. BELOW GRADE FLANGED JOINTS SHALL BE PAINTED WITH COAL TAR.

9. BURIED PIPE SHALL HAVE A MINIMUM 4" SAND BEDDING, AND 6" MIN. SAND COVER, UNLESS OTHERWISE INDICATED ON THESE PLANS.

10. PIPE DISINFECTION SHALL CONFORM TO THE REQUIREMENTS OF AWWA STANDARD C651 AND TANK DISINFECTION SHALL CONFORM TO THE REQUIREMENTS OF AWWA STANDARD C652 AND NSF/ANSI 60.

11. BACTERIOLOGICAL TESTING SHALL BE PERFORMED AFTER DISINFECTION AND FLUSHING OF THE TANK AND THE MAINS, AND BEFORE PLACING THE SYSTEM IN SERVICE. CONTRACTOR SHALL TAKE 2 SAMPLES, 24 HOURS APART, FROM EACH SAMPLING POINT AS DIRECTED BY THE ENGINEER. THE CONTRACTOR'S STATE CERTIFIED LABORATORY SHALL NOTIFY THE CONTRACTOR AND THE ENGINEER OF THE RESULTS OF THE BACTERIOLOGICAL TESTS.

12. THE CONTRACTOR SHALL VERIFY LOCATIONS OF SEWERS, LEACH FIELDS, CESSPOOLS, SEPTIC TANKS, SEEPAGE PITS, AND OTHER SANITARY HAZARDS PRIOR TO INSTALLING PIPE. WATER PIPE SHALL BE INSTALLED A MINIMUM OF 10-FEET HORIZONTALLY AND 1-FOOT VERTICALLY ABOVE PARALLEL SEWER LINES. WATER PIPE SHALL CROSS SEWER LINES AT A MINIMUM OF 1-FOOT ABOVE THE SEWER LINES. WATER PIPE SHALL BE INSTALLED A MINIMUM OF 25-FEET FROM LEACH FIELDS, SEPTIC TANKS, SEEPAGE PITS, OR CESSPOOLS UNLESS OTHERWISE SHOWN ON THESE PLANS.

13. ALL FLANGED, WELDED, GROOVED, AND SCREWED PIPING SHALL BE STEEL. ALL STEEL PIPE 6-INCHES IN DIAMETER OR LESS SHALL BE SCHEDULE 40. STEEL PIPE 8-INCHES IN DIAMETER SHALL BE SCHEDULE 30. STEEL PIPING LESS THAN 2.5-INCHES IN DIAMETER SHALL BE GALVANIZED. STEEL PIPING GREATER THAN 2-INCHES IN DIAMETER SHALL BE FLUIDIZED BED FUSION BONDED POTABLE WATER SERVICE EPOXY LINED AND COATED PER NFPA 24 AND AWWA STANDARD C-213 AFTER WELDING UNLESS OTHERWISE NOTED ON THE PLANS. ALL BELOW-GRADE STEEL PIPING SHALL BE WRAPPED WITH "PROTECT-O-WRAP 200" PIPE TAPE OR APPROVED EQUAL, WITH 1/2-INCH MINIMUM LAP, SPIRAL LAP, PER THE MANUFACTURER'S RECOMMENDATIONS. ALL FLANGES SHALL BE RATED 150#, UNLESS OTHERWISE NOTED. BOLTS AND NUTS SECURING FLANGED JOINTS IN CONTACT WITH THE EARTH SHALL BE STAINLESS STEEL. FLANGED JOINTS IN CONTACT WITH THE EARTH SHALL BE PAINTED WITH COAL TAR. ALL BOLTS AND NUTS IN CONTACT WITH THE EARTH SHALL BE STAINLESS STEEL.

14. POLYVINYL CHLORIDE (PVC) PRESSURE PIPE SHALL BE VIRGIN PVC ASTM D 1784, CELL CLASS 12454B. ALL PVC PIPE SHALL CONFORM TO THE REQUIREMENTS OF AWWA STANDARD C900 CLASS 150 WITH ELASTOMERIC SEAL, ASTM F-477. MAXIMUM LENGTH OF EACH SECTION OF PIPE BETWEEN ELASTOMERIC RINGS SHALL BE TWENTY (20) FEET. MANUFACTURER'S CERTIFICATES SHOWING CONFORMANCE WITH THESE SPECIFICATIONS SHALL BE DELIVERED TO THE ENGINEER WITH EACH SHIPMENT OF MATERIALS DELIVERED TO THE JOB SITE.

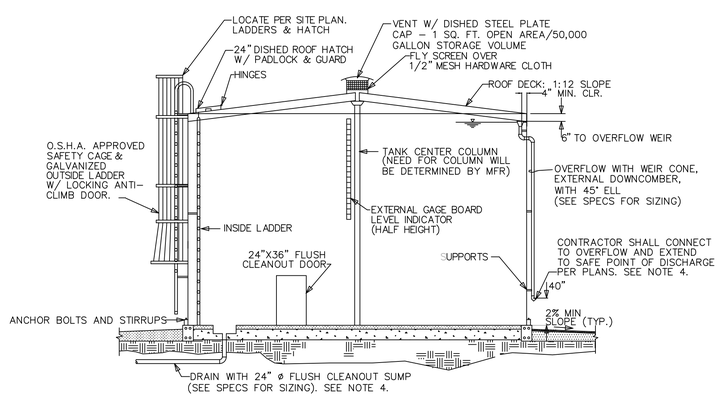
15. HIGH DENSITY POLYETHYLENE (HDPE OR PE) PIPE SHALL HAVE A CELL CLASSIFICATION OF ASTM D-3350 AND SHALL HAVE A STANDARD DIMENSIONAL RATIO (SDR) AS NOTED ON THE PLANS. THE PIPE SHALL BE BLACK, HIGH DENSITY, EXTRA HIGH MOLECULAR WEIGHT POLYETHYLENE PRESSURE PIPE, DRISCOPIPE 1000 OR APPROVED EQUAL. THE PIPE SHALL BE HEAT FUSION JOINED IN THE FIELD BY THE MANUFACTURER. HDPE PIPE SHALL CONFORM TO THE REQUIREMENTS OF AWWA STANDARD C906.

16. DUCTILE IRON (DI) PIPE SHALL BE PRESSURE CLASS 200, WITH CEMENT MORTAR LINED INTERIOR, COAL TAR COATED EXTERIOR, RUBBER GASKET JOINTS AND SHALL BE RESTRAINED AS SHOWN ON THE PLANS. DI PIPE SHALL CONFORM TO THE FOLLOWING AWWA STANDARDS: C104, C110, C111, C150, AND C151.

17. IT IS THE CONTRACTORS' RESPONSIBILITY TO PREVENT CONSUMPTION OF WATER FROM THE PIPES OR TANKS FOR ANY REASON, WHETHER BY HIS WORKERS, SUB-CONTRACTORS, OR OTHER PEOPLE.

18. ALL ELECTRICAL WORK SHALL COMPLY WITH NEC AND LOCAL CODES.

19. ALL MATERIALS WHICH MAY COME IN CONTRACT WITH THE STORED OR TRANSMITTED POTABLE WATER MUST MEET THE REQUIREMENTS OF NSF/ANSI 61.



NOTES: 1. LOCATE ALL APPURTENANCES PER APPURTENANCE AND SITE PLANS. LOCATIONS SHOWN ON THIS DETAIL ARE SCHEMATIC ONLY.
2. SIZE AND QUANTITY OF ANCHOR BOLTS AND BOLT LAYOUT BY TANK MANUFACTURER. BOLTS SUPPLIED BY TANK MFR. STIRRUPS BY TANK MFR.
3. SEE TANK SPECIFICATIONS, SITE PLANS, AND DETAILS FOR SPECIFIC SIZING OF TANK AND TANK NOZZLES.
4. FOR CONTINUATION OF TANK OVERFLOW AND DRAIN, AND FOR DISCHARGE DETAIL, SEE EACH TANK SITE PLAN (SHEETS 7 AND 8), THE TANK DRAIN AND OVERFLOW DETAIL ON SHEET 9, AND THE BON VISTA DRAIN OUTFALL DETAIL ON SHT 9.

TANK APPURTENANCE SCHEMATIC SECTION

N.T.S.

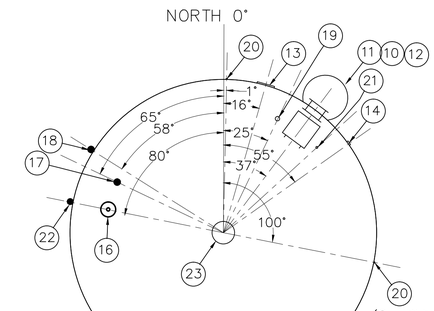
TANK STRUCTURE SPECIFICATIONS

Bon Vista Tank: Furnished and installed by Superior Tank Company or approved equal. 165,000 gallon (nominal) bolted steel tank for potable water storage as follows:
1. Tank design shall comply with the current issue of **AWWA Standard D103**, Seismic Zone 4, 100 MPH Wind Load, Normal Product and Deck Loading. No Snow Load. Location: San Jose, CA.
2. Tank dimensions shall be: Diameter=34'-2", Height=24'-1.5"
3. Tank shall have foundation Anchor Bolts
4. Tank minimum Floor Steel Thickness: 10 gage
5. Tank minimum Roof Steel Thickness: 12 gage
6. Tank minimum Bottom Ring Steel Thickness: ¼"
7. Tank minimum Upper Ring Steel Thicknesses: 10 Gage
8. Exterior Epoxy Primer with Baked on Enamel (Color TBD), 3 mil **Minimum** DFT is required
9. Interior shall be Potable Water Service Epoxy, two coats, over near white metal sandblast, **Minimum** DFT 5mil, 15 year coating warranty and shall meet the requirements of **NSF/ANSI 61.**
10. Interior Ladder, Potable Water Service Epoxy Coated
11. Galv. Exterior Ladder with OSHA Cage and Locking Anti-Climb Door
12. Locking Top Hatch, 24"x24"
13. Shell Cleanout Flush, 24"x36"
14. Half Travel Liquid Level Indicator
15. Polycap Bolts (and nuts on tank floor)
16. One 4" Flanged Floor Nozzle (DRAIN) with 24" Ø Cleanout Sump
17. One 8" Flanged Shell Nozzle (OUTLET)
18. One 4" Flanged Shell Nozzle (INLET)
19. One double sided 6" Flanged Roof Nozzle (flange parallel with floor) (Alternative future booster pump port - to be blined flanged by contractor and not used at this time)
20. Two 1" NPT Shell Nozzles (Contractor shall install CDPH approved threadless downturned sample tap on one, and cap the other if not used for controls or telemetry)
21. One 2" NPT Roof Nozzle (Optional control port, to be capped by contractor if not used)
22. One Epoxy Coated Overflow with Weir Cone designed for minimum 600 GPM, 4" Diameter Downcomber with 45° Ell.
23. Min. 20" Ø Roof Vent With Insect Screen Over 1/2" Hardware Cloth
24. All Nozzle Flanges Rated 150 psi
25. All Nozzles Epoxy Lined and Coated
26. One Year Tank Warranty Against Leakage and Defects
27. Detailed Shop Drawing Submittals and Calculations, Signed and Stamped by Professional Engineer Registered in State of California
28. Prevailing wages not required
29. Vacuum Testing of Floor. Tank shall be demonstrated to be leakage free to the satisfaction of the Engineer prior to acceptance.

Crothers Tank: Furnished and installed by Superior Tank Company or approved equal. 50,000 (nominal) gallon bolted steel tank for potable water storage as follows:
1. Tank Design Shall Comply with the current issue of **AWWA Standard D103**, Seismic Zone 4, 100 MPH Wind Load, Normal Product and Deck Loading. No Snow Load. Location: San Jose, CA
2. Tank Dimensions: Diameter=23'-2", Height=16'-1"
3. Foundation Anchor Bolts
4. Minimum Floor Steel Thickness: 10 gage
5. Minimum Roof Steel Thickness: 12 gage
6. Minimum Bottom Ring Steel Thickness: ¼"
7. Minimum Upper Ring Steel Thicknesses: 10 Gage
8. Exterior Epoxy Primer with Baked on Enamel (Color TBD), 3 mil **Minimum** DFT
9. Interior Potable Water Service Epoxy, two coats, over near white metal sandblast, **Minimum** DFT 5mil, 15 year coating Warranty, and shall meet the requirements of **NSF/ANSI 61**.
10. Interior Ladder, Potable Water Service Epoxy Coated
11. Galv. Exterior Ladder with OSHA Cage and Locking Anti-Climb Door
12. Locking Top Hatch, 24"x24"
13. Shell Cleanout Flush, 24"x36"
14. Half Travel Liquid Level Indicator
15. Polycap Bolts (and nuts on tank floor)
16. One 4" Flanged Floor Nozzle with 24" Ø Cleanout Sump (DRAIN)
17. One 8" Flanged Shell Nozzle (OUTLET)
18. One 4" Flanged Shell Nozzle (INLET)
19. Two 1" NPT Shell Nozzles (Contractor shall install CDPH approved threadless downturned sample tap on one, and cap the other if not used for controls/telemetry)
20. One doubled sided 6" Flanged Roof Nozzle (Flange Parallel with Floor) (Contractor shall reinstall existing pump in this nozzle and ensure seal)
21. One 2" NPT Roof Nozzle (Optional control/telemetry port: Contractor shall install cap if not used for controls)
22. One Epoxy Coated Overflow with Weir Cone, 4" Diameter Downcomber with 45° ell
23. Min. 20"Ø Roof Vent With Insect Screen Over 1/2" Hardware Cloth
24. All Nozzle Flanges Rated 150 psi
25. All Nozzles Epoxy Lined and Coated
26. One Year Tank Warranty Against Leakage and Defects
27. Detailed Shop Drawing Submittals and Calculations, Signed and Stamped by Professional Engineer Registered in State of California
28. Prevailing wages not required
29. Vacuum Testing of Floor. Tank shall be demonstrated to be leakage free to the satisfaction of the Engineer prior to acceptance.

TANK NOTES:
1. TANK APPURTENANCE PLANS SHOWING EXACT LOCATIONS OF ALL SPECIFIED APPURTENANCES WILL BE CONFIRMED IN FIELD BY CONTRACTOR TOGETHER WITH ENGINEER AND OWNER PRIOR TO ORDERING TANK. ANY CHANGES TO PLAN SHALL BE APPROVED BY ENGINEER PRIOR TO ORDERING TANK.
2. SHOULD THE CONTRACTOR SUBMIT A TANK THAT VARIES AT ALL IN HEIGHT, DIAMETER, VOLUME, MATERIALS, OR ANY OTHER WAY, BINKLEY ASSOCIATES SHALL BE NOTIFIED IMMEDIATELY TO CHECK FOUNDATION CALCULATIONS AND DESIGN. IN ADDITION, SUCH TANK MUST BE APPROVED BY BINKLEY ASSOCIATES AND THE PERMITTING AGENCIES INCLUDING THE COUNTY AND THE STATE DEPARTMENT OF PUBLIC HEALTH.
3. TANK STRUCTURE DRAWINGS PREPARED BY THE MANUFACTURER, INCLUDING DETAILS OF ALL APPURTENANCES, SIGNED AND STAMPED BY A LICENSED CIVIL ENGINEER IN THE STATE OF CALIFORNIA, SHALL BE SUBMITTED BY THE CONTRACTOR TO ROSEVIEW HEIGHTS MUTUAL WATER COMPANY, BINKLEY ASSOCIATES, CALIFORNIA DEPARTMENT OF PUBLIC HEALTH, AND SANTA CLARA COUNTY FOR APPROVAL PRIOR TO ORDERING OF TANK.

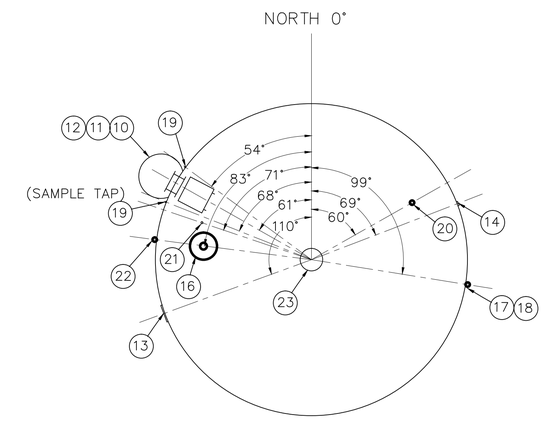
CONTROL NOTES:
1. CONTRACTOR SHALL CAREFULLY REMOVE CONTROLS FROM OLD TANKS PRIOR TO DEMOLITION, AND INSTALL EXISTING CONTROLS ON NEW TANKS. FUNCTIONALITY WILL BE TESTED PRIOR TO ACCEPTANCE. FLOAT SWITCHES SHALL BE SET TO CALL FOR WATER WHEN WATER LEVEL DROPS 2' BELOW OVERFLOW WEIR, AND SHUT OFF WHEN WATER LEVEL REACHES 2" BELOW OVERFLOW WEIR.



NOTES:
1. ITEM NUMBERS REFER TO "TANK SPECIFICATIONS" LIST FOR BON VISTA TANK ON THIS SHEET.
2 FOR SHELL NOZZLE HEIGHTS, SEE INLET AND OUTLET DETAILS. FOR OVERFLOW WEIR HEIGHT, SEE SCHMATIC SECTION THIS SHEET.
3. ALL APPURTENANCE AND NOZZLE LOCATIONS SHALL BE CONFIRMED IN THE FIELD PRIOR TO ORDERING TANK.

BON VISTA TANK
TANK APPURTENANCE LOCATIONS

N.T.S.



NOTES:
1. ITEM NUMBERS REFER TO "TANK SPECIFICATIONS" LIST FOR CROTHERS TANK ON THIS SHEET.
2 FOR SHELL NOZZLE HEIGHTS, SEE INLET AND OUTLET DETAILS. FOR OVERFLOW WEIR HEIGHT, SEE SCHMATIC SECTION THIS SHEET.
3. ALL APPURTENANCE AND NOZZLE LOCATIONS SHALL BE CONFIRMED IN THE FIELD PRIOR TO ORDERING TANK.

CROTHERS TANK
TANK APPURTENANCE LOCATIONS

N.T.S.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

UNAUTHORIZED CHANGES AND USES:
THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS, ALL CHANGES TO THESE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS.

CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; AND THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

REVISIONS	BY

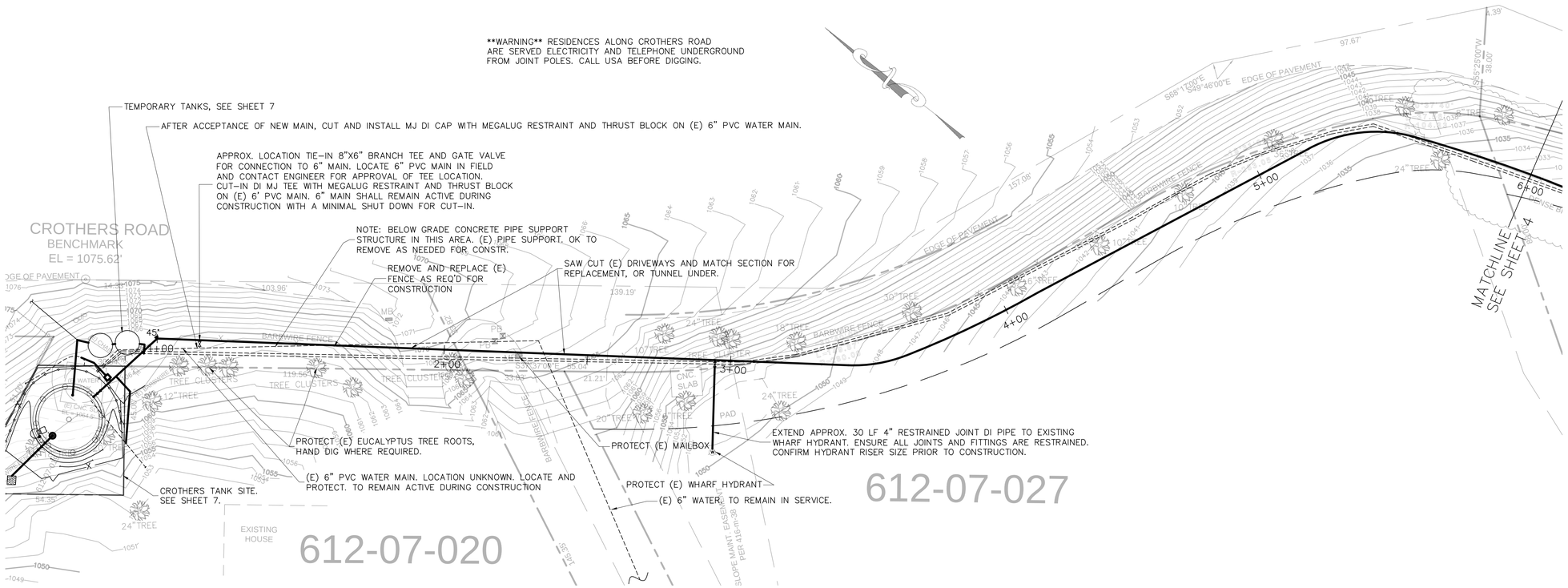
Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. J o SAN JOSE o CALIFORNIA 95129 o (408) 257-9252

SPECIFICATIONS

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

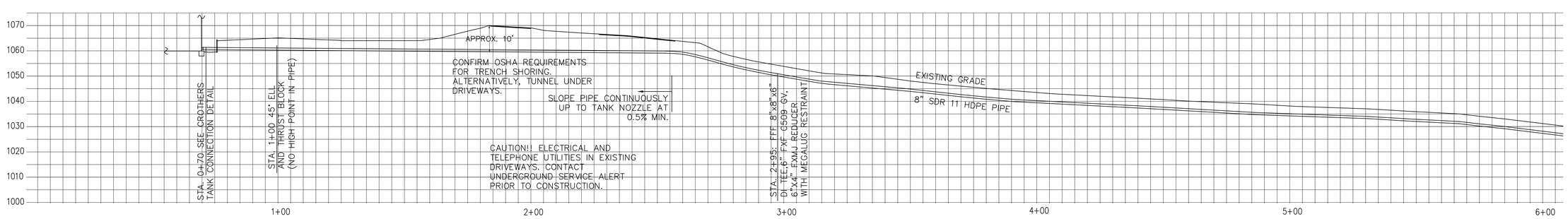
WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/2012
SCALE: AS SHOWN
DRAWN: EAB
DWG.#38301110907F
SHEET 2 OF 9 SHEETS



PIPELINE PLAN

SCALE: 1" = 20'



PIPELINE PROFILE

HORIZ. AND VERT. SCALE: 1" = 20'

ISSUED FOR REVIEW
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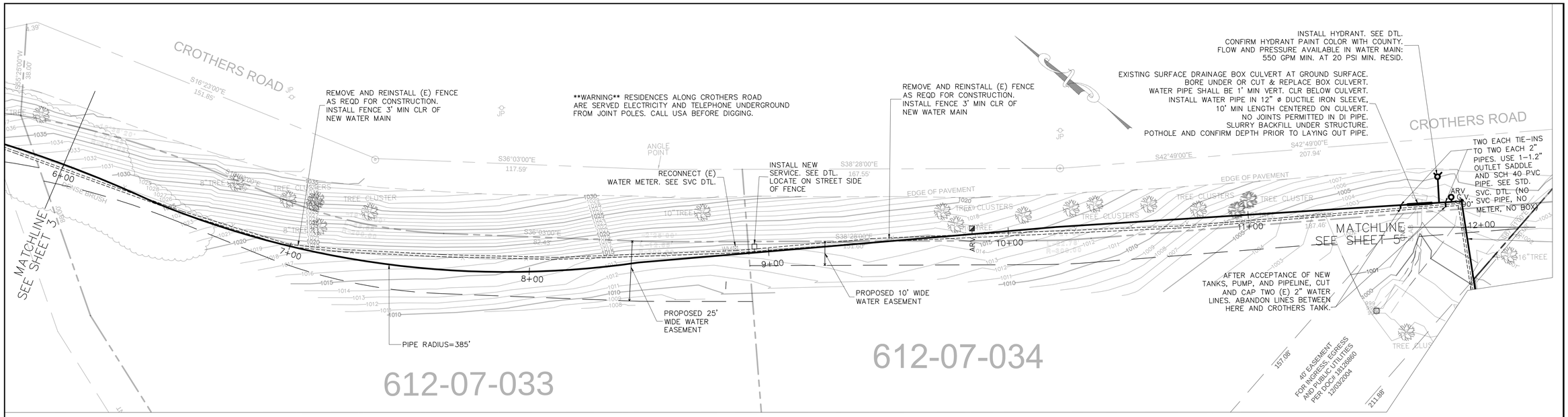
PHASE I:
PIPELINE
PLAN AND PROFILE

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

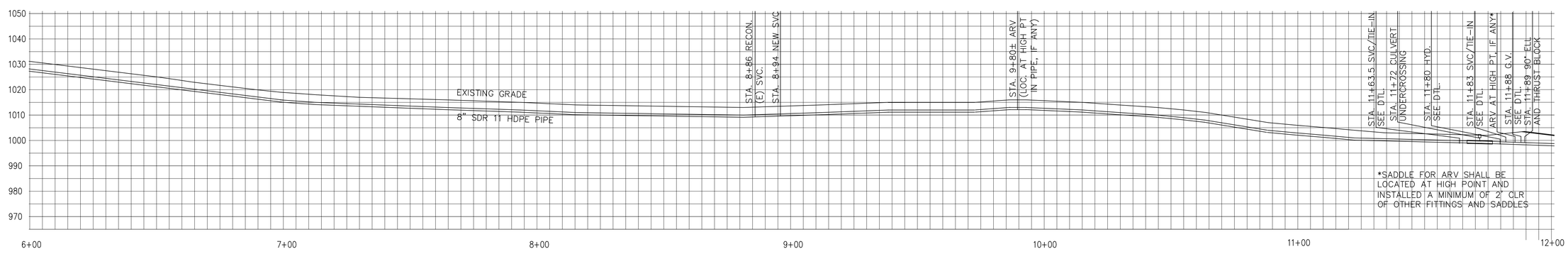
WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
SCALE: AS SHOWN
DRAWN: EAB
DWG.#38301110907F
SHEET 3 OF 9 SHEETS



PIPELINE PLAN

SCALE: 1" = 20'



PIPELINE PROFILE

HORIZ. AND VERT. SCALE: 1" = 20'

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PHASE I:
PIPELINE
PLAN AND PROFILE

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
SCALE: AS SHOWN
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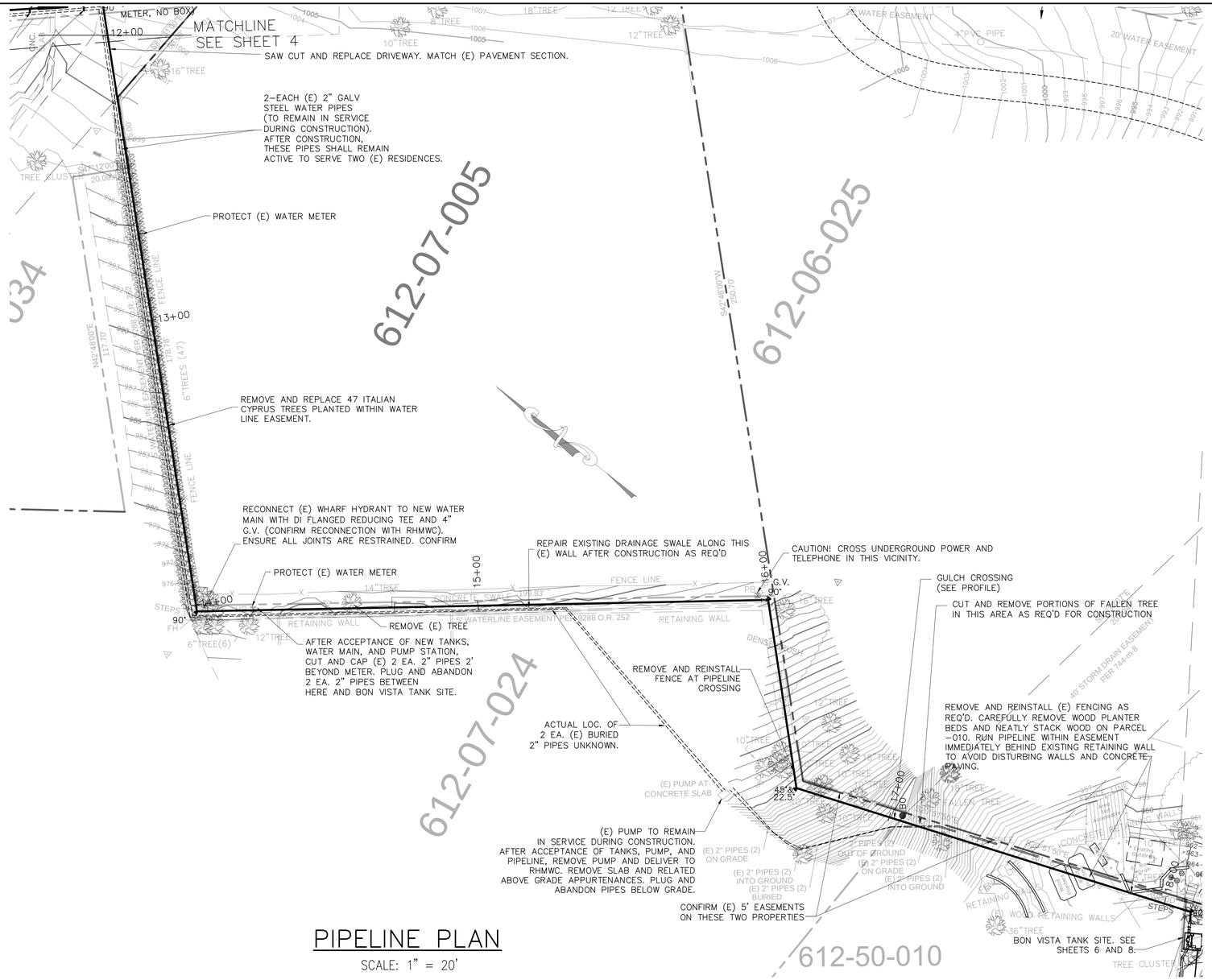
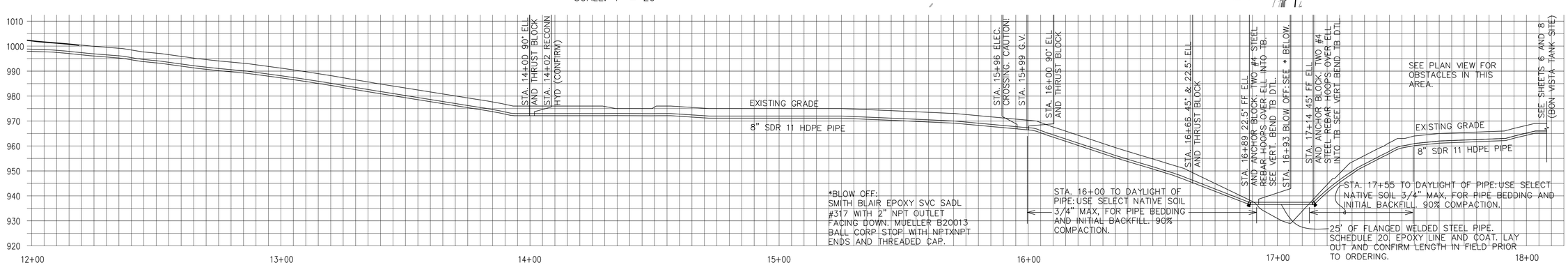
DWG.#38301110907F



PIPELINE PLAN

SCALE: 1" = 20'

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION



PIPELINE PROFILE

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PHASE I:
PIPELINE
PLAN AND PROFILE

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
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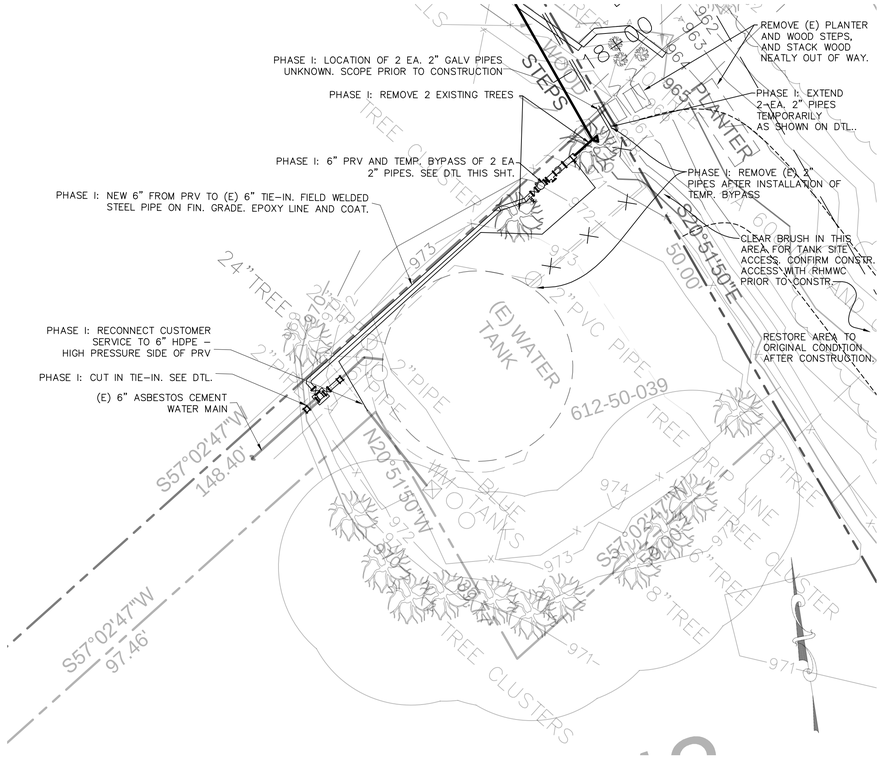
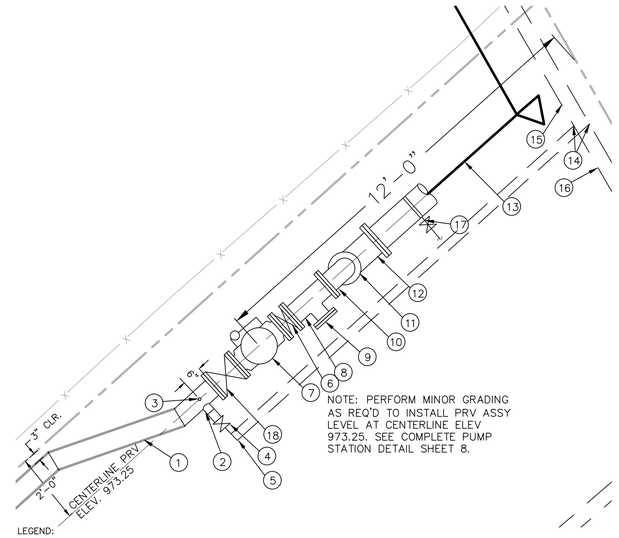
SHEET 5 OF 9 SHEETS



BON VISTA TANK SITE PLAN: PHASE I ITEMS

SCALE 1" = 10'



LEGEND:

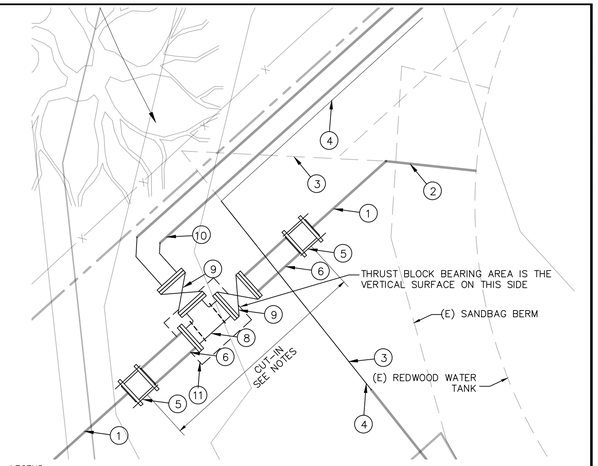
1. 6" FIELD WELDED STEEL PIPE. 22.5° MITERED HORIZONTAL OFFSET. VERTICAL OFFSET MAY BE REQUIRED. FIELD CONFIRM AFTER MINOR GRADING. EPOXY LINE AND COAT.
2. 2-1/2" THREAD-O-LET. NPT.
3. 1" THREAD-O-LET. NPT. INSTALL VERTICALLY 1" GALV. NIP, 1" HEAVY DUTY BALL VALVE, 1" TEE WITH PRESSURE GAGE (0-100 PSI) ON SIDE OUTLET AND ON TOP: CRISPIN MIDGET MODEL M10 AIR RELEASE WITH 3/32 ORIFICE AND 2-40 PSI RATING.
4. 2-1/2" GALV. NIP, 2-1/2" LEAD FREE BRONZE HEAVY DUTY GATE VALVE.
5. INSTALL TWO EACH 2" TEMPORARY BY-PASS PIPES. USE 2-1/2" TEES, SCH. 40 PVC OR GALV. STEEL.
6. 6" FF BUTTERFLY VALVE. M&H STYLE 4500, CL 150, WITH HAND WHEEL OPERATOR, OR APPROVED EQUAL.
7. 6" CLA-VAL 150 LB FLANGED PRESSURE REDUCING VALVE MODEL 90-01 WITH LOW PRESSURE PILOT (2-30 PSI). SET AT 10 PSI.
8. 6"X4" FFF DI TEE
9. 4" BLIND FLANGE
10. 6" FXMJ 90° VERTICAL ELBOW WITH EBAA IRON MEGALUG RESTRANT.
11. 6" FXPE SPOOL (VERTICAL). FIELD CUT AS NEEDED.
12. 8"X6" FLANGED REDUCING ELBOW ORIENTED VERTICALLY. INSTALL THRUST BLOCK PER THRUST BLOCK DETAILS.
13. 8" HDPE PIPE PER PLAN. 3' CVR. MIN.
14. TIE-IN 2 EACH TEMPORARY 2" PIPES TO EXISTING. SHUT-DOWN SHALL BE KEPT TO A MINIMUM.
15. TWO EACH EXISTING 2" PIPES. CONTRACTOR TO LOCATE AND CONFIRM SIZE, TYPE, OPTIMAL TIE-IN LOCATION, AND NEAREST SHUTOFF VALVES PRIOR TO CONSTRUCTION.
16. EXISTING 2" PIPES (2 EA) TO BE REMOVED AFTER INSTALLATION OF BYPASS.
17. CUSTOMER SERVICE SADDLE AND CORP STOP. SEE STANDARD SERVICE DETAIL. SEE ITEM 4 ON PIPING TIE-IN DTL. THIS SHEET. EXTEND AROUND AREA OF FUTURE CONCRETE SLAB FLOOR TO (E) SERVICE.
18. 6" FF C509 GATE VALVE WITH HAND WHEEL OPERATOR. TO REMAIN NORMALLY CLOSED AFTER COMPLETION OF CONSTRUCTION AND ACCEPTANCE.

NOTES:
1. PROTECT PRV AND PIPING DURING CONSTRUCTION. ANY DAMAGED PRV PARTS SHALL BE REPLACED BY CONTRACTOR IMMEDIATELY. PRV MUST REMAIN IN SERVICE DURING PHASE II.
2. PROTECT PRV AND OTHER ABOVE GRADE PIPING FROM FREEZING (IF APPLICABLE).

PHASE I
BON VISTA SITE PRV DETAIL

TEMPORARY CONFIGURATON FOR USE DURING PHASE I

SCALE: 1/2" = 1'-0"



LEGEND:

1. (E) 6" ASBESTOS CEMENT PIPE. SEE NOTE 1.
2. (E) 6" GALV. STEEL PIPE - TANK INLET/OUTLET NOZZLE.
3. (E) 2" CUSTOMER SVC PIPE. EXACT LOCATION BELOW GRADE UNKNOWN.
4. INSTALL NEW 2" CUSTOMER SERVICE PIPE BELOW GRADE AND TIE-IN TO (E) METER. CONNECT TO HIGH PRESSURE SIDE OF NEW PRV. NEW PIPE SHALL BE 2" SCH. 40 PVC OR SDR 11 HDPE AND JOINTS AND FITTINGS SHALL BE RESTRAINED. SEE NOTE 4.
5. SMITH BLAIR TRANSITION COUPLING (2 EA.). CONFIRM REQUIRED O.D. IN FIELD.
6. 6" FLANGE BY PLAIN END D.I. SPOOL. ASSUME 2' LENGTH. SEE NOTE 1.
8. 6" FFF DI TEE
9. 6" FF C509 GATE VALVE (SEE STANDARD DTL.)
10. 6" FIELD WELDED STEEL PIPE. ROTATE MITERED ELBOW UP 45° ABOVE GRADE AND MITER TO ON GRADE. PIPE SHALL RUN ON FIN. GRADE ALONG SIDE OF EXISTING TANK TO PRV. SEE PRV DTL. THIS SHEET.
11. CONCRETE THRUST BLOCK WITH 2 EA. #5 REBAR HOOPS OVER TEE. 4 SQUARE FEET MIN BEARING AREA - THRUST BLOCK SHALL BE KEYED IN BELOW TRENCH BOTTOM TO BEAR AGAINST UNDISTURBED EARTH.

NOTES:
1. POTHOLING IS REQUIRED PRIOR TO ORDERING OF MATERIALS. EXISTING DEPTH, LOCATION, AND TRANSITION OF 6" AC PIPE ARE UNKNOWN. THIS DRAWING IS SCHEMATIC ONLY. LOCATION OF CUT-IN, POSITIONING OF ELBOWS, AND LENGTH OF SPOOL WILL DEPEND ON FINDINGS. CONTACT ENGINEER TO OBSERVE FINDINGS AND TO PROVIDE CLARIFICATION AFTER POTHOLING. PROVIDE AT LEAST 2 WORKING DAYS NOTICE TO ENGINEER.
2. CONTRACTOR SHALL TAKE ALL POSSIBLE PRECAUTIONS WHEN WORKING AROUND AND CUTTING ASBESTOS-CEMENT PIPE AND ADHERE TO OSHA AND ANY OTHER APPLICABLE HEALTH AND SAFETY CODES.
3. THRUST RESTRAINT BLOCK SHALL BE ALLOWED TO CURE FOR A MINIMUM OF 7 DAYS PRIOR TO REMOVING EXISTING TANK CONNECTING PIPING OR DISTURBING EXISTING THRUST BLOCKS.
4. IT IS OF THE UTMOST IMPORTANCE TO MINIMIZE DOWNTIME OF THE WATER SYSTEM AND/OR INDIVIDUAL CUSTOMERS. THE CONTRACTOR SHALL ENSURE THAT THE ENTIRE CUT-IN ASSEMBLY IS ASSEMBLED AND DISINFECTED PRIOR TO SHUT DOWN AND CUTTING OF THE WATER MAIN. CONTRACTOR SHALL EXPEDITE THE INSTALLATION OF THE ASSEMBLY AND REACTIVATE THE WATER MAIN AS QUICKLY AS POSSIBLE.

PHASE I
BON VISTA PIPING TIE-IN DETAIL

SCALE: 1/2" = 1'-0"

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

UNAUTHORIZED CHANGES AND USES:
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CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; AND THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

REVISIONS	BY

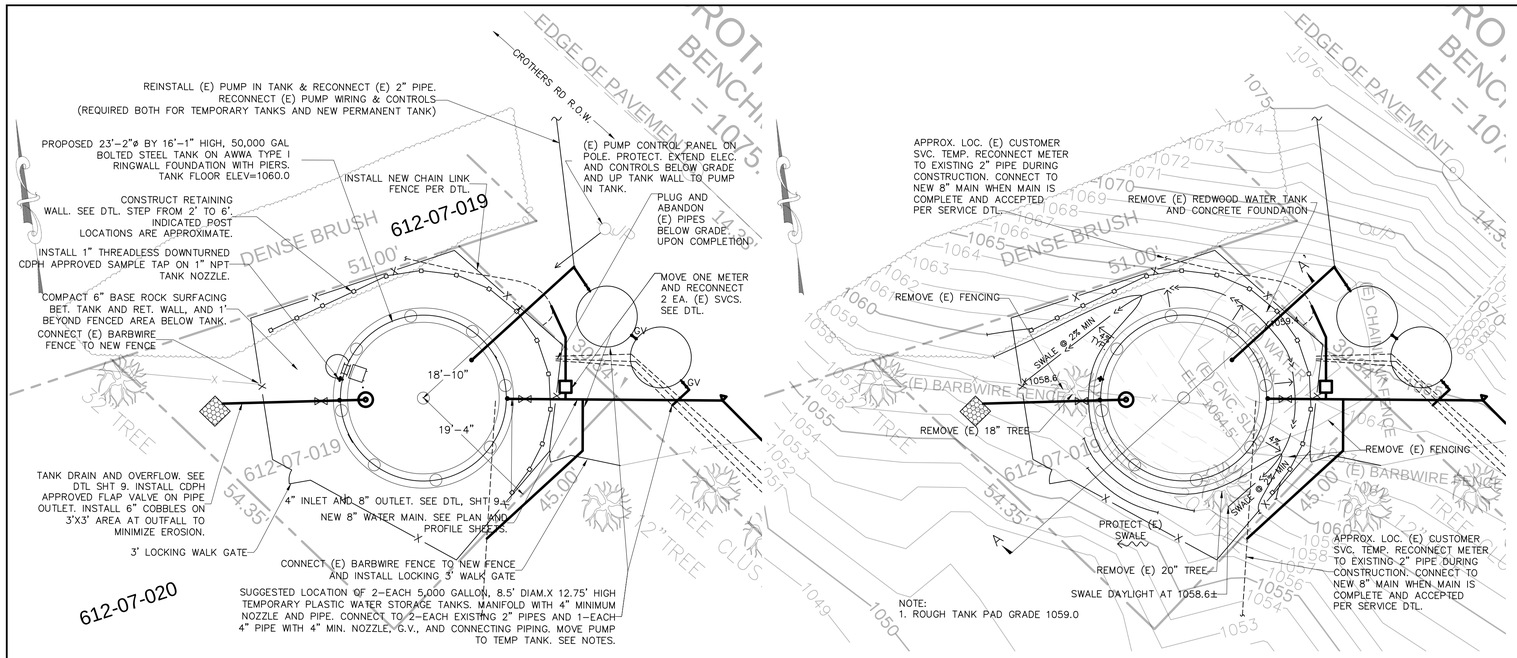
Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. J ○ SAN JOSE ○ CALIFORNIA 95129 ○ (408) 257-9252

PHASE I:
BON VISTA PRV AND TIE-IN

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
SCALE: AS SHOWN
DRAWN: EAB
DWG.#38301110907F
SHEET 6 OF 9 SHEETS



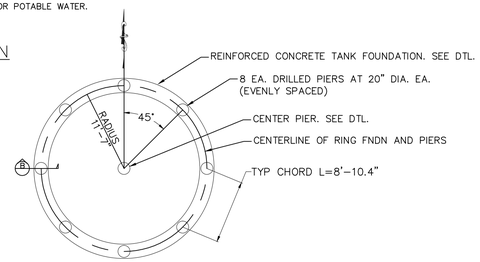
CROTHERS TANK SITE GRADING PLAN

SCALE 1" = 10'

NOTES:
1. TEMPORARY TANKS SHALL BECOME THE PROPERTY OF RHMWC UPON COMPLETION OF PHASE 1. CONTRACTOR SHALL REMOVE THE TANKS TO THE LOCATION SPECIFIED BY RHMWC.
2. TEMPORARY TANKS SHALL BE INSTALLED ON LEVEL GROUND, AND WITHIN 2" ELEVATION OF EACH OTHER, AND AT A SIMILAR ELEVATION TO THE EXISTING TANK.
3. TEMPORARY TANK LOCATION SHALL BE APPROVED BY THE ENGINEER.
4. PRIME AND PAINT ALL ABOVE-GRADE PIPING TO MATCH TANK.
5. ALL ELECTRICAL WORK PER NEC AND LOCAL CODES.
6. TEMPORARY TANKS SHALL MEET THE REQUIREMENTS OF NSF/ANSI 61 FOR POTABLE WATER.

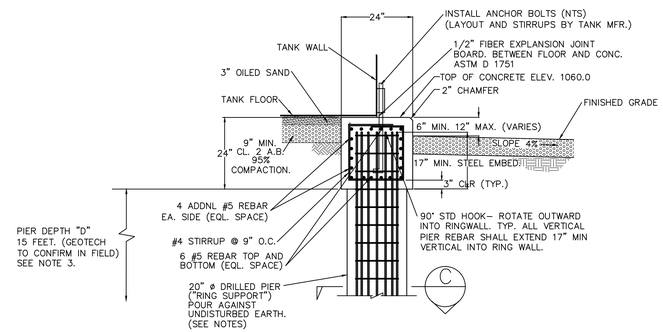
CROTHERS TANK SITE PLAN

SCALE 1" = 10'



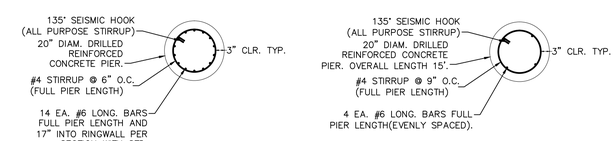
CROTHERS TANK FOUNDATION PLAN

SCALE 1" = 10'



SECTION B: PIER AND RINGWALL FOUNDATION DETAIL

SCALE: 1/2" = 1'-0"

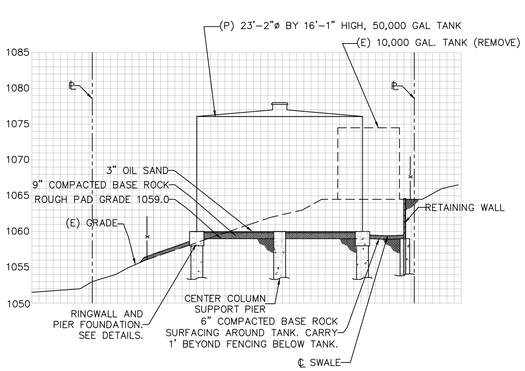


SECTION C
RING SUPPORT PIER

CENTER PIER
SEE NOTE 10

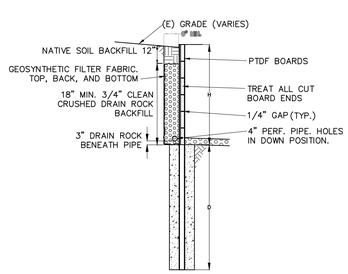
DRILLED PIER DETAILS

SCALE: 1/2" = 1'-0"



SECTION A-A': CROTHERS TANK SITE

SCALE 1" = 10'



WALL HEIGHT (H)	2 FT	3 FT	4 FT	5 FT	6 FT
POST TYPE	4X6 PTDF	W6X12	W6X12	W6X12	W6X12
POST SPACING	4 FT	5 FT	5 FT	5 FT	5 FT
BOARDS	2x12	3x12	3x12	3x12	3x12
PIER DIAMETER	16"	16"	16"	16"	16"
PIER DEPTH (D)*	8 FT	8 FT	8 FT	8 FT	8 FT

*ASSUMES NO SOIL CREEP AROUND PIERS. DEEPER PIER DEPTHS MAY BE REQUIRED BY GEOTECHNICAL ENGINEER IN FIELD IF INADEQUATE SOIL IS OBSERVED.

NOTE: SEE GEOTECHNICAL REPORT AND NOTES ELSEWHERE ON THIS SHEET FOR GEOTECHNICAL REQUIREMENTS. PIER DEPTHS SHOWN IN THIS TABLE IMPLY PIER DEPTHS INTO COMPETENT MATERIAL. MURRAY ENGINEERS, INC. WILL CONFIRM ADEQUATE DEPTH OF PIERS IN THE FIELD. PROVIDE A MINIMUM 48 HOUR NOTICE TO MURRAY ENGINEERS, INC. PRIOR TO DRILLING.

RETAINING WALL DETAIL

N.T.S.

NOTES:

1. SEE GEOTECHNICAL REPORT FOR SUBGRADE AND FILL TREATMENT REQUIREMENTS.
2. ALL CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH OF 3000 PSI PER ACI-318. WATER CEMENT RATIO 0.45 MAX. REINFORCING STEEL SHALL BE UNCOATED GRADE 60. 2' MIN. LAP.
3. FOUNDATION DESIGN BASED ON A SOIL BEARING PRESSURE OF 2500 PSF AND THE REQUIREMENTS OF MURRAY ENGINEERS INC. GEOTECHNICAL REPORT DATED OCTOBER 2009. PIERS MUST EXTEND IN TO COMPETENT MATERIAL AS SHOWN ON THE PLANS AND DESCRIBED IN THE REPORT. EXCAVATION SHALL BE INSPECTED AND APPROVED BY MURRAY ENGINEERS INC. PRIOR TO PLACING STEEL. SCHEDULE WITH MURRAY ENGINEERS PRIOR TO DRILLING. BINKLEY ASSOCIATES WILL INSPECT ALL STEEL PRIOR TO POURING CONCRETE. PROVIDE MIN. 2 WORKING DAYS NOTICE. PER MURRAY ENGINEERS, INC.: DRILLED PIERS SHALL BE A MINIMUM OF 15 FEET DEEP, AND EXTEND AT LEAST 10 FEET INTO THE UNDERLYING ANCIENT LANDSLIDE DEBRIS/OLDER COLLUVIUM OR AN EQUIVALENT DEPTH OF NATIVE SOIL PLUS ANY PROPOSED FILL AS INTO ANCIENT LANDSLIDE DEBRIS/OLDER COLLUVIUM, WHICHEVER IS DEEPER. BASED ON THIS SITE PLAN AND THE SUBSURFACE INVESTIGATION, PIER DEPTHS ARE ANTICIPATED TO RANGE FROM 15 TO 20 FEET.
4. PIER VERTICAL DIMENSIONS MAY VARY BASED ON FIELD FINDINGS OF DEPTH TO COMPETENT MATERIAL.
5. OILED SAND SHALL BE REED AND GRAHAM "TANK MIX" OR EQUAL.
6. PIERS SHALL BE POURED AGAINST UNDISTRUBED EARTH, EXCEPT TOP 2-3 FEET OF PIERS SHALL BE POURED IN SONOTUBES TO PREVENT MUSHROOMING DUE TO EXPANSIVE SOIL PER THE GEOTECHNICAL REPORT. TYPICAL FOR ALL PIERS (TANK AND RETAINING WALL) ON CROTHERS SITE.
7. FOUNDATION SHALL BE CONSTRUCTED IN ACCORDANCE WITH AWWA STANDARD D103. TOLERANCES: RINGWALL BEFORE PLACING CANE FIBER FILLER SHALL BE LEVEL WITHIN 1/8" IN ANY 30' OF CIRCUMFERENCE. THE LEVELNESS OF THE CIRCUMFERENCE SHALL NOT VARY BY MORE THAN ±1/4 INCH. RINGWALL FINISH SHALL BE SMOOTH PER ACI 301. ANY SMALL HOLES SHALL BE TROWELED OVER WITH MORTAR ASAP AFTER REMOVAL OF FORMS.
8. EACH ANCHOR BOLT SHALL BE PLACED WITHIN 1/4" OF MANUFACTURER'S SPECIFIED LAYOUT POSITION. NO CUMULATIVE ERROR WILL BE PERMITTED.
9. CONCRETE FORMS SHALL BE CONSTRUCTED AND BRACED AS REQUIRED TO PREVENT ANY BULDGING OR MOVEMENT BEYOND THE SPECIFIED TOLERANCE. CONCRETE WORK WILL NOT BE ACCEPTED IF FINAL DIMENSIONS ARE OUTSIDE SPECIFIED TOLERANCE.
10. IF TANK STRUCTURE DESIGNER DOES NOT REQUIRE CENTER COLUMN, NO CENTER PIER WILL BE NECESSARY. NOTIFY BINKLEY ASSOC IMMEDIATELY FOR EVALUATION OF FOUNDATION DESIGN.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

UNAUTHORIZED CHANGES AND USES:
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CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; AND THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

REVISIONS	BY

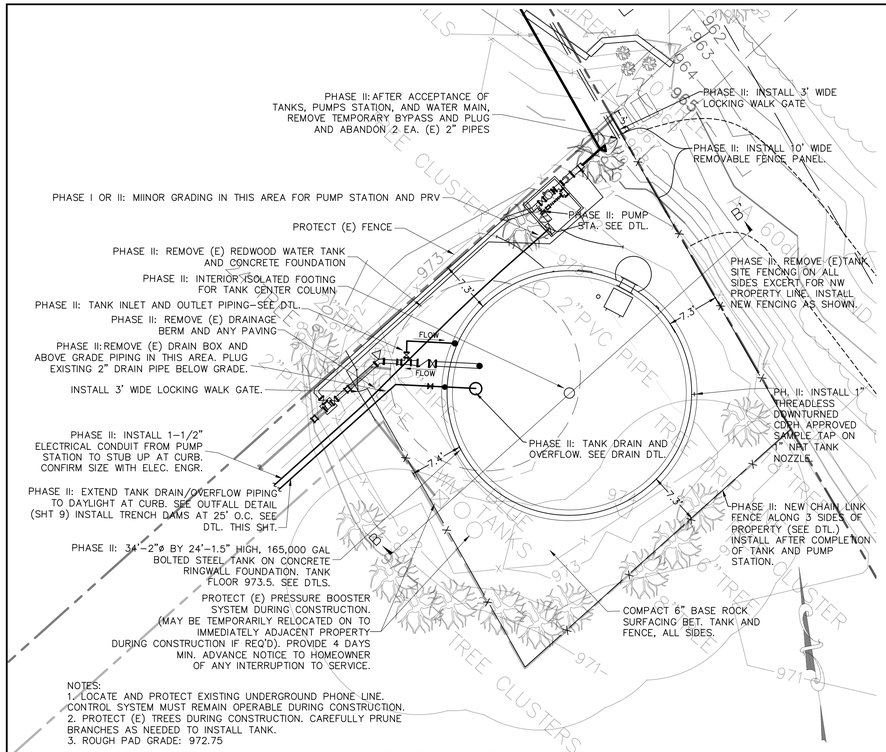
Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. J ○ SAN JOSE ○ CALIFORNIA 95129 ○ (408) 257-9252

PHASE I:
CROTHERS TANK

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

WATER TANK AND PIPELINE REPLACEMENT PROJECT

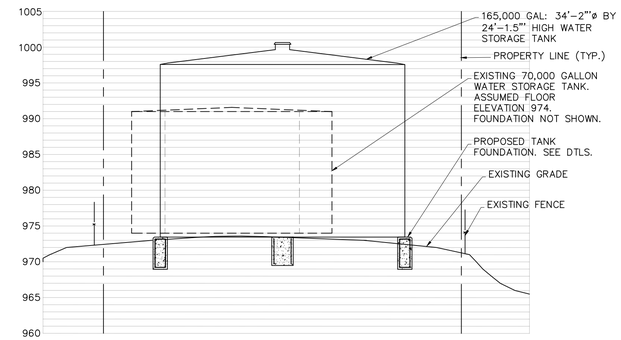
DATE: 9/17/12
SCALE: AS SHOWN
DRAWN: EAB
DWG.#38301110907F
SHEET 7 OF 9 SHEETS



NOTES:
1. LOCATE AND PROTECT EXISTING UNDERGROUND PHONE LINE. CONTROL SYSTEM MUST REMAIN OPERABLE DURING CONSTRUCTION.
2. PROTECT (E) TREES DURING CONSTRUCTION. CAREFULLY PRUNE BRANCHES AS NEEDED TO INSTALL TANK.
3. ROUGH PAD GRADE: 972.75

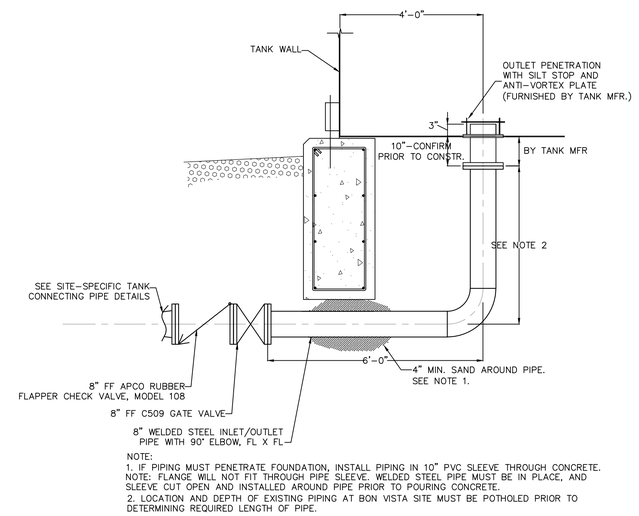
BON VISTA TANK SITE PLAN

SCALE 1" = 10'



BON VISTA TANK SITE SECTION B–B'

SCALE 1" = 10'

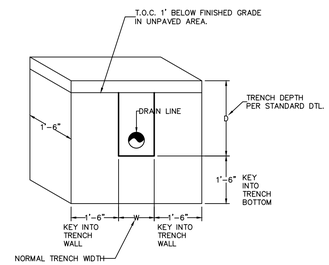


NOTE:
1. IF PIPING MUST PENETRATE FOUNDATION, INSTALL PIPING IN 10" PVC SLEEVE THROUGH CONCRETE. NOTE: FLANGE WILL NOT FIT THROUGH PIPE SLEEVE. WELDED STEEL PIPE MUST BE IN PLACE, AND SLEEVE CUT OPEN AND INSTALLED AROUND PIPE PRIOR TO POURING CONCRETE.
2. LOCATION AND DEPTH OF EXISTING PIPING AT BON VISTA SITE MUST BE POTHOLED PRIOR TO DETERMINING REQUIRED LENGTH OF PIPE.

SEE SHEET 9 FOR INLET DETAIL

TANK OUTLET DETAIL– BON VISTA TANK

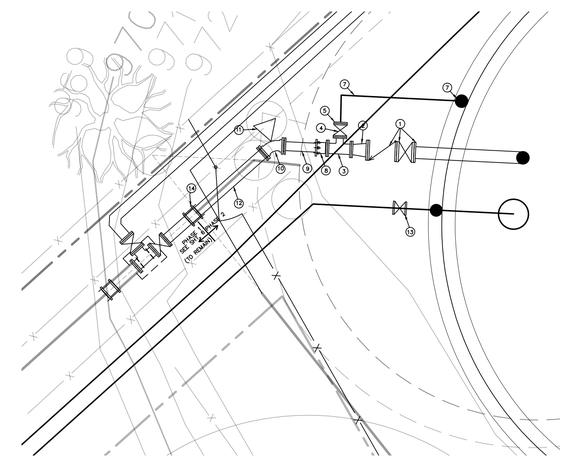
SCALE: 1/2"=1'–0"



LEGEND:
1. TRENCH DAM CONCRETE SHALL REACH A STRENGTH OF 2500 PSI AFTER 7 DAYS.
2. BEARING AREA OF TRENCH DAM SHALL BE RESTING ON UNDISTURBED SOIL.
3. NO FITTINGS SHALL BE LOCATED WITHIN 5' OF TRENCH DAM
4. REMOVE ALL ORGANIC MATERIAL PRIOR TO POURING CONCRETE

TYPICAL TRENCH DAM

N.T.S.

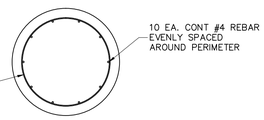


BON VISTA TANK CONNECTING PIPING

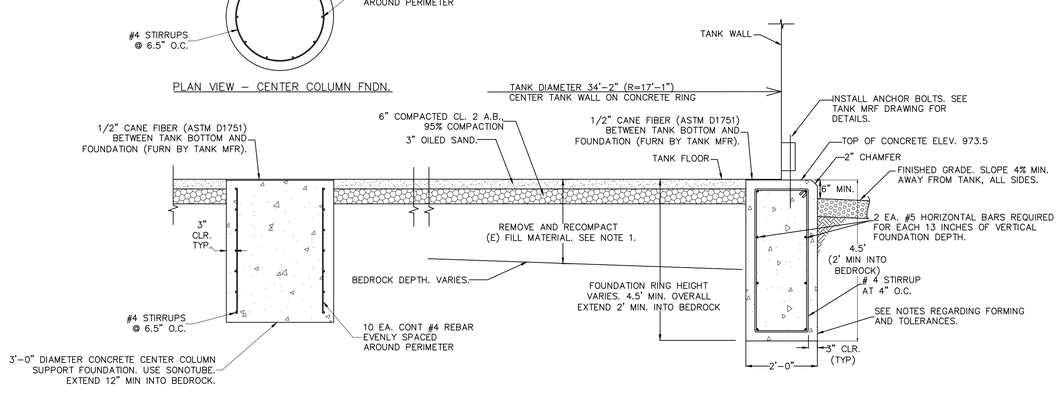
SCALE: 1/4"=1'–0"

LEGEND:
1. TANK OUTLET. SEE DETAIL THIS SHEET.
2. 8"X6" FF DI REDUCER
3. 6" X 4" FFF DI TEE
4. 4" C509 FF GATE VALVE
5. 4" X 3" COMPANION FLANGE
7. SEE TANK INLET DETAIL. SHEET 9.
8. 6" F X MJ DI ADAPTER WITH MEGALUG RESTRAINT
9. 6" DI PLAIN END SPOOL. FIELD CUT TO LENGTH.
10. 6" DI MJ 45° ELL WITH MEGALUG RESTRAINTS
11. THRUST BLOCK. SEE STANDARD DETAIL.
12. 6" DI PLAIN END SPOOL, FIELD CUT TO LENGTH
13. DRAIN VALVE AND PIPING, AND OVERFLOW PIPING. SEE DETAIL SHEET 9.
14. REMOVE PHASE I TRANSITION COUPLING AND REPLACE WITH SMITH BLAIR 411 COUPLING OR APPROVED EQUAL.

NOTE:
PRIME AND PAINT ALL ABOVE–GRADE PIPING TO MATCH TANK.



PLAN VIEW – CENTER COLUMN FNDN.



NOTES:

① SEE GEOTECHNICAL REPORT FOR SUBGRADE AND FILL TREATMENT REQUIREMENTS. ALL EXISTING FILL MATERIAL WITHIN PROPOSED CONCRETE RINGWALL SHALL BE REMOVED AND RECOMPACTED AS ENGINEERED FILL. FILL SHALL BE PLACED IN 8" UNCOMPACTED LIFTS, AND COMPACTED TO 95% RELATIVE COMPACTION. COMPACTION WILL BE TESTED BY GEOTECHNICAL ENGINEER. CONTRACTOR SHALL PROVIDE A MINIMUM 1 WEEK NOTICE TO MURRAY ENGINEERS.

② ALL CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH OF 3000 PSI PER ACI–318. WATER CEMENT RATIO 0.45 MAX. REINFORCING STEEL SHALL BE UNCOATED GRADE 60. 2' MIN. LAP.

③ FOUNDATION DESIGN BASED ON A SOIL BEARING PRESSURE OF 2500 PSF AND THE REQUIREMENTS OF MURRAY ENGINEERS INC. GEOTECHNICAL REPORT DATED MAY 2011. FOUNDATION MUST BE FOUNDED IN COMPETENT BEDROCK. EXCAVATION SHALL BE INSPECTED AND APPROVED BY MURRAY ENGINEERS INC. PRIOR TO PLACING STEEL. STEEL SHALL BE INSPECTED BY BINKLEY ASSOCIATES PRIOR TO POURING CONCRETE. PROVIDE MINIMUM 2 WORKING DAYS NOTICE.

④ FOUNDATION VERTICAL DIMENSION WILL VARY BASED ON FIELD FINDINGS OF DEPTH TO BEDROCK. OVERALL RINGWALL FOUNDATION HEIGHT IS ANTICIPATED TO VARY BETWEEN 4.5' AND 6.5' OVERALL DIMENSION. CONTRACTOR SHALL PROVIDE SHORING AS REQUIRED BY OSHA FOR EXCAVATION DEPTHS OF 5' OR GREATER. BOTTOM OF FOUNDATION SHALL BE STEPPED, NOT SLOPED, TO MEET NEW DEPTHS.

⑤ OILED SAND SHALL BE REED AND GRAHAM "TANK MIX" OR EQUAL.

⑥ BOTTOM 2' MIN. OF RINGWALL FOUNDATION SHALL BE POURED AGAINST UNDISTRUBED EARTH. NO FORMING WILL BE PERMITTED ON BOTTOM 2'. FORMING SHALL BE REQUIRED ABOVE GRADE EXTENDING TO 6" BELOW FINISHED GRADE ON BOTH SIDES OF THE RINGWALL. FINISH SHALL BE SMOOTH PER ACI 301. ANY SMALL HOLES SHALL BE TROWELED OVER WITH MORTAR ASAP AFTER REMOVAL OF FORMS.

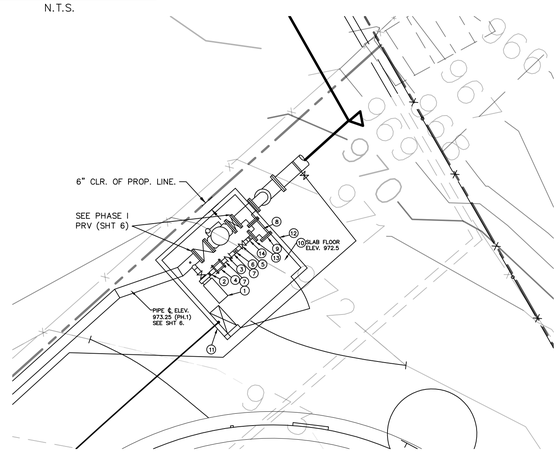
⑦ FOUNDATION SHALL BE CONSTRUCTED IN ACCORDANCE WITH AWWA STANDARD D103. TOLERANCES: RINGWALL BEFORE PLACING CANE FIBER FILLER SHALL BE LEVEL WITHIN 1/8" IN ANY 30' OF CIRCUMFERENCE. THE LEVELNESS OF THE CIRCUMFERENCE SHALL NOT VARY BY MORE THAN ±1/4 INCH.

⑧ EACH ANCHOR BOLT SHALL BE PLACED WITHIN 1/4" OF MANUFACTURER'S SPECIFIED LAYOUT POSITION. NO CUMULATIVE ERROR WILL BE PERMITTED.

⑨ CONCRETE FORMS SHALL BE CONSTRUCTED AND BRACED AS REQUIRED TO PREVENT ANY BULDGING OR MOVEMENT BEYOND THE SPECIFIED TOLERANCE. CONCRETE WORK WILL NOT BE ACCEPTED IF FINAL DIMENSIONS ARE OUTSIDE SPECIFIED TOLERANCE.

BON VISTA TANK RINGWALL FOUNDATION DETAIL

SCALE: 1/2" = 1'–0"



BON VISTA PUMP STATION

SCALE: 1/4"=1'–0"

LEGEND:
1. 1–1/2 X 2" GOULDS MODEL 3656 CLOSE COUPLED PUMP, "UP–SHOOT" NOZZLE. 100 GPM @90 FEET TDH, WITH 3 PHASE, 3 HORSEPOWER 3500 RPM ODP MOTOR. PUMP TO OPERATE WITHIN MOTOR SERVICE FACTOR ACROSS ENTIRE CURVE. CONFIRM AVAILABILITY OF 3 PHASE POWER PRIOR TO ORDERING.
2. 1–1/2" X 2–1/2" GALVANIZED STEEL INCREASING 90° ELBOW
3. 2–1/2" NPT CHECK VALVE, SPRING LOADED
4. 2–1/2" FLEX COUPLING FOR STEEL PIPE, SHORT PATTERN – SMITH BLAIR 411 OR APPROVED EQUAL
5. 2–1/2" HEAVY DUTY BRASS GATE VALVE (LEAD FREE)
6. ASSY: 2–1/2" TEE, NPT, FACING UPWARD. BUSH DOWN TO 1" HEAVY DUTY GATE VALVE, THEN ADDITIONAL 1" TEE WITH AIR RELEASE VALVE AT THE TOP, AND PRESSURE GAGE TO THE SIDE. GAGE: 0–200 PSI. AIR VALVE: CRISPIN MIDGET M10 WITH 3/32 ORIFICE.
7. 2–1/2" GALVANIZED STEEL PIPE, SCH. 40 (TYPICAL). NPT.
8. 4" FFF DI TEE, ROLL UP 45 DEGREES (45 DEGREE ROTATION NOT SHOWN)
9. 4" DI BLIND FLANGE
10. 5–1/2" CONCRETE SLAB W/ #4@12" O.C.E.W., THICKENED EDGE TO EXTEND 6" MIN BELOW GRADE, EXTEND TO BEDROCK AT EA. CORNER
11. RELOCATE AND RECONNECT (E) PUMP CONTROL PANEL. MODIFY AS REQUIRED. CONFIRM CONDITION AND SUITABILITY WITH OWNER.
12. 6' BY 6' SOUND INSULATED ALL SIDES, PREMIER RANCH TUFF SHED (NO FLOOR) WITH 4' LOCKING DOOR, PTDF SILL BOLTED TO SLAB, OR APPROVED EQUAL. PAINT COLOR TO BE APPROVED BY OWNER.
13. 4" BY 2–1/2" DI COMPANION FLANGE
14. 2–1/2" 45° ELBOW

ISSUED FOR REVIEW
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REVISIONS	BY

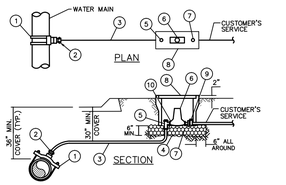
Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. 1 o SAN JOSE o CALIFORNIA 95129 o (408) 257–9252

PHASE II
BON VISTA TANK,
SITE PIPING & PUMP STA.

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
SCALE: AS SHOWN
DRAWN: EAB
DWG.#38301110907F
SHEET 8 OF 9 SHEETS



SERVICE SIZE	1"	1-1/2"
CORP. STOP	MUELLER H-35008 (INSULATED)	MUELLER H-15000 OR MUELLER H-15013
METER STOP	MUELLER H-14255 OR 14258	MUELLER H-14276 OR MUELLER H-15013
METER BOX & LID	CHRISTY B9 WITH B9D LID	CHRISTY B30 WITH B30E LID

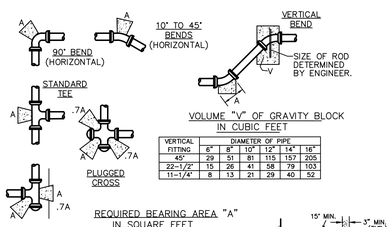
LEGEND

1. SERVICE SADDLE FOR HDPE PIPE, SMITH-BLAIR NO. 372 OR APPROVED EQUAL, STAINLESS STEEL SADDLE WITH STAINLESS STEEL SPRING WASHERS.
2. CORPORATION STOP, SEE TABLE
3. 1" OR 1-1/2" - TYPE K SOFT COPPER PIPE. UNIONS OR COUPLINGS NOT PERMITTED.
4. 3/4" DRAIN ROCK (AS DIRECTED BY ENGINEER)
5. METER STOP, SEE TABLE
6. 1" METER
7. METER COUPLING, MUELLER H-10871
8. METER BOX, SEE TABLE. TRAFFIC COVER SHALL BE PROVIDED IN TRAFFIC AREAS AND WHERE DIRECTED BY ENGINEER.
9. BALL VALVE
10. FOR 1-1/2" SERVICES ONLY: 1-1/2" FORD 6F FLANGE WITH BRASS BUSHING AND NIPPLE, MUELLER H-10871 METER COUPLING (INSULATED)

NOTE: 3 FEET MINIMUM SPACING BETWEEN SERVICE SADDLES, CENTER TO CENTER

SERVICE CONNECTION

N.T.S.



VOLUME "V" OF GRAVITY BLOCK IN CUBIC FEET

VERTICAL FITTING	DIAMETER OF PIPE 6"	8"	10"	12"	14"	16"
45°	29	51	81	115	157	205
22-1/2°	15	26	41	58	79	103
11-1/4°	8	13	21	29	40	52

REQUIRED BEARING AREA "A" IN SQUARE FEET

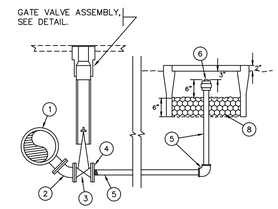
HORIZONTAL FITTING	DIAMETER OF PIPE 6"	8"	10"	12"	14"	16"
90°	3	5	8	11	15	19
45°	2	3	4	6	8	11
22-1/2°	2	2	2	3	4	
11-1/4°	2	2	2	2	2	3
PLUG/TEE	2	4	6	8	11	14

NOTE: BASED ON SOIL BEARING VALUE OF 2000 LBS. PER SQ. FT. AND WATER PRESSURE OF 200 PSI. FORM AS REQUIRED TO KEEP CONCRETE OFF OF MECHANICAL JOINT OR FLANGE BOLTS.

NOTES:
1. ALL THRUST BLOCKS SHALL BEAR AGAINST UNDISTURBED EARTH, BACK AND BOTTOM.
2. A MINIMUM OF 24 HOURS CURING TIME REQUIRED FOR CONCRETE THRUST BLOCKS BEFORE ANY WATER SHOULD BE INTRODUCED INTO PIPELINE AND A MINIMUM OF 7 DAYS CURING TIME BEFORE PRESSURE TEST.

THRUST RESTRAINT – THRUST BLOCK DETAILS

N.T.S.



LEGEND

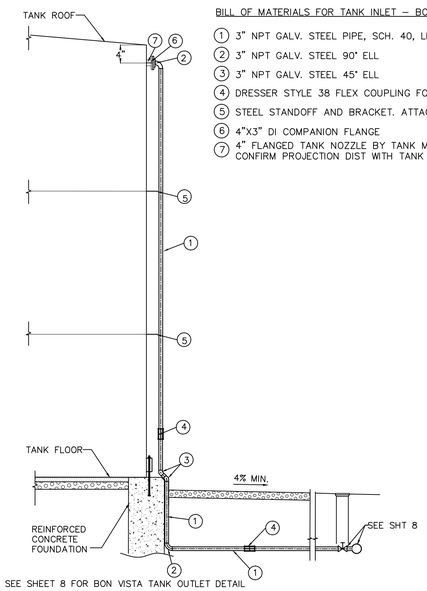
1. 4" BRANCH DI TEE, FLG, ROATE 45° DOWN FROM HORIZ.
2. 4" 45° DI BEND, FLG
3. 4" GATE VALVE, FLG, PER DTL.
4. 2" (FPT) TAPPED BLIND FLANGE
5. 2" SCHEDULE 40 GALVANIZED STEEL PIPE AND FITTINGS
6. 2" COUPLING WITH PLUG
7. PRECAST UTILITY VAULT, CHRISTY NO. B30 WITH B30D COVER, OR BROOKS NO. 35. TRAFFIC COVER SHALL BE USED IN TRAFFIC AREAS AND WHERE DIRECTED BY ENGINEER.
8. 3/4" DRAIN ROCK

NOTES

1. THE TOP OF THE BOX SHALL BE FLUSH WITH PAVEMENT WHEN LOCATED IN TRAFFIC AREAS.
2. THE SIZE OF THE BLOW-OFF SHALL BE AS DETERMINED BY THE ENGINEER.
3. ALL BURIED NUTS AND BOLTS SHALL BE TYPE 316 STAINLESS STEEL.

2" BLOW OFF VALVE

N.T.S.



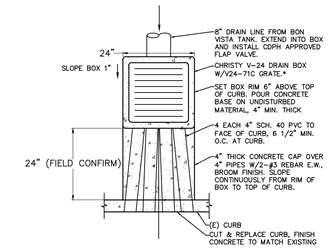
BILL OF MATERIALS FOR TANK INLET – BON VISTA TANK

1. 3" NPT GALV. STEEL PIPE, SCH. 40, LENGTH AS REQ'D
2. 3" NPT GALV. STEEL 90° ELL
3. 3" NPT GALV. STEEL 45° ELL
4. DRESSER STYLE 38 FLEX COUPLING FOR STEEL PIPE
5. STEEL STANDOFF AND BRACKET. ATTACH TO BOLTED TANK SEAM
6. 4"X3" DI COMPANION FLANGE
7. 4" FLANGED TANK NOZZLE BY TANK MFR. CONFIRM PROJECTION DIST WITH TANK MFR.

SEE SHEET 8 FOR BON VISTA TANK OUTLET DETAIL

TANK INLET DETAIL–BON VISTA TANK

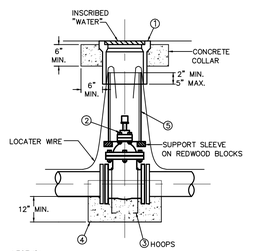
N.T.S.



*THIS BOX IS NOT A SURFACE DRAINAGE INLET. TOP OF BOX AND GRATE WILL BE INSTALLED ABOVE SURROUNDING GRADE AND THE INTENT IS TO NOT ALLOW INFLOW. THE PURPOSE OF GRATE IS TO ALLOW OUTFLOW SHOULD THE 4" CURB DISCHARGE PIPES BECOME CLOGGED.

BON VISTA DRAIN OUTFALL–PLAN VIEW

N.T.S.



LEGEND:

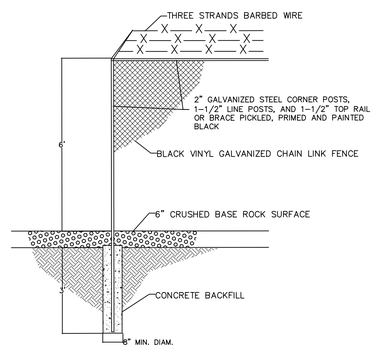
1. CHRISTY G5 TRAFFIC BOX W/ COVER MARKED "WATER."
2. M & H AWWA C509 NRS RESILIENT SEATED GATE VALVE W/ 2 – "O" RINGS AND 2" SQ. OPERATING NUT.
3. 1/2" DIAMETER REBAR ANCHORS (2 REQ'D).
4. CONCRETE THRUST BLOCKS (REFER TO THRUST BLOCK TABLE OF BEARING AREAS).
5. 8" DIAMETER PIPE SLEEVE, LENGTH AS REQ'D.

NOTES:

1. CONCRETE ANCHOR NOT REQUIRED FOR VALVES 4" AND LESS ON STRAIGHT PIPE RUNS.
2. ALL FERROUS METAL FITTINGS, TIE RODS, BOLTS, NUTS, ETC. IN CONTACT WITH EARTH SHALL BE COATED WITH COAL TAR ENAMEL.
3. VALVE BOX MUST BE CENTERED ON THE AXIS OF THE VALVE.

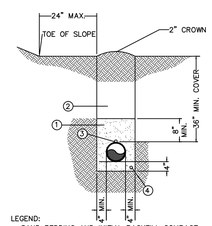
TYPICAL GATE VALVE INSTALLATION

N.T.S.



TYP. FENCE DETAIL

N.T.S.



LEGEND:

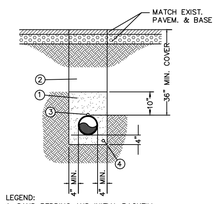
1. SAND BEDDING AND INITIAL BACKFILL COMPACT TO 90%, 8" LIFTS.
2. SELECT NATIVE OR IMPORTED SOIL, COMPACT TO 90%, 12" LIFTS
3. #8 COPPER CONDUCTOR, CONNECT TO GATE VALVES. ATTACH TO TOP OF MAIN WITH WIRE TIES OR TAPE.
4. LOCATION OF CONTROL CONDUIT IN TRENCH(WHEN REQ'D)

* ALL DIMENSIONS ARE "MINIMUM"

TRENCH SECTION

WITHIN EASEMENT BUT NOT WITHIN ROADWAY OR SHOULDER

N.T.S.



LEGEND:

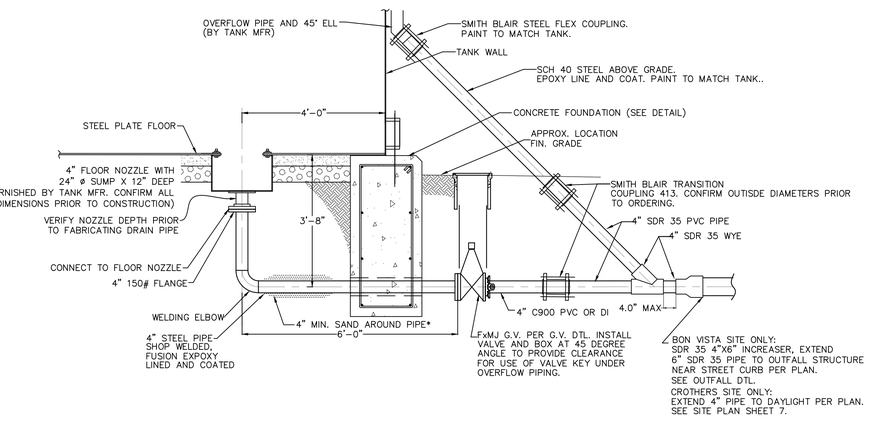
1. SAND BEDDING AND INITIAL BACKFILL. COMPACT TO 90%
2. SELECT NATIVE OR IMPORTED SOIL, COMPACT TO 95%, 12" LIFTS.
3. #8 COPPER CONDUCTOR, ATTACH TO TOP OF MAIN WITH WIRE TIES OR TAPE. INSERT INTO GATE VALVE BOXES.
4. LOCATION OF CONTROL CONDUIT IN TRENCH (WHEN REQ'D)

* ALL DIMENSIONS ARE MINIMUM

TRENCH SECTION

WITHIN ROADWAY, SHOULDER, OR DRIVEWAY

N.T.S.

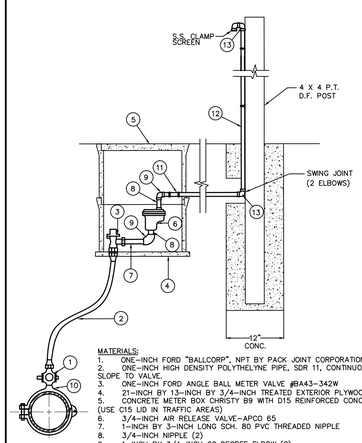


* IF PIPING MUST PENETRATE FOUNDATION, INSTALL PIPING IN 6" PVC SLEEVE THROUGH CONCRETE.

NOTE: FLANGE WILL NOT FIT THROUGH PIPE SLEEVE. WELDED STEEL PIPE MUST BE IN PLACE, AND SLEEVE CUT OPEN AND INSTALLED AROUND PIPE PRIOR TO POURING CONCRETE.

DRAIN PIPE DETAIL AND OVERFLOW TIE IN – TYP BOTH SITES

SCALE: 1/2"=1'-0"

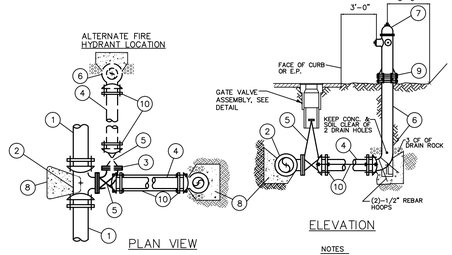


MATERIALS:

1. ONE-INCH FORD "BALLCORP", NPT BY PACK JOINT CORPORATION STOP
2. ONE-INCH HIGH DENSITY POLYTHELYNE PIPE, SDR 11, CONTINUOUS UPWARD SLOPE TO VALVE.
3. ONE-INCH FORD ANGLE BALL METER VALVE #BA43-342W
4. 21-INCH BY 13-INCH BOX 1/4-INCH TREATED EXTERIOR PLYWOOD BOTTOM
5. CONCRETE METER BOX CHRISTY B9 WITH D15 REINFORCED CONCRETE LID (USE C15 LID IN TRAFFIC AREAS)
6. 3/4-INCH AIR RELEASE VALVE-APCO 65
7. 1-INCH BY 3-INCH LONG SCH. 80 PVC THREADED NIPPLE
8. 3/4-INCH NIPPLE (2)
9. 1-INCH BY 3/4-INCH 90 DEGREE ELBOW (2)
10. SMITH BLAIR 372 SADDLE OR APPROVED EQUAL FOR HDPE PIPE, WITH 1" NPT OUTLET.
11. 1-INCH FLEX COUPLING
12. 1-INCH GALV. STEEL PIPE, SECURE TO POST
13. 1-INCH GALV. 90 DEGREE ELBOW (4)

AIR RELEASE VALVE

N.T.S.



PLAN VIEW

ELEVATION

LEGEND

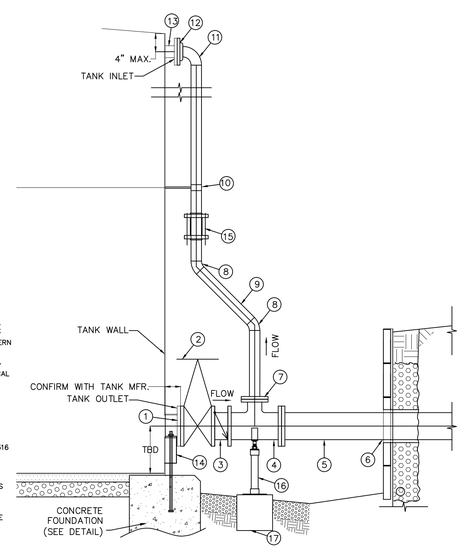
1. WATER MAIN, DUCTILE IRON OR C900 PVC PIPE
2. ANCHORING TEE, (MAIN SIZE) FLG. x 6" FLG.
3. 6" – 90° D.I. BEND, FLG.
4. 6" DUCTILE IRON OR C900 PVC PIPE
5. 6" GATE VALVE, FLG x MJ (RESTRAINED)
6. 6" BURY, MJ (RESTRAINED) x FLG.
7. DRY BARREL HYDRANT, AMERICAN DARLING B62B OR APPROVED EQUAL WITH TWO 2 1/2" AND ONE 4" OUTLETS, ALL NSHT. PAINT "SAFETY YELLOW" PER SANTA CLARA COUNTY STANDARD CFMO-W3.
8. THRUST BLOCK- KEEP CONCRETE CLEAR OF HYDRANT DRAIN HOLES
9. 6", "BREAK-AWAY" SPOOL OR LUGS.
10. 6" MECHANICAL JOINT RESTRAINT FOR D.I. PIPE, EBAA IRON, "MEGALUG" SERIES 1100, OR 3/4" STAINLESS STEEL RODS, ONE ON EACH SIDE, WITH DOUBLE NUTS EACH END.

NOTES

1. FIRE HYDRANTS SHALL BE LOCATED AS SHOWN ON THE PLANS AND AS APPROVED BY THE SANTA CLARA COUNTY FIRE MARSHAL. FIRE MARSHAL REQUIREMENTS SHALL GOVERN OVER THESE PLANS.
2. ALL D.I. PIPE JOINTS USED IN THE HYDRANT ASSEMBLY SHALL BE RESTRAINED AND SHALL BE OF THE MECHANICAL JOINT RETAINER TYPE, EBAA IRON "MEGALUG", OR EQUIVALENT.
3. BOTTOM OF HYDRANT FLANGE SHALL BE AT LEAST 3" BUT NOT MORE THAN 8" ABOVE FINISH GRADE. THE HYDRANT SHALL BE ATTACHED TO THE BURY WITH A "BREAK-AWAY" SPOOL OR LUGS.
4. ALL BURIED STEEL BOLTS AND NUTS SHALL BE TYPE 316 STAINLESS STEEL.
5. PLACE BOLLARDS TO PROTECT FROM VEHICLES AS SPECIFIED BY THE ENGINEER. BOLLARDS SHALL BE THREE FEET MINIMUM FROM THE FACE OF HYDRANT. ALL ORIFICES SHALL BE UNUBSTRUCTED. SEE SANTA CLARA COUNTY BOLLARD DTL.
6. BLUE REFLECTORS SHALL BE PLACED IN ROAD PER THE REQUIREMENTS OF SANTA CLARA COUNTY STANDARD CFMO-W3.

TYP. FIRE HYDRANT ASSEMBLY

N.T.S.



BILL OF MATERIALS FOR CROTHERS TANK OUTLET AND INLET

1. 8" SHELL NOZZLE. FURNISHED BY TANK MFR. SPEC LOWEST POSSIBLE POSITION ON SHELL WALL. (TANK OUTLET)
2. 8" FLANGED GATE VALVE W/ HAND WHEEL, AWWA C509
3. 8" WAFER STYLE TECHNO CHECK VALVE, ELASTOMER HINGED, #5296
4. 8" X 4" DI FLANGED TEE.
5. 8" FLANGED HDPE PIPE. SEE SPEC ELSEWHERE IN THESE DWGS.
6. RETAINING WALL PENETRATION. STRUCTURALLY REINFORCE WALL AROUND PIPE (METHOD OF REINFORCEMENT SHALL BE SUBMITTED TO AND APPROVED BY ENGINEER PRIOR TO CONSTR.) SIDE DIMENSIONS OF SQUARE WALL CUT-OUT SHALL MEASURE NO MORE THAN 1" LONGER THAN PIPE O.D. SEAL GAPS WITH EXPANDING FOAM.
7. 4" x 3" DI COMPANION FLANGE
8. 3" NPT GALV. 45° ELL
9. 3" NPT GALV PIPE, LENGTH AS REQ'D
10. STEEL STANDOFF AND BRACKET. ATTACH TO BOLTED TANK SEAM
11. 3" NPT 90° GALV. ELL
12. 4"X3" DI COMPANION FLANGE
13. 4" FLANGED TANK NOZZLE. CONFIRM PROJECTION DIST. WITH TANK MFR. (TANK INLET)
14. ANCHOR BOLT STIRRUP (BY TANK MFR)
15. DRESSER STYLE 38 FLEX COUPLING FOR STEEL PIPE
16. STANDON SADDLE STYLE PIPE SUPPORT
17. SUPPORT: 12X12 CONCRETE BLOCK, CARRY TO UNDISTURBED SOIL.

TANK INLET–OUTLET DETAIL–CROTHERS TANK

N.T.S.

ISSUED FOR REVIEW
NOT FOR CONSTRUCTION

UNAUTHORIZED CHANGES AND USES:
THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS, ALL CHANGES TO THESE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS.

CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; AND THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

REVISIONS	BY

Binkley Associates, Inc.
CONSULTING ENGINEERS
7246 SHARON DRIVE STE. J ○ SAN JOSE ○ CALIFORNIA 95129 ○ (408) 257-9252

DETAILS

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY
WATER TANK AND PIPELINE REPLACEMENT PROJECT

DATE: 9/17/12
SCALE: AS SHOWN
DRAWN: EAB
DWG.#3830111090 7F
SHEET 9 OF 9 SHEETS

October 10, 2012

Mr. Timothy Schacher
President
Roseview Heights Mutual Water Company
10517 Crothers Road
San Jose, CA 95127

Dear Mr. Schacher,

REPLACEMENT OF THE BON VISTA AND CROTHERS TANKS
DOMESTIC WATER SUPPLY PERMIT REQUIREMENTS
ROSEVIEW HEIGHTS MUTUAL WATER COMPANY, WATER SYSTEM NO. 4300562

This letter is in response to Roseview Heights Mutual Water Company's (RHMWC) proposed project, *Roseview Heights Mutual Water Company Water Tank and Pipeline Replacement Project*, which includes the construction of replacement storage tanks and supply piping between the two tank sites. Due to the size and complexity of the project, the California Health and Safety Code and California Waterworks Standards require that RHMWC apply for a permit. The Department has reviewed the information submitted to date from RHMWC regarding the permit request and has the following comments.

The proposed project includes replacement of the Crothers and Bon Vista Tanks with bolted steel tanks of 55,000 gallons and 165,000 gallons, respectively, at the same sites. Due to the necessity to maintain storage and delivery systems for RHMWC's upper pressure zone while the Crothers is razed and replaced, two 5000 gallon plastic tanks will be sited and plumbed into the system adjacent to the Crothers Tank. The temporary tanks will be removed once the new Crothers tank goes on-line. The project also includes the replacement of existing water mains with approximately 1700 feet of High Density Polyethylene, Polyvinyl Chloride, Ductile Iron, and Steel piping, and other distribution system appurtenances.

RHMWC has submitted a permit application, permit application fee, and plan drawings that were revised and submitted to the Department electronically on September 18, 2012. To complete the application package, RHMWC needs to complete and submit the following documents:

Environmental Information Form

Storage Reservoir, Pump, and Pipe Data Sheets

Regarding the submitted plans, the Department has reviewed them and hereby finds them in conformance with the California Waterworks Standards and acceptable. Please submit the attached forms and a complete set of plans with wet stamp and submit them at your earliest convenience. Please notify us when construction is planned. If you have any question regarding this letter, please contact Ms. Elena Pelen at (510) 620-3654.

Sincerely,

Eric Lacy, P.E.
District Engineer
Santa Clara District
Drinking Water Field Operations Branch
Department of Public Health

Enclosures: Environmental Information Form
Storage Reservoir, Pump, and Pipe Data Sheets

cc: Santa Clara County Environmental Health Department (no encl.)
bcc: E. Pelen, E. Lacy, chron, system file-permit (no encl.)

GEOTECHNICAL INVESTIGATION
NEW WATER TANK
APN 612-07-019
CROTHERS ROAD
SANTA CLARA COUNTY, CALIFORNIA

THIS REPORT HAS BEEN PREPARED FOR:

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

ATTN: MR. TIM SCHACHER

10517 CROTHERS ROAD

SAN JOSE, CALIFORNIA 95127

OCTOBER 2009

MURRAY ENGINEERS INC

GEOTECHNICAL SERVICES

October 15, 2009
Project No. 451-2R1

Roseview Heights Water Company
Attn: Mr. Tim Schacher, President
10517 Crothers Road
San Jose, California 95127

RE: GEOTECHNICAL INVESTIGATION,
NEW WATER TANK,
APN 612-07-019, CROTHERS ROAD,
SANTA CLARA COUNTY, CALIFORNIA

Dear Mr. Schacher:

We are pleased to present the results of our geotechnical investigation relating to the design and construction of a new water tank on the Roseview Heights Mutual Water Company property, APN 612-07-019, located on Crothers Road in an unincorporated area of Santa Clara County, California. This report summarizes the results of our field, laboratory, and engineering work, and presents conclusions and recommendations concerning the geologic and geotechnical engineering aspects of the project.

Our report is contingent upon our approval of the project plans and our observation and testing, as necessary, of the foundation, earthwork, and drainage aspects of the construction.

If you have any questions concerning our investigation, please call.

Very truly yours,
MURRAY ENGINEERS, INC.

Jason Kong, E.I.T.
Staff Engineer

John A. Stillman, G.E., C.E.G.
Principal Geotechnical Engineer

JK:JAS

Copies: Addressee (6)

2951 El Camino Real, Palo Alto, California 94306
Phone: 650.326.0440 Fax: 650.326.0540

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GEOTECHNICAL INVESTIGATION
NEW WATER TANK
APN 612-07-019, CROTHERS ROAD
SANTA CLARA COUNTY, CALIFORNIA

INTRODUCTION

This report presents the results of our geotechnical investigation relating to the design and construction of a new water tank on the Roseview Heights Mutual Water Company property, APN 654-07-016, located on Crothers Road in unincorporated Santa Clara County, California. The project location is indicated on the Vicinity Map, Figure A-1. The purpose of our investigation was to evaluate the site's subsurface conditions and provide geotechnical design criteria and recommendations for the new tank foundation.

Project Description

The Roseview Heights Mutual Water Company property is located approximately 30 feet southeast of Crothers Road. An existing approximately 10-foot tall by 14-foot diameter, 10,000-gallon redwood water tank is located along the northeastern side of the site. We understand that the project will include replacing the existing water tank with a new larger tank. We anticipate that moderate amounts of cut or fill and a retaining wall may be needed to create a large relatively flat pad for the new water tank. The final tank size will depend on the type of foundation and storage requirements by the Santa Clara County Fire Department, but we understand that it will be located in the same general area as the existing tank. Based on a discussion with Mr. Tom Schacher of Roseview Heights Mutual Water Company, the project civil engineer's usage calculations show that a 25,000-gallon tank is needed; however, the Santa Clara County Fire Department may require up to 70,000 gallons. Therefore, tank sizes will most likely range from approximately 18 to 24 feet in diameter and approximately up to 20 feet tall. The general configuration of the property, location of the existing water tank, and relative scale and assumed location of the proposed water tank are shown in Figure A-2, Site Plan.

The property is located within the State earthquake fault zone and a State landslide hazard zone. In addition, the site is located within the County fault rupture hazard zone associated with Hayward fault zone. Based on our conversations with the County Geologist, Mr. Jim Baker, we have been informed that as long as a catastrophic failure of the tank will not significantly impact neighboring residences, then fault location and seismic slope stability evaluations will not be required. We have therefore not included these detailed geologic hazard evaluations as a part of this scope.

Scope of Services

We performed the following services in accordance with our agreement with you dated June 16, 2009 (executed on July 15, 2009):

- Reviewed geologic and seismic conditions in the site vicinity and commented on the geologic hazards that could potentially affect the site
- Performed an engineering geologic reconnaissance and mapping on the site in the vicinity of the proposed improvements
- Explored the subsurface conditions by excavating, logging, and sampling two exploratory borings in the vicinity of the planned improvements
- Performed laboratory analyses and testing on selected soil samples for soil classification and to evaluate engineering properties of the subsurface materials
- Performed geotechnical engineering analyses to develop geotechnical engineering design criteria for the proposed water tank
- Prepared this report containing a summary of our investigation and our geotechnical conclusions and recommendations

GEOLOGIC & SEISMIC CONDITIONS

Geologic Overview

The subject property is located in the foothills along the southwestern side of the Diablo Mountain Range, a northwest-trending range within the California Coast Ranges geomorphic province. According to the USGS topographic map of the San Jose East and Calaveras Reservoir Quadrangles, the site is situated at an approximate elevation of 1060 feet above mean sea level (see Figure A-1, Vicinity Map).

According to the geologic maps of the San Jose East and Calaveras Reservoir Quadrangles (1997), the subject property is located in an area underlain by Panoche Formation conglomerate (Kpc). The Cretaceous age (approximately 65 to 140 million years old) Panoche Formation consists of clastic lithologies of marine origin, including conglomerate (Kpc), sandstone (Kps), and mudstone (Kp). The Panoche Formation conglomerate is generally described as brown, crudely bedded, conglomerate consisting of cobbles of mostly porphyritic metavolcanic rock, hard plutonic rocks and some gray quartzite. According to the geologic map, the subject property is located near a massive ancient landslide (Qls) which occupies the hillside approximately 1000 feet to the south and approximately 1,600 feet to the east of the site. The pertinent portion of the geologic map is included in Figure A-3, Vicinity Geologic Map.

According to a JPEG map clip provided by the County Geologist, the site is presumably located near the center of a suspected dormant landslide feature. Based on our rough measurements, the dormant landslide feature is approximately 450 feet wide and 650 feet long facing downhill towards the east-southeast direction (see Figure A-4).

According to the State Seismic Hazard Zones map for the Calaveras Reservoir Quadrangle, the site is located within a zone classified as having a potential for earthquake-induced landsliding. The pertinent portion of the Seismic Hazard Zones map is included in Figure A-5, State Seismic Hazard Zones Map.

Seismicity

Geologists and seismologists recognize the San Francisco Bay Area as one of the most active seismic regions in the United States. There are three major faults that trend in a northwest direction through the Bay Area, which have generated about 12 earthquakes per century large enough to cause significant structural damage. The faults along which these earthquakes occur are part of the San Andreas fault system that extends for at least 700 miles along the California Coast, and includes the San Andreas, Hayward, and Calaveras faults. The Calaveras Fault is located approximately 3.9 kilometers northeast of the site and the main trace of the San Andreas Fault is located approximately 28.8 kilometers southwest of the site, respectively.

We note that the site is located within the Hayward fault zone, a broad zone of faulting that runs along the western margin of the Diablo Range. As a consequence, the proposed tank site is located within a County of Santa Clara fault hazard zone (see Figure A-6, Santa Clara County Fault Hazard Zone Map). In addition, according to available maps, an active splay of the Hayward fault zone presumably crosses the tank site property (see Figure A-4).

Seismologic and geologic experts convened by the U. S. Geological Survey, California Geological Survey, and the Southern California Earthquake Center conclude that there is a 63 percent probability for at least one "large" earthquake of magnitude 6.7 or larger in the Bay Area before the year 2038. The northern portion of the San Andreas fault is estimated to have a 21 percent probability of producing a magnitude 6.7 or larger earthquake by the year 2038 (2007 WGCEP, 2008).

SITE EXPLORATION AND RECONNAISSANCE

Exploration Program

An initial site reconnaissance was performed by our principal engineering geologist on June 27, 2009. Our subsurface investigation was performed on July 17, 2009 and included the excavation of two exploratory borings to depths ranging from 16 to 18 feet at the locations shown on Figure A-2, Site Plan. The boring locations were approximately determined by measuring distance and bearing from known points on the site using a tape measure and should be considered accurate only to the degree implied by the mapping technique used.

The borings were advanced by continuous sampling using a portable minuteman drilling/sampling apparatus. Soil samples were collected with split-spoon samplers that were driven with a 140-pound hammer repeatedly dropped from a height of 30 inches with a rope and cathead. Samplers included the 2-inch outside diameter (OD) Standard Penetration Test (SPT) sampler, as well as 2.5- and 3-inch OD split-spoon samplers. The sampler types used are indicated on the log at the appropriate depth. The number of hammer blows required to drive the samplers were recorded in 6-inch increments and the sum of the second and third increments is presented on the boring logs. The blow count data has not been corrected for sampler type or hammer efficiency. The logs of our borings are presented in Appendix B as Figures B-1 and B-2. Also included in Appendix B are Figure B-3, Key Borings Logs and Figure B-4, Unified Soil Classification System.

Our staff engineer logged the borings in general accordance with the Unified Soil Classification System. The boring logs show our interpretation of the subsurface conditions at the locations and on the date indicated and it is not warranted that these conditions are representative of the subsurface conditions at other locations and times. In addition, the stratification lines shown on the logs represent approximate boundaries between the soil and bedrock materials and the transitions may be gradual.

Site Description

The approximately 1,900 square-foot property is located on the southwestern side of Crothers Road in a developed residential area of unincorporated Santa Clara County near San Jose. The site is trapezoid-shaped with the parallel sides measuring approximately 30 and 54 feet in length; and the irregular sides measuring approximately 45 and 51 feet in length. The site is bounded by Crothers Road to the northeast and by a neighboring residence on all other sides.

The natural topography of the site slopes downward to the southwest at an average gradient of approximately 3:1 (horizontal to vertical). The topography was modified to create a flat

building pad for the water tank. Access to the site is provided by an easement, which extends southwest from Crothers Road down to the northeastern side of the site. A series of wood steps extend down the approximately 10-foot high 2:1 (horizontal to vertical) cut slope on the northeastern side of the site to a chain link fence which surrounds the existing water tank. The approximately 10-foot tall by 14-foot diameter, 1,500-gallon redwood water tank is situated on a flat pad which appears to have been created by cutting into the hillside. The water tank appears to be supported by a slab-on-grade foundation. A 3:1 slope descends southwesterly from the cut pad to the southwestern edge of the site.

Drainage across the property is generally characterized as uncontrolled sheet flow to the southwest. Natural sheet flow is interrupted by the building pad.

Subsurface

Although the exact size and position of the proposed water tank has not been finalized at the time of our investigation, the two exploratory borings were excavated at points around the property to delineate a broad building envelope.

In general, the two exploratory borings encountered colluvium underlain by what our firm interprets to be ancient landslide debris/older colluvium from the surface to the full depth explored of 18 feet. Detailed logs of the borings are presented in Appendix B. The location of each boring is presented on Figure A-2, Site Plan. A general description of the subsurface conditions and the approximate location of each exploratory boring are described hereunder.

Boring B-1, located at the northeastern side of the anticipated area of the proposed water tank, encountered approximately 4.5 feet of colluvium consisting of hard to very stiff silty clay with gravel underlain by approximately 1.5 feet of ancient landslide debris/older colluvium consisting of hard silty clay with gravel. The silty clay with gravel was underlain by approximately 8 feet of very stiff to hard sandy clay with gravel underlain in turn by medium dense gravelly sand with silt, which persisted to the full depth explored of approximately 16 feet.

Boring B-2, located at the southwestern side of the anticipated area of the proposed water tank, encountered approximately 5 feet of colluvium consisting of very stiff to stiff silty clay with gravel underlain by approximately 1 foot of ancient landslide debris/older colluvium consisting of very stiff sandy clay with gravel. The sandy clay with gravel was underlain by medium dense gravelly sand, which persisted to the full depth explored of approximately 18 feet.

Atterberg Limits testing was performed on a sample of surficial silty clay colluvium from Boring B-1 between a depth of 0 and 2 feet. The testing yielded a plasticity index of 26 percent and a liquid limit of 41 percent, indicating that this material has a moderate to high potential for expansion.

Groundwater

We did not encountered free groundwater while drilling; however, we noted that Boring B-2 appeared to be grading to saturated below a depth of approximately 14 feet. The borings were backfilled prior to our departure from the site on the day of drilling. We note that fluctuations in the level of groundwater can occur due to variations in rainfall, temperature, landscaping, and other factors that may not have been evident at the time our observations were made.

CONCLUSIONS

From a geotechnical perspective, it is our opinion that the site is suitable for the proposed new water tank, provided the recommendations contained in this report are implemented in the design and construction of the water tank foundation. In our opinion, the primary geotechnical constraints to the proposed improvements include the moderately steep slope, the presence of moderately to highly expansive surficial soil, the potential for downhill creep of the relatively weak surficial soil present on the slope, the potential for landsliding, the potential for fault rupture, and the potential for strong ground shaking during a moderate to large earthquake on any one of the nearby active faults.

As indicated in our project description section above, the property is located within the State earthquake fault zone and the State landslide hazard zone. In addition, the site is located within the County fault rupture hazard zone associated with Hayward fault zone. Based on our conversations with the County Geologist, Jim Baker, we have been informed that as long as a catastrophic failure of the tank will not impact adjacent residences, then fault location and seismic slope stability evaluations will not be required.

We note that there are existing residences at 10555 Crothers Road located roughly 75 feet south and at 10600 Crothers Road located roughly 850 feet west of the project site. The residence at 10555 Crothers Road is not located directly downhill of the proposed water tank. The residence at 10600 Crothers Road is located on a spur ridge at a high elevation than the immediate surrounding topography. Based on our observations at the site and review of the surrounding topography, these two existing residences appear to be far enough from the tank site that they would not be significantly impacted in the event of a catastrophic failure of the tank initiated by landsliding or seismic induced ground deformation.

Specifically, in the event of a catastrophic failure of the tank, we anticipate that any uncontrolled water and potential soil debris resulting from this water source would likely be contained in the west-southwesterly swale feature and eventually dissipate into the reservoir feature located below the tank site.

Based on our investigation, it appears that the site is underlain by approximately 4 to 5 feet of moderate to highly expansive fine-grained colluvial soils underlain by ancient landslide debris/older colluvium. In our opinion, the ancient landslide debris should provide adequate support for the foundations of the proposed water tank.

Geologic Hazards

As part of our investigation, we evaluated the potential for geologic hazards to impact the site and the proposed improvements. The results of our review are presented below:

- Landsliding – Based on our site reconnaissance, we did not observe any evidence of active landsliding on the property in the form of bare scarps, ground cracks, seepage, etc. We interpret that the landslide feature shown on the map provided by the County Geologist appears dormant and does not show evidence of recent slope movement. We note that the long-term stability of this landslide feature was not evaluated as a part of this scope. However, because of the moderately steep natural slopes on the site and the layer of relatively weak colluvial soil blanketing the site it is our opinion that, the occurrence of a new shallow landslide in this area cannot be excluded. A new shallow landslide could be triggered by excessive precipitation or strong ground shaking associated with an earthquake. In our opinion, a new shallow landslide should not pose a significant hazard to the proposed improvements, provided that they are designed and constructed in accordance with the recommendations of this report.

  It should be noted that although our knowledge of the causes and mechanisms of landslides has greatly increased in recent years, it is not yet possible to predict with certainty exactly when and where all landslides will occur. At some time over the span of thousands of years, most hillsides will experience landslide movement as mountains are reduced to plains. Therefore, an unknown level of risk is always present to structures located in hilly terrain. Owners of property located in these areas must be aware of and be willing to accept this risk.

- Fault Rupture – Based on our site reconnaissance and review of published maps, it is our opinion that there may be an active splay of the Hayward Fault zone that crosses the proposed tank site property (see Figure A-4). We note that the exact location

and relative activity of the fault splay is uncertain because the surficial soil is underlain by what we interpret to be ancient landslide debris/older colluvium. In addition, we did not observe any discernable evidence of shearing in our exploratory borings suggestive of past fault activity. Given this information, in our opinion the potential for fault rupture to occur at the site is moderate to high. In our opinion, there is a risk that fault rupture may damage the proposed tank structure and associated buried pipe connections. We note that there is no means to design against fault rupture; however, designing the new water tank in accordance with current earthquake resistant standards should mitigate the potential for catastrophic damage to some degree. In addition, the flexible nature of the water tank structure should also aid in reducing the potential damage from fault rupture.

- Ground Shaking – As noted in the Seismicity section above, moderate to large earthquakes are probable along several active faults in the greater Bay Area. Therefore, strong ground shaking should be expected several times during the design life of the proposed improvements. In our opinion, the new water tank should be designed in accordance with current earthquake resistant standards, and design parameters presented in this report to mitigate this concern.

- Differential Compaction - During moderate and large earthquakes, soft or loose, natural or fill soils can become densified and settle, often unevenly across a site. In general, the soil materials encountered at the site are stiff to hard, in our opinion, are not susceptible to differential compaction. In our opinion, differential compaction of this material should not constitute a significant hazard to the proposed improvements provided that they are supported on foundations designed in accordance with the recommendations presented in this report.

- Liquefaction – Liquefaction is a process by which soil deposits below the water table temporarily lose strength and behave as a viscous liquid rather than a solid, typically during a moderate to large earthquake. In general very loose to medium dense, clean fine- to medium-grained sand and very soft to firm, low plasticity silts, which are free of clay are most susceptible to liquefaction. Earthquake-induced ground shaking can cause these loose or soft materials to densify, resulting in increased pore water pressures and an upward movement of groundwater that may result in a liquefied condition. Depending on the weight of the structure, the depth to the liquefied stratum and the nature of the overlying soils, structures situated above such temporarily liquefied soils may sink or tilt, causing significant structural damage. Because the site is underlain by competent ancient landslide debris/older colluvium at relatively shallow depths, it is our opinion that the potential for liquefaction to occur at the site is negligible.

RECOMMENDATIONS

Because of the moderately steep slopes, the presence of moderately to highly expansive surficial soil, the potential for downhill creep of the relatively weak surficial soil present on the slope, and the potential for strong ground shaking; we recommend that the flat bottom, bolted steel tank be supported on either a Type 1 (Ringwall Foundation) or Type 2 (Structural Slab Foundation), designed and constructed in accordance with our recommendations and that of the American Water Works Association Standard for Factory-Coated Bolted Steel Tanks for Water Storage. Due to the geotechnical constraints noted above, both Type 1 and Type 2 foundation options should be supported on drilled, reinforced, cast-in-place, concrete friction piers gaining support in the underlying ancient landslide debris/older colluvium. Although plans are tentative, we anticipate that Type 1 and Type 2 options may require retaining walls to accommodate a relatively flat building pad. The retaining walls should be supported on drilled piers.

Alternatively, the new water tank may be supported on a Type 3 (Mat Slab Foundation). The mat slab should bear on a relatively thick section of engineered fill to help provide uniform bearing conditions across the anticipated cut-fill pad that will be utilized. We note that based on review of historical performance from past earthquakes, a mat foundation without the use of piers may potentially sustain less damage from primary fault rupture or secondary seismic induced ground deformation than a foundation supported on relatively deep piers by allowing the structure to float on top of a moving/shifting surface. In addition, repair of differential foundation settlement could be readily performed by means of pressure grouting beneath the mat slab to bring it to an operating level soon after the earthquake. We note that the use of this foundation type would not help the potential issue of damage to pipes servicing the water tank source; however, utilizing flexible pipe connections should mitigate this concern to some degree. In addition, this Type 3 foundation option may be impacted by differential foundation movement associated with soil creep, expansion and contraction of the near-surface support soils, and different bearing support material transitioning across the anticipated cut-fill pad. The use of a relatively thick section of engineered fill beneath the mat slab should help provide relatively uniform bearing conditions across the anticipated cut-fill pad and mitigate the potential for expansive soil movement. In addition, installing a stitch pier retaining wall along the downhill tank should help resist against downhill creep.

Detailed foundation, grading, and drainage recommendations and geotechnical design criteria are presented below. We should review the proposed layout and design, prior to completion of the final plans, to verify that the following recommendations are appropriate.

2007 CBC EARTHQUAKE DESIGN PARAMETERS

We understand that the proposed water tank will fall under the seismic design category for ground-supported flat-bottom reservoirs. To aid the structural engineering in the design of the proposed tank structure against earthquake resistance, we have developed site-specific earthquake design parameters based on the procedures described in Chapter 16, Section 1613 of the 2007 California Building Code (California Building Standards Commission, 2007). These procedures utilize State standardized spectral acceleration values for maximum considered earthquake ground motion taking into account historical seismicity, available paleoseismic data, and activity rates along known fault traces, as well as site-specific soil and bedrock response characteristics. Contour maps of Class B bedrock horizontal spectral acceleration values for the State of California are included as figures in Chapter 16 of the 2007 CBC, representing both short (0.2 seconds) and long (1.0 second) periods of spectral response and taking into account 5 percent of critical damping. Leyendecker and others (2007) have prepared a software program for public use that allows for site-specific adjustments of these acceleration values for different subsurface conditions, which are defined by site classes. Given a representative latitude of 37.383 and longitude of -122.800, in accordance with guidelines presented in the 2007 CBC, the following seismic design parameters will apply for this site:

- Site Class D – Soil Profile Name: Stiff Soil (Table 1613A.5.2)
- Mapped Spectral Accelerations for 0.2 second Period: S_S= 1.506 (Site Class B)
- Mapped Spectral Accelerations for a 1-second Period: S_1= 0.600 (Site Class B)

DRILLED PIER FOUNDATION

We recommend that the proposed water tank be supported on either a Type 1 (Ringwall Foundation) or Type 2 (Structural Slab Foundation) on drilled, reinforced, cast-in-place, concrete friction piers gaining support in the underlying ancient landslide debris/old colluvium. In addition, if site retaining walls will be incorporated to modify site grades, we recommend that the site retaining walls be supported on drilled piers gaining support in the underlying ancient landslide debris/old colluvium. Drilled piers should be at least 16 inches in diameter, a minimum of 15 feet deep, and extend at least 10 feet into the underlying ancient landslide debris/older colluvium or an equivalent depth of native soil plus any proposed fill as into ancient landslide debris/older colluvium, whichever is deeper. Based on our subsurface investigation, we anticipate that pier depths will range from approximately 15 to 20 feet but will depend on the amount of grading to be performed.

The piers should be designed to resist dead plus live loads using an allowable skin friction value of 450 pounds per square foot for the depth of the pier in ancient landslide

debris/older colluvium, below any fill, with a one-third increase allowed for transient loads, including wind and seismic forces. The portion of the pier in fill or weak native soil and any point-bearing resistance should be neglected for support of vertical loads. In general, drilled piers should be spaced no closer than approximately three pier-diameters, center-to-center.

Piers should be designed to resist active loads from downhill creep of the colluvial soil, which blanket project site. Active loads from downhill soil creep can be calculated on the basis of an equivalent fluid weight of 85 pounds per cubic foot (pcf) taken over 2 pier diameters for the depth of the pier embedded in fill and colluvial soil. The depth of the colluvial soil and active soil creep loads will vary across the site depending on the thickness of the colluvial soil and the extent of any proposed grading. Based on our subsurface investigation, we encountered approximately 5 feet of active soil. However, because the extent of proposed grading is unknown at this time, we recommend that the structural engineer include a pier design table that will allow for varying pier designs depending on the observed fill/colluvium thickness observed by us during pier drilling.

Lateral loads may be resisted by passive earth pressure based upon an equivalent fluid pressure of 400 pounds per cubic foot, acting on 1.5 times the projected area for the depth of the pier in ancient landslide debris/older colluvium. Any passive resistance corresponding to the surficial soil described above should be neglected.

Because of the potentially expansive nature of the surficial soil, the tops of piers should be prevented from "mushrooming." This may be accomplished by placing Sonotubes within the upper 2 to 3 feet of the pier excavations prior to placement of concrete or by other construction methods. If Sonotubes are used, they should fit snugly within the pier excavations.

Pier reinforcing should be determined by the project structural engineer based on the preceding design criteria and structural requirements. However, as a minimum, piers should be reinforced with a cage of four No. 4 steel reinforcing bars for the full length of the piers.

The bottoms of the pier excavations should be substantially free of loose cuttings and soil slough prior to the installation of reinforcing steel and the placement of concrete. In addition, any significant amounts of accumulated water in the pier excavations should be pumped out prior to placing concrete or displaced using the tremie method when placing concrete. A representative of Murray Engineers, Inc. should observe the pier excavations to evaluate whether the piers are founded in the supportive material and whether the pier excavations are properly prepared. The pier depths recommended above may require adjustment, if differing conditions are encountered during excavation. Pier excavations

should be filled with concrete as soon as practical after drilling to minimize the potential for caving.

TYPE 1 – RINGWALL FOUNDATION

A ringwall foundation, if proposed, should be supported on drilled piers designed in accordance with the recommendations provided above for the water tank. The top of the ringwall foundation should extend at least 6 inches above the final adjacent exterior grade. The bottom of the ringwall foundation should also at least 6 inches below the final adjacent exterior grade. If additional bearing capacity is required by the structural engineer to support the interior span of the new water tank, the interior of the water tank may gain some support from a relatively uniform thickness of engineered fill.

As a minimum, we recommend the ringwall foundation include a minimum of four No. 5 steel reinforcing bars, two near the top and two near the bottom, to provide structural continuity and to permit the spanning of local irregularities. Actual ringwall reinforcing should be determined by the project structural engineer based on the preceding design criteria and structural requirements.

TYPE 2 – STRUCTURAL SLAB FOUNDATION

Structural slab foundations should be supported on drilled piers designed in accordance with the recommendations provided above for the water tank. The structural slab should be reinforced with a grid of steel reinforcing bars with sufficient capacity to span to adjacent pier elements. The project structural engineer should establish structural slab reinforcing based on anticipated loading and the design criteria presented in this report.

TYPE 3 – MAT SLAB FOUNDATION

As an alternative to Type 1 and Type 2 foundation options, the new water tank may be supported on a mat slab foundation bearing on a relatively thick section of engineered fill. The engineered fill pad should conform to the recommendations presented in the Earthwork section of this report. Specifically, we recommend that the upper 24 inches within the tank footprint and a minimum of about 3 feet on all sides should be removed and replaced with 24 inches of compacted select granular fill, such as baserock. The final depth of over-excavation, however, should be evaluated in the field by a representative from this firm.

The mat should be a minimum of 10 inches in thickness and be designed for allowable bearing pressures of 2,000 pounds per square foot for combined dead plus live loads, with a one-third increase allowed for transient loads, including wind or seismic forces.

If the structural engineer will utilize a modulus of subgrade reaction in the mat design, we estimate that the modulus of vertical subgrade reaction for a 1-foot square plate (based on Terzaghi's method - Figure 6 of the Navy Design Manual, Chapter 5, NAVFAC DM 7.1) for the dense soil below a depth of approximately 2 feet to be approximately 90 pounds per cubic inch (pounds per square inch per inch). We caution that the structural engineer should consider the dimensions of the loaded area and the various column and line loading/spacing in establishing the modulus of subgrade reaction in accordance with the guidance presented in the Navy design manual or in Section 9.6 of Foundation Analysis and Design (Bowles, 1996).

Lateral loads may be resisted by friction between the mat bottom using a friction coefficient of 0.30 for concrete formed on prepared subgrade materials. The mat foundation should be reinforced with a grid of steel reinforcing bars. The project structural engineer should establish mat reinforcing based on anticipated loading and the design criteria presented in this report.

Our representative should observe the mat slab excavation prior to placing reinforcing steel and concrete forms to note that they are founded in competent bearing materials and have been properly cleaned of loose soil. In addition, any loose soil that falls into the excavations during placement of reinforcing steel and formwork should be removed prior to placing concrete.

If this option is considered, we anticipate that some form of a retaining wall supported on piers may be required to create a relatively flat building pad and also mitigate the potential for soil creep movement along the downhill side of the tank. The piers should be designed in accordance with the drilled pier recommendations provided above. In addition, the piers for this wall may have to be spaced relatively close together (maximum of approximately 3 pier diameters) to help mitigate the potential for creep of the active soil column.

SITE RETAINING WALLS

Site retaining walls may be utilized to accommodate site grade changes. Site retaining wall foundations should be designed in accordance with the recommendations provided above.

Lateral Earth Pressures

Retaining walls should be designed to resist lateral earth pressure from the adjoining natural soils, backfill, seismic, and surcharge loads. Assuming that the backfill behind the walls will be level (e.g., not sloping upward) and that adequate drainage will be incorporated as recommended below, we recommend that walls restrained from movement at the top be designed to resist an equivalent fluid pressure of 45 pounds per cubic foot (pcf) plus a

uniform lateral pressure of 8H pounds per square foot (psf), where H is the height of the retained soil in feet. Restrained walls should also be designed to resist an additional uniform pressure equal to one-half of any surcharge loads applied at the surface. Any unrestrained retaining walls with level backfill and adequate drainage should be designed to resist an equivalent fluid pressure of 45 pcf plus one-third of any surcharge loads.

In accordance with the 2007 CBC, new retaining walls, if applicable, may also be designed to resist lateral earth pressure from seismic loading. We recommend that the seismic loading be based on a uniform equivalent fluid pressure of 12H pounds per square foot (psf)/foot of wall height, where H is the height in feet of the retained soil. We also note that the allowable passive pressures provided for retaining wall foundations may be increased by one-third for short-term seismic forces.

If the backfill behind the wall will be sloping upward from the wall, we recommend that the equivalent fluid pressures given above be increased by 3 pcf for each 4-degree increase in slope inclination.

Retaining Wall Drainage

We recommend that any proposed retaining walls be provided with a subsurface drainage system to mitigate the buildup of water pressure from surface water infiltration and/or other possible sources of water. The retaining wall drainage system should consist of a minimum 4-inch diameter, perforated, SDR 35 or Schedule 40 PVC pipe (or similar) with the perforations facing down, resting on a thin layer of drainrock at the base of the wall.

The pipe should be backfilled with drainrock consisting either of Caltrans Class 2 permeable material or ½- to ¾-inch clean crushed rock. If crushed rock is used, it should be separated from the native soil and soil backfill by a geosynthetic filter fabric, such as TC Mirafi 140N or equivalent. The perforated pipe itself should not be wrapped with filter fabric because, in our opinion, this practice increases the likelihood of clogging of the small perforations in the pipe. The drainrock should extend vertically to within 12 inches (no higher) of the finished grade and laterally at least 12 inches from the wall. The upper 12 inches of backfill should consist of compacted on-site soil to mitigate surface water infiltration into the subdrain system.

The subdrain pipes should be provided with a minimum 1 percent slope to discharge and should be provided with cleanout risers at their up-gradient ends and at most sharp directional changes to facilitate maintenance. Perforated subdrain pipes should be connected to solid (non-perforated) discharge pipes to convey collected water to discharge at an appropriate downslope location. Roof downspouts and any proposed surface area drains should not be permitted to discharge into the retaining wall drainage system.

Retaining Wall Backfill

Backfill placed behind site retaining walls should be compacted in accordance with the Compaction specifications given in our referenced geotechnical report, using light compaction equipment. If heavy compaction equipment is used, the walls should be temporarily braced.

EARTHWORK

A moderate amount of earthwork is anticipated as part of the project, including grading of the proposed building pad, retaining wall backfill, and the excavation of drilled pier foundations. Any proposed earthwork should be performed in accordance with the following recommendations.

Clearing & Site Preparation

Initially, the proposed improvement areas should be cleared of the existing tank, its foundations and water supply lines, and surface vegetation. Holes or depressions resulting from the removal of underground obstructions, such as foundations, root balls, or decommissioned utilities, which extend below proposed subgrade levels should be backfilled with engineered fill, placed and compacted in accordance with the recommendations provided below. After clearing, the proposed improvement areas should be stripped to a depth of approximately 3 inches to remove organic-laden topsoil. The stripped material should not be used as engineered fill; however, it may be stockpiled and used for landscaping purposes.

Material for Fill

Fill placed beneath the proposed water tank should consist of select granular fill material composed predominantly of non-expansive granular soil. If Class 2 aggregate baserock is used as select fill, it should meet the general specifications outlined in the Caltrans Standard Specifications, latest edition.

All on-site soils below the stripped layer having an organic content of less than 3 percent organic material by volume (ASTM D 2974) should be suitable for use as engineered fill. In general, fill material should not contain rocks or pieces larger than 6 inches in greatest dimension, and contain no more than 15 percent larger than 2.5 inches. Imported fill should be predominately granular or should have a plasticity index of less than 15 percent. Any proposed fill for import should be approved by Murray Engineers, Inc. prior to importing to the site. Our approval process may require index testing to establish the expansivity of the

soil; therefore, it is important that we receive samples of any proposed import material at least 3 days prior to importing.

Fill Slope Construction

Fill placed on slopes steeper than 5:1 should be retained or should be keyed and benched into supportive material to provide a firm, stable surface on which to support the fill. Prior to fill placement on slopes steeper than 5:1, a construction keyway should be excavated at the toe of the fill. The keyway should be a minimum of 10 feet wide or of a width equal to half the height of the fill slope; whichever is greater. The keyway should be excavated a minimum of 3 feet into supportive material, as measured on the downhill side of the excavation. The base of the keyway excavation should have a nominal slope of approximately 2 percent dipping toward the back (uphill side) of the key. Subsequent construction benches should be excavated to remove any non-supportive surficial soil and should also have a nominal slope of approximately 2 percent dipping in the uphill direction. Our representative should observe the completed keyway and bench excavations to confirm that they are founded in materials with sufficient supporting capacity.

In general, fills exceeding roughly 5 feet in depth should be provided with subdrainage. Subdrains should consist of a 4-inch diameter, rigid, heavy-duty, perforated pipe (Schedule 40, SDR 35 or similar), approved by the soil engineer, embedded in Class 2 permeable material or ½- to ¾-inch clean crushed rock placed along the upslope side of keyways and benches for the full height of the keyway or bench cut. If crushed rock is used, it should be separated from the fill and the native material by a geotextile filter fabric. The perforated subdrain pipe should be placed with the perforations down on a 2- to 3-inch bed of drainrock. Subdrain pipes should be provided with clean-out risers at their up-gradient ends and at all sharp changes in direction. Subdrain systems should be provided with a minimum 1 percent gradient and should discharge onto an energy dissipater at an appropriate downhill location. The keyway, benching, and subdrain details are shown schematically on Figure A-7, Schematic Fill Slope Detail.

Compaction

Prior to fill placement, the surface to receive the fill should be scarified to a depth of 6 inches, as necessary, and then recompacted in accordance with the recommendations presented below. Any proposed engineered fill should be compacted in uniform lifts no thicker than approximately 8-inches in uncompacted thickness, conditioned to the appropriate moisture content, and compacted to the specifications listed in Table 1 below. The relative compaction and moisture content specified in Table 1 is relative to ASTM D 1557, latest edition. Compacted lifts should be firm and non-yielding under the weight of compaction equipment prior to the placement of successive lifts.

Table 1. Compaction Specifications

Fill Element	Relative Compaction*	Moisture Content*
General fill for raising of site grades and retaining wall backfill (for fills up to 4 feet thick)	90 percent	2-3% Over Optimum
General fill for raising of site grades and retaining wall backfill (for fills greater than 4 feet thick)	93 Percent (entire fill)	Near optimum
Select granular engineered fill such as baserock	95 percent	Near optimum
½- to ¾-inch Crushed Rock - Compact with at least 3 passes of a vibratory plate with lift-thickness ≤ 12 inches.	see note at left	Not Critical
Backfill of utility trenches using on-site soil	90 percent	2-3% Over Optimum
Backfill of utility trenches using imported sand	90 percent	2-3% Over Optimum

* Relative to ASTM D 1557, latest edition.

Temporary Slopes and Trench Excavations

The contractor should be responsible for the stability of all temporary slopes and trenches excavated at the site and design and construction of any required shoring. Shoring and bracing should be provided in accordance with all applicable local, state, and federal safety regulations, including the current OSHA excavation and trench safety standards. Because of the potential for variable soil conditions, field modifications of temporary cut slopes may be required. Unstable materials encountered on the slopes during the excavation should be trimmed off, even if this requires cutting the slope back at flatter inclinations.

Final Slopes

Any proposed cut slopes in the surficial soil and any proposed fill slopes should have gradients no steeper than 2:1 (horizontal to vertical). In general, all fill slopes should be over-filled and then cut back to proposed final slope gradients.

All graded surfaces or areas disturbed by construction should be revegetated prior to the onset of the rainy season following construction to mitigate excessive soil erosion. If vegetation is not established, other erosion control provision should be employed. Ground cover, once established should be properly maintained to provide long-term erosion control.

SITE DRAINAGE

Control of surface drainage is critical to the successful development of hillside properties. Surface run-off from rain or any potential discharge should not be allowed to pond near the tank structure. The finished grades should be designed to drain surface water away from the proposed tank foundations, to suitable discharge points. The ground surface should be graded to slope away from the tank with a minimum slope of 2 percent for a distance of at least 5 feet around the structure. Where such surface gradients are difficult to achieve, we recommend that area drains or surface drainage swales be installed to collect surface water and convey it to a suitable discharge location.

Surface runoff should not be allowed to flow over the top of any artificial slope. The ground surface at the top of the slope should be graded to slope away from the slope or a berm or lined drainage ditch should be provided at the top of the slope. All collected water should be conveyed away from the structures via buried closed conduit and discharged either onto an energy dissipater at an appropriate downslope location.

We recommend that annual maintenance of the surface drainage systems be performed. This maintenance should include; inspection and flushing of area drains to make sure that they are free of debris and are in good working order, and inspection of surface drainage outfall locations to verify that introduced water flows freely through the discharge pipes and that no excessive erosion has occurred. If erosion is detected, this office should be contacted to evaluate its extent and to provide mitigation recommendations, if needed.

REQUIRED FUTURE SERVICES

Plan Review

To better assure conformance of the final design documents with the recommendations contained in this report, and to better comply with the building department's requirements, Murray Engineers, Inc. must review the completed project plans prior to construction. The plans should be made available for our review as soon as possible after completion so that we can better assist in keeping your project schedule on track. We recommend that the following note be added to the architectural, structural, and civil plans:

- All earthwork and site drainage, including, the excavation of the drilled pier foundation, placement and compaction of engineered fill, and installation of surface and subsurface drainage should be performed in accordance with the recommendations of the geotechnical report prepared by Murray Engineers, Inc., dated October 15, 2009. Murray Engineers, Inc. should be provided at least 48 hours advance notification (650-326-0440) of any earthwork operations and should

be present to observe and/or test as necessary the earthwork and foundation installation phases of the project.

Construction Observation Services

Murray Engineers, Inc. should observe and test as necessary, the earthwork and foundation phases of construction in order to a) confirm that subsurface conditions exposed during construction are substantially the same as those interpolated from our limited subsurface exploration, on which the analysis and design were based; b) evaluate compliance with the geotechnical design concepts, specifications, and recommendations; and c) allow design changes in the event that subsurface conditions differ from those anticipated. The recommendations in this report are based on limited subsurface information. The nature and extent of variation across the site may not become evident until construction. If variations are exposed during construction, it may be necessary to re-evaluate our recommendations.

LIMITATIONS

This report has been prepared for the sole use of the Roseview Heights Mutual Water Company specifically for developing geotechnical design criteria relating to design and construction of the new water tank and associated improvements, as discussed above, at APN 612-07-019 located on Crothers Road in an unincorporated portion of Santa Clara County, California. In the event that any changes in the nature or locations of the proposed improvements are planned, the conclusions and recommendations of this report shall not be considered valid unless such changes are reviewed, and the conclusions and recommendations presented in this report are modified or verified in writing by this firm.

The opinions presented in this report are based upon information obtained from borings at widely separated locations, site reconnaissance, review of field data made available to us, and upon local experience and engineering judgment, and have been formulated in accordance with generally accepted geotechnical engineering practices that exist in the San Francisco Bay Area at the time this report was prepared. Further, our recommendations are based on the assumption that soil and geologic conditions at or between borings do not deviate substantially from those encountered. In addition, geotechnical issues may arise during the course of construction that were not apparent at the time this report was prepared. No warranty, expressed or implied, is made or should be inferred. In addition, we are not responsible for data presented by others.

The recommendations provided in this report are based on the assumption that we will be retained to provide the Future Services described above in order to evaluate compliance with

our recommendations. If we are not retained for these services, Murray Engineers, Inc. cannot assume any responsibility for any potential claims that may arise during or after construction, as a result of misuse or misinterpretation of Murray Engineers, Inc.'s report by others. Furthermore, if another geotechnical consultant is retained for follow-up service to this report, Murray Engineers, Inc. will at that time cease to be the Engineer-of-Record.

The opinions presented in this report are valid as of the present date for the property evaluated. Changes in the condition of a property can occur with the passage of time, whether due to natural processes or the works of man, on this or adjacent properties. In addition, changes in applicable standards of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the opinions presented in this report may be invalidated, wholly or partially, by changes outside of our control. Therefore, this report is subject to review and should not be relied upon after a period of three years. In addition this report should not be used and is not applicable for any property other than that evaluated.

TEXT REFERENCES

American Water Works Association, 1998, AWWA Standard for Factory-Coated Bolted Steel Tanks for Water Storage: American Water Works Association, ANSI/AWWA D103-97

ASTM International, 2003, Annual Book of ASTM Standards, 2003, Section Four, Construction, Volume 04.08, Soil and Rock (I): D 420-D 5611: ASTM International, Baltimore, MD, 1486 p.

California Building Standards Commission, 2007, 2007 California Building Code, California Code of Regulations, Title 24, Part 2, Volume 2 of 2: California Building Standards Commission, Sacramento, CA, 702 p.

California Department of Conservation, Division of Mines and Geology (CDMG), 2001, State of California Seismic Hazard Zones, Calaveras Reservoir Quadrangle, CDMG

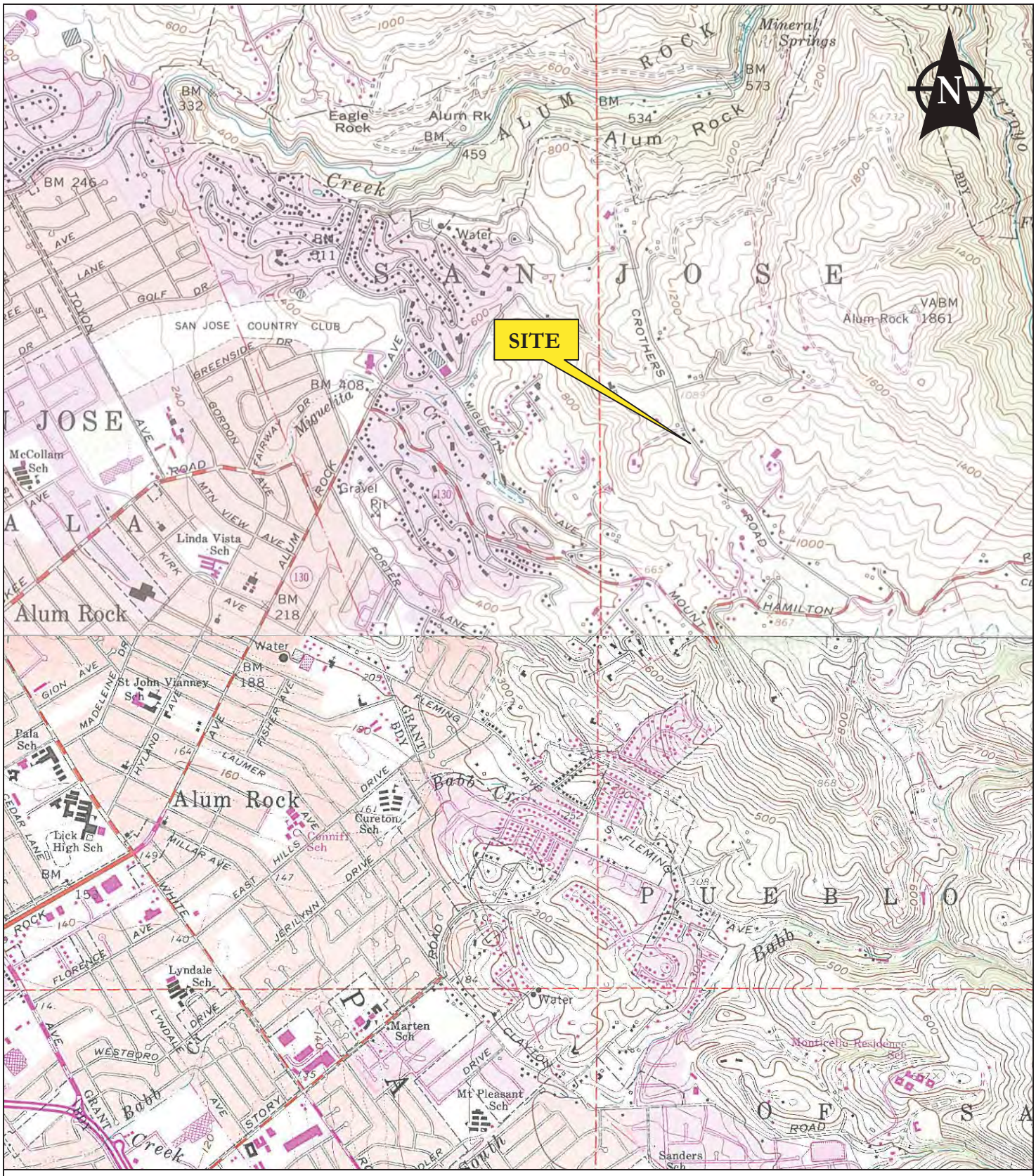
California Department of Conservation, Division of Mines and Geology (CDMG), 2001, Seismic Hazard Evaluation of the Calaveras Reservoir 7.5-Minute Quadrangle, Santa Clara County, California, CDMG Seismic Hazard Zone Report 048.

California Department of Conservation, Division of Mines and Geology, 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California, CDMG Special Publication 117.

Dibblee, T. W. Jr., 2005, Geologic Map of the Calaveras Reservoir Quadrangle Santa Clara County California, Dibblee Geology Center Map #DF-155.

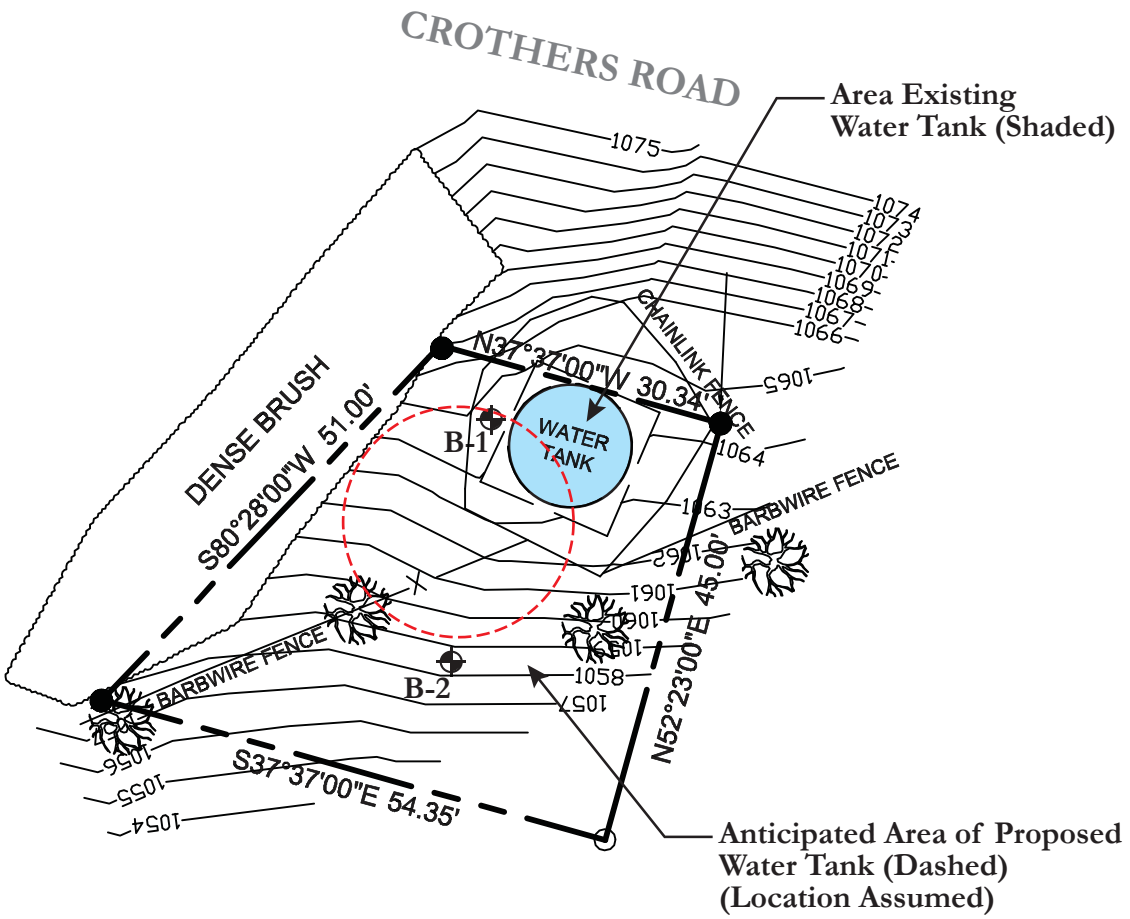
Santa Clara County, 2002, Santa Clara County Geologic Hazard Zones Map, Sheet 13, Santa Clara County Planning Department

Working Group on California Earthquake Probabilities (2007), 2008, The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2): U.S. Geological Survey Open-File Report 2007-1437; California Geological Survey Special Report 203214; Southern California Earthquake Center Contribution #1138.



Base: USGS San Jose East and Calaveras Reservoir Quadrangles, 7.5 Minute Series (Topographic), 1997.
Approximate Scale: 1 inch = 2,000 feet

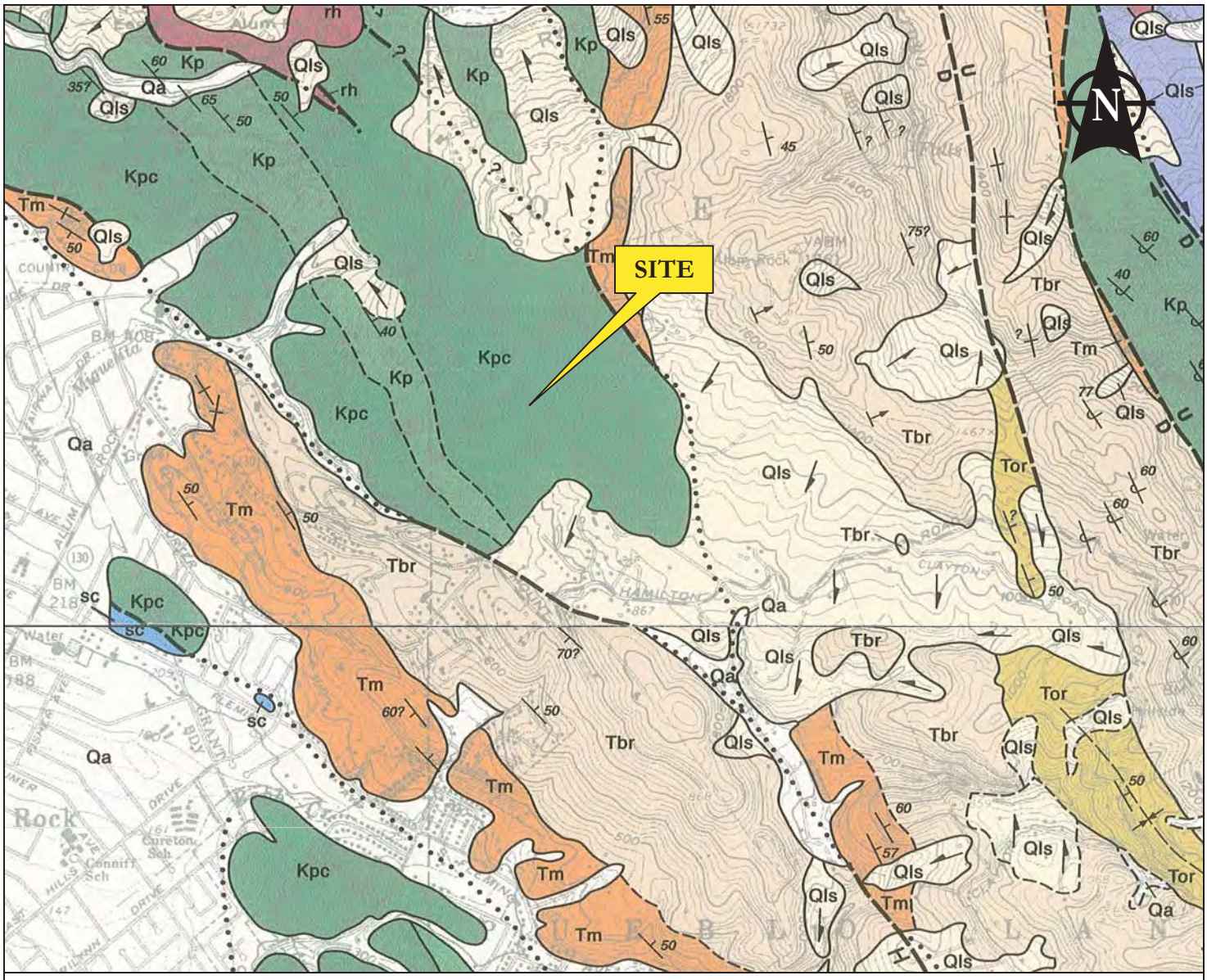
MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA		VICINITY MAP
	PROJECT NO. 451-2R1	OCTOBER 2009	FIGURE A-1



LEGEND

B-1 ⊕ Approximate Location of Soil Boring by Murray Engineers, Inc., July 17, 2009
Base: Map Reference by Alvarez & Associates, dated May 14, 2009
Approximate Scale: 1 inch = 20 feet

MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA	SITE PLAN
	PROJECT NO. 451-1R2 / OCTOBER 2009	FIGURE A-2



Legend & Selected Map Symbols

Qls	Landslide Rubble
Tbr	Briones Formation
Tm	Monterey Formation
Kps	Panoche Formation Sandstone
Kpc	Panoche Formation Conglomerate

Geologic Contact

Fault, dashed where approximately located, dotted where concealed, queried where uncertain

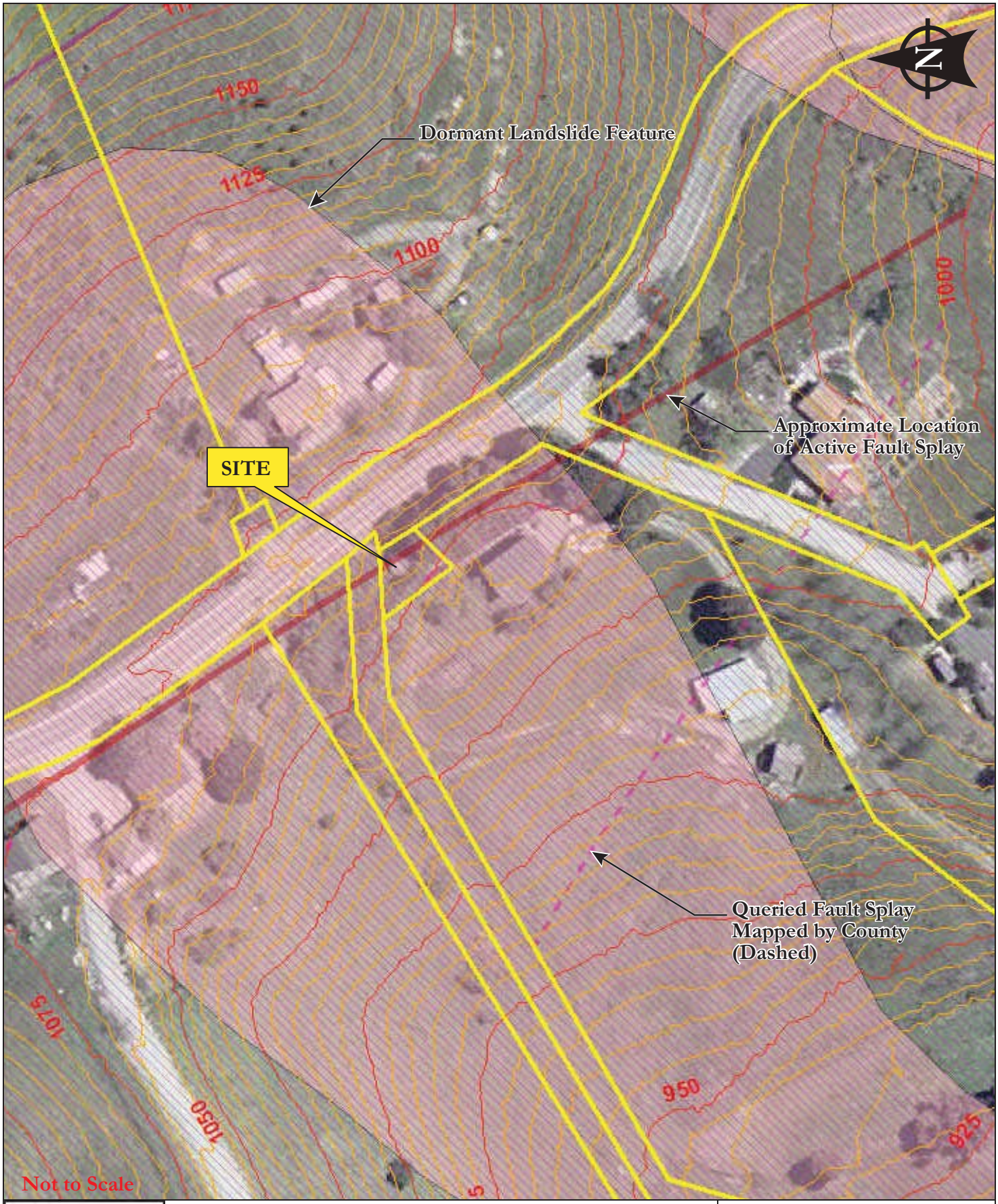
SCARP

TOE

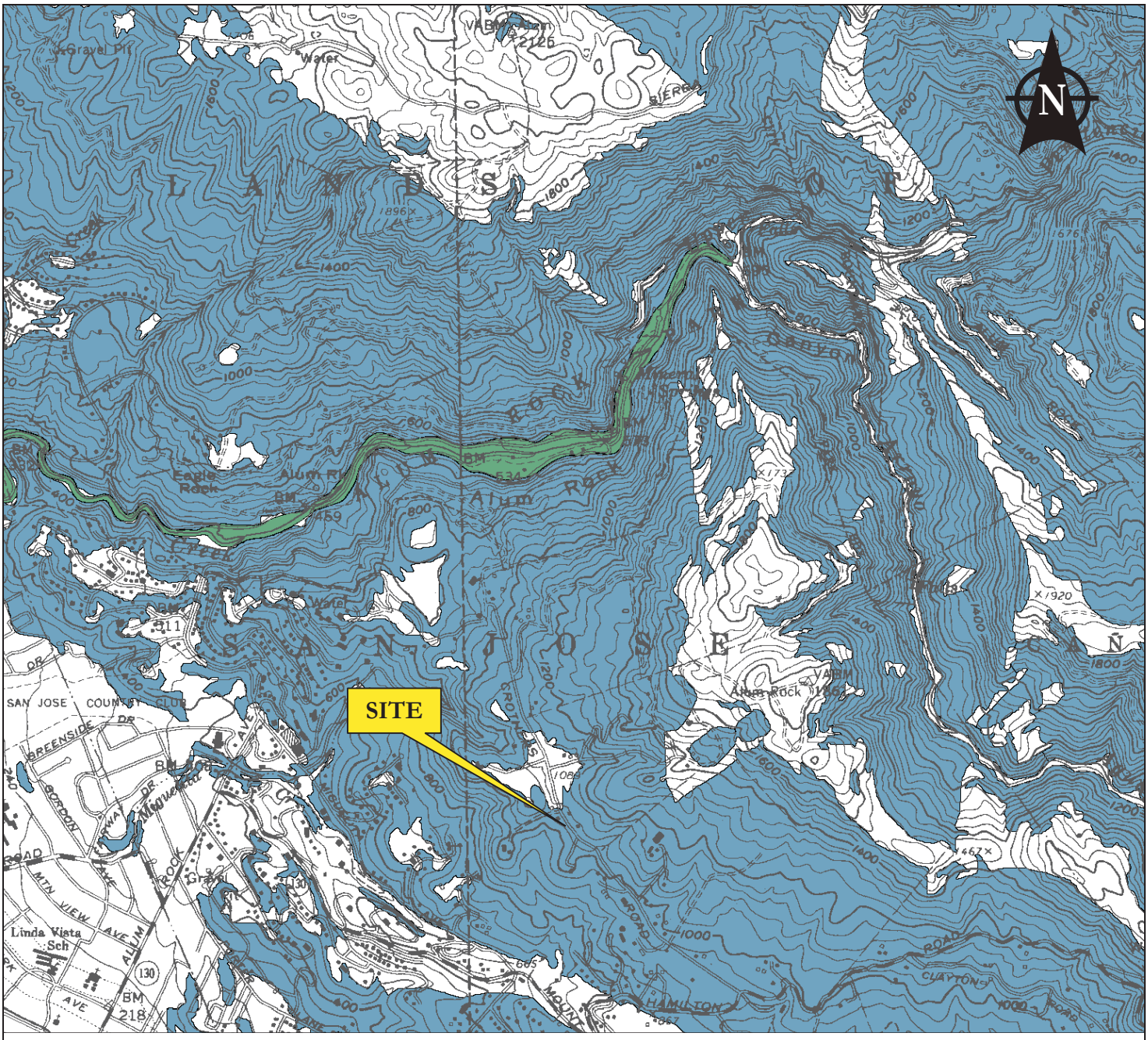
Landslide, arrow indicates direction of movement, queried where identification is uncertain

Base: Geologic Maps of the Calaveras Reservoir and San Jose East Quadrangles, Santa Clara County, California, by Thomas W. Dibblee, Jr., 2005 Scale: 1 inch = 2,000 feet

MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA		VICINITY GEOLOGIC MAP
	PROJECT NO. 451-2R1	OCTOBER 2009	FIGURE A-3



MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA	LANDSLIDE & FAULT MAP PROVIDED BY COUNTY GEOLOGIST
	PROJECT NO. 451-2R1 / OCTOBER 2009	FIGURE A-4



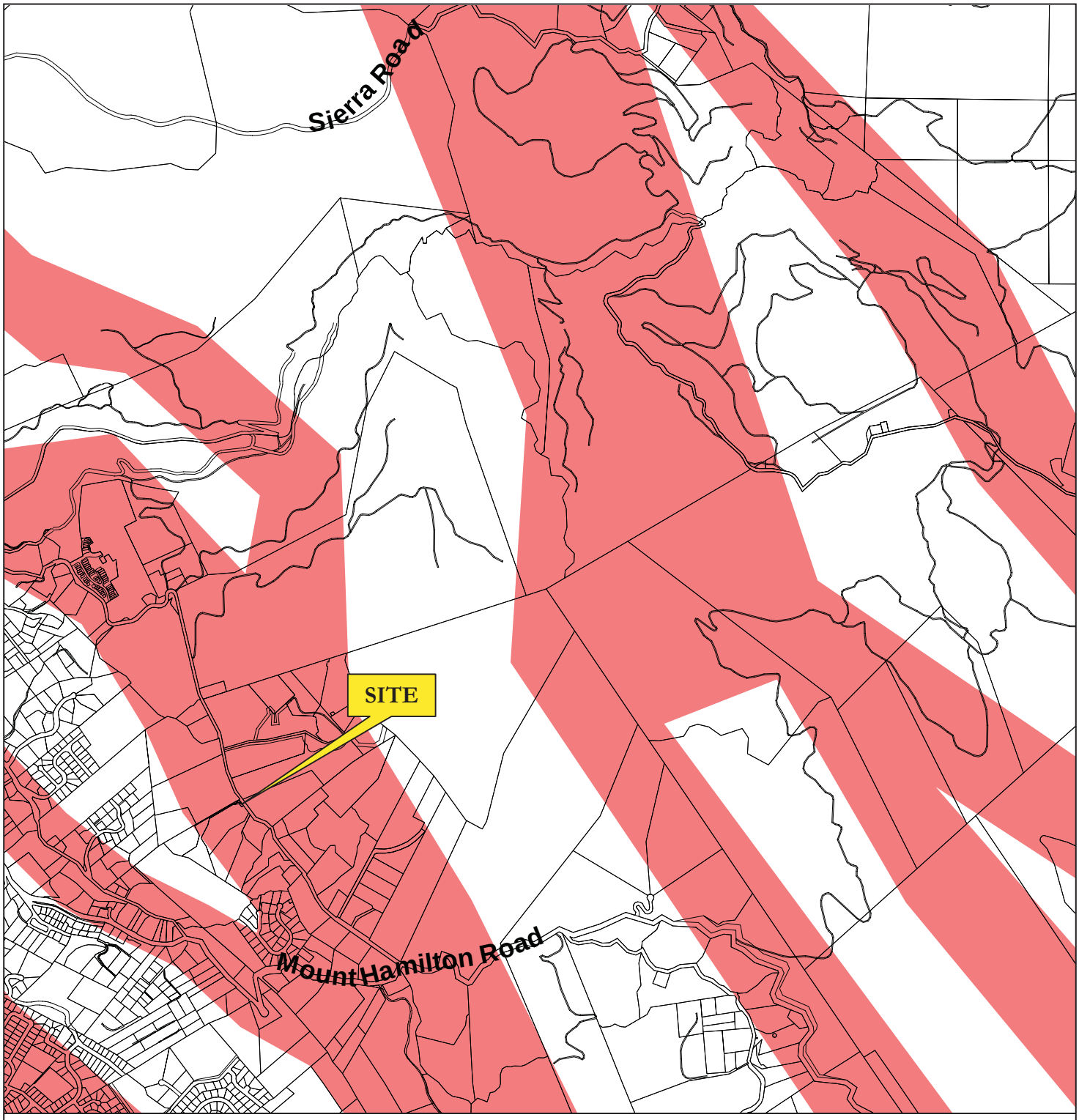
Legend

Areas where historic occurrence of liquefaction, or local, geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Areas where previous occurence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Base: State of California Seismic Hazard Zone Map, Calaveras Reservoir Quadrangle, 7.5-Minute Quadrangle, CDMG 2001 Approximate Scale: 1 inch = 2,000 feet

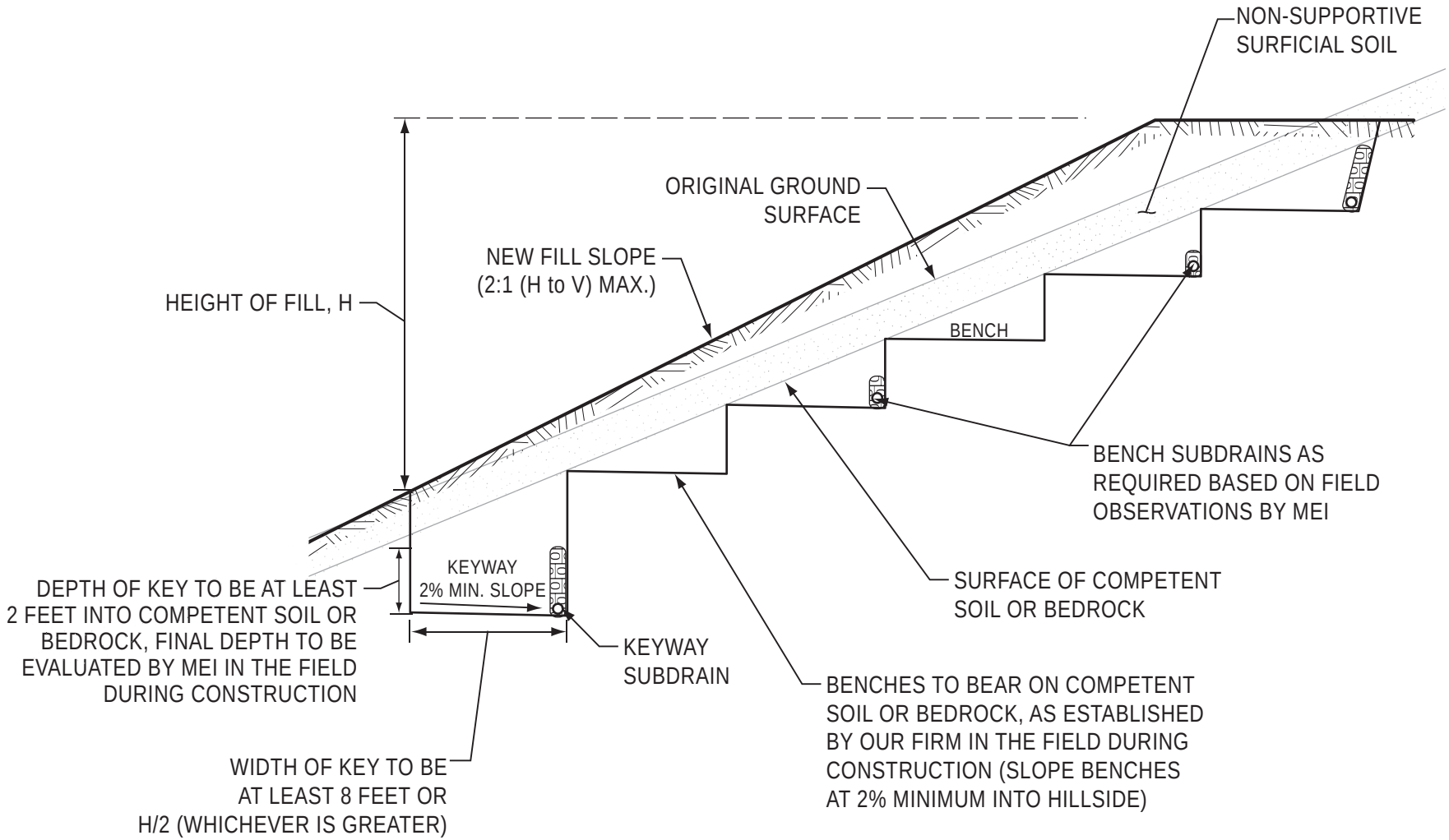
MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	**PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA**	**STATE SEISMIC HAZARD ZONES MAP**
	PROJECT NO. 451-2R1 / **OCTOBER 2009**	**FIGURE A-5**



Legend: Fault Rapture Hazard Zones

Base: Santa Clara County Geologic Hazard Map, Sheet 13, adopted by the Santa Clara County Board of Supervisors on February 26, 2002. Note: Shaded areas denote fault rupture hazard zones
Approximate Scale 1 inch = 2,000 feet

MURRAY ENGINEERS INC GEOTECHNICAL SERVICES	PROPOSED WATER TANK APN: 612-07-019, CROTHERS ROAD SANTA CLARY COUNTY, CALIFORNIA	SANTA CLARA COUNTY FAULT HAZARD ZONES MAP
	PROJECT NO. 451-2R1 / OCTOBER 2009	FIGURE A-6



MURRAY ENGINEERS INC
GEOTECHNICAL SERVICES

PROPOSED WATER TANK
APN: 612-07-019, CROTHERS ROAD
SANTA CLARY COUNTY, CALIFORNIA

SCHEMATIC FILL SLOPE DETAIL

PROJECT NO. 451-2R1 | **OCTOBER 2009** | **FIGURE A-7**

Date(s) Drilled	**July 17, 2009**	Logged By	**JK**	Checked By	**JAS**
Drilling Method	**Continuous Sampling**	Drill Bit Size/Type	**N/A**	Total Depth of Borehole	**16 feet bgs**
Drill Rig Type	**Sampling Tripod**	Drilling Contractor	**Access Soil Drilling, Inc.**	Approximate Surface Elevation	**1064 feet (relative)**
Groundwater Level and Date Measured	**Not Encountered ATD**	Sampling Method(s)	**3" OD, 2.5" OD, & 2" OD SPT Split Spoon Samplers**	Hammer Data	**140 lb, 30 in drop, rope & cathead**
Borehole Backfill	**Cuttings**	Location	**Northeast side of proposed water tank**		

Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	Water Content, %	Torvane Shear Strength, TSF	Pocket Pen Comp. Strength, TSF	Dry Density (pcf)
1064	0		43	Hard to Very Stiff	CL/CH	SILTY CLAY with GRAVEL, dark grayish brown to dark olive brown, subrounded to subangular sandstone shale and chert gravels up to 3/4", heterogeneous, moderate to high plasticity, slightly moist to moist (Colluvium)	11	>1.0	>4.5	
			36			PI=26%; LL=41% (sample from 0 to 2 feet)	13	>1.0	>4.5	
							22			
1059	5		45	Hard	CH	SILTY CLAY with GRAVEL, olive brown, subrounded to subangular, sandstone shale and chert gravels up to 3/4", heterogeneous, high plasticity, very moist (Ancient Landslide Debris/Older Colluvium?)	21	1.0	2.5	
			34	Very Stiff to Hard	CL		12			
			55			SANDY CLAY with GRAVEL, yellowish brown, minor silt, subrounded to subangular sandstone siltstone chert and shale gravels up to 1/2", heterogeneous, moderate plasticity fines, very moist (Ancient Landslide Debris/Older Colluvium?)	11			115
1054	10		42				14			
			46			no recovery (drove down 1" gravel)				
1049	15		18	Medium Dense	SW	GRAVELLY SAND with SILT, yellowish brown, well-graded, subrounded to subangular sandstone gravels up to 1/4", heterogeneous, very moist (Ancient Landslide Debris/Older Colluvium?)	15			
						Bottom of Boring at 16 feet bgs				
1044	20									

P:\AABorinGS Files\Projects\Roseview Heights Water Co. 451-2.bgs [Murray New 20 - WC, PP, TV, DD.tpl]

MURRAY ENGINEERS INC
GEOTECHNICAL SERVICES

PROPOSED WATER TANK
APN: 612-07-019, CROTHERS ROAD
SANTA CLARY COUNTY, CALIFORNIA

LOG OF BORING B-1

PROJECT NO. 451-1R2 | **OCTOBER 2009** | **FIGURE B-1**

Date(s) Drilled **July 17, 2009**	Logged By **JK**	Checked By **JAS**
Drilling Method **Continuous Sampling**	Drill Bit Size/Type **N/A**	Total Depth of Borehole **18 feet bgs**
Drill Rig Type **Sampling Tripod**	Drilling Contractor **Access Soil Drilling, Inc.**	Approximate Surface Elevation **1059 feet (relative)**
Groundwater Level and Date Measured **Not Encountered ATD**	Sampling Method(s) **3" OD, 2.5" OD, & 2" OD SPT Split Spoon Samplers**	Hammer Data **140 lb, 30 in drop, rope & cathead**
Borehole Backfill **Cuttings**	Location **Southwest side of proposed water tank**	

Elevation, feet	Depth, feet	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	Water Content, %	Torvane Shear Strength, TSF	Pocket Pen Comp. Strength, TSF	Dry Density (pcf)
1059	0								
		25	Very Stiff to Stiff	CL/CH	SILTY CLAY with GRAVEL, dark grayish brown to dark olive brown, subrounded to subangular sandstone shale and chert gravels up to 3/4", heterogeneous, moderate to high plasticity, slightly moist to moist, trace roots (Colluvium)	12 18	>1.0	>4.5	89
		16				25	>1.0	>4.5	
						29			
1054	5	29	Very Stiff	CH	SANDY CLAY with GRAVEL, olive brown, subrounded to subangular, sandstone shale and chert gravels up to 3/4", heterogeneous, moderate plasticity fines, very moist (Ancient Landslide Debris/Older Colluvium?)	24	1.0	2.5	
		35	Medium Dense	SW		9			
		29			GRAVELLY SAND, yellowish brown, well-graded, occasional sandy clay lenses, subrounded to subangular sandstone gravels up to 3/4", heterogeneous, moist to very moist (Ancient Landslide Debris/Older Colluvium?)	11			
1049	10								
		30			greenish-gray	10			
		17				12			
					grading to saturated				
1044	15	15				18			
		22				16			112
					Bottom of Boring at 18 feet bgs				
1039	20								

MURRAY ENGINEERS INC
GEOTECHNICAL SERVICES

PROPOSED WATER TANK
APN: 612-07-019, CROTHERS ROAD
SANTA CLARY COUNTY, CALIFORNIA

LOG OF BORING B-2

PROJECT NO. 451-1R2 | **OCTOBER 2009** | **FIGURE B-2**

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Elevation, feet	Depth, feet	Sample Type	Sampling Resistance, blows/foot	Relative Consistency	USCS Symbol	MATERIAL DESCRIPTION	Water Content, %	Torvane Shear Strength,TSF	Pocket Pen Comp. Strength, TSF	Dry Density (pcf)
1	2	3	4	5	6	7	8	9	10	11

COLUMN DESCRIPTIONS

1 **Elevation, feet:** Elevation (MSL, feet)

2 **Depth, feet:** Depth in feet below the ground surface.

3 **Sample Type:** Type of soil sample collected at the depth interval shown.

4 **Sampling Resistance, blows/foot:** Number of blows to advance driven sampler foot (or distance shown) beyond seating interval using the hammer identified on the boring log.

5 **Relative Consistency:** Relative consistency of the subsurface material.

6 **USCS Symbol:** USCS symbol of the subsurface material.

7 **MATERIAL DESCRIPTION:** Description of material encountered. May include consistency, moisture, color, and other descriptive text.

8 **Water Content, %:** Water content of the soil sample, expressed as percentage of dry weight of sample.

9 **Torvane Shear Strength,TSF:** Shear strength, TSF

10 **Pocket Pen Comp. Strength, TSF:** The percent fines (soil passing the No. 200 Sieve) in the sample. WA indicates a Wash Sieve, SA indicates a Sieve Analysis.

11 **Dry Density (pcf):** Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

TYPICAL MATERIAL GRAPHIC SYMBOLS

- Sandstone
- Well graded GRAVEL (GW)
- Poorly graded GRAVEL (GP)
- Well graded GRAVEL with Silt (GW-GM)
- Well graded GRAVEL with Clay (GW-GC)
- Poorly graded GRAVEL with Silt (GP-GM)
- Poorly graded GRAVEL with Clay (GP-GC)
- Silty GRAVEL (GM)
- Clayey GRAVEL (GC)
- Well graded SAND (SW)
- Poorly graded SAND (SP)
- Well graded SAND with Silt (SW-SM)
- Well graded SAND with Clay (SW-SC)
- Poorly graded SAND with Silt (SP-SM)
- Poorly graded SAND with Clay (SP-SC)
- Silty SAND (SM)
- Clayey SAND (SC)
- SILT, SILT w/SAND, SANDY SILT (ML)
- Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)
- SILT, SILT w/SAND, SANDY SILT (MH)
- Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
- SILT, SILT with SAND, SANDY SILT (ML-MH)
- Lean-Fat CLAY, CLAY w/SAND, SANDY CLAY (CL-CH)
- SILTY CLAY (CL-ML)
- Lean CLAY/PEAT (CL-OL)
- Fat CLAY/SILT (CH-MH)
- Fat CLAY/PEAT (CH-OH)
- Silty SAND to Sandy SILT (SM-ML)
- Silty SAND to Sandy SILT (SM-MH)
- Clayey SAND to Sandy CLAY (SC-CL)
- Clayey SAND to Sandy CLAY (SC-CH)
- SILT to CLAY (CL/ML)
- Silty to Clayey SAND (SC/SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

- 2 inch-OD Unlined Split Spoon (SPT)
- 2.5 inch-OD Unlined Split Spoon
- 3 inch-OD Unlined Split Spoon
- Shelby Tube (thin-walled, fixed head)
- Grab Sample
- Bulk Sample
- Pitcher Sample
- Other Sampler

OTHER GRAPHIC SYMBOLS

- Water level (at time of drilling, ATD)
- Water level (after waiting a given time)
- Minor change in material properties within a stratum
- Inferred or gradational contact between strata
- Queried contact between strata

GENERAL NOTES

1. Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

PRIMARY DIVISIONS			SOIL TYPE	SECONDARY DIVISIONS
COARSE GRAINED SOILS (< 50 % Fines)	GRAVEL	CLEAN GRAVEL (< 5% Fines)	GW	Well graded gravel, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravel or gravel-sand mixtures, little or no fines.
		GRAVEL with FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SAND	CLEAN SAND (< 5% Fines)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SAND WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS (> 50 % Fines)	SILT AND CLAY Liquid limit < 50%		ML	Inorganic silts and very fine sands, with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, lean clays.
			OL	Organic silts and organic clays of low plasticity.
	SILT AND CLAY Liquid limit > 50%		MH	Inorganic silt, micaceous or diatomaceous fine sandy or silty soil.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

RELATIVE DENSITY

SAND & GRAVEL	BLOWS/FOOT*
VERY LOOSE	0 to 4
LOOSE	4 to 10
MEDIUM DENSE	10 to 30
DENSE	30 to 50
VERY DENSE	OVER 50

CONSISTENCY

SILT & CLAY	STRENGTH^	BLOWS/FOOT*
VERY SOFT	0 to 0.25	0 to 2
SOFT	0.25 to 0.5	2 to 4
FIRM	0.5 to 1	4 to 8
STIFF	1 to 2	8 to 16
VERY STIFF	2 to 4	16 to 32
HARD	OVER 4	OVER 32

GRAIN SIZES

BOULDERS	COBBLES	GRAVEL		SAND			SILT & CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

12" 3" 3/4" 4 10 40 200

SIEVE OPENINGS U.S. STANDARD SERIES SIEVE

Classification is based on the Unified Soil Classification System; fines refer to soil passing a No. 200 sieve.

* Standard Penetration Test (SPT) resistance, using a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler; blow counts not corrected for larger diameter samplers.

^ Shear strength in tons/sq. ft. as estimated by SPT resistance, field and laboratory tests, and/or visual observation.

APPENDIX C

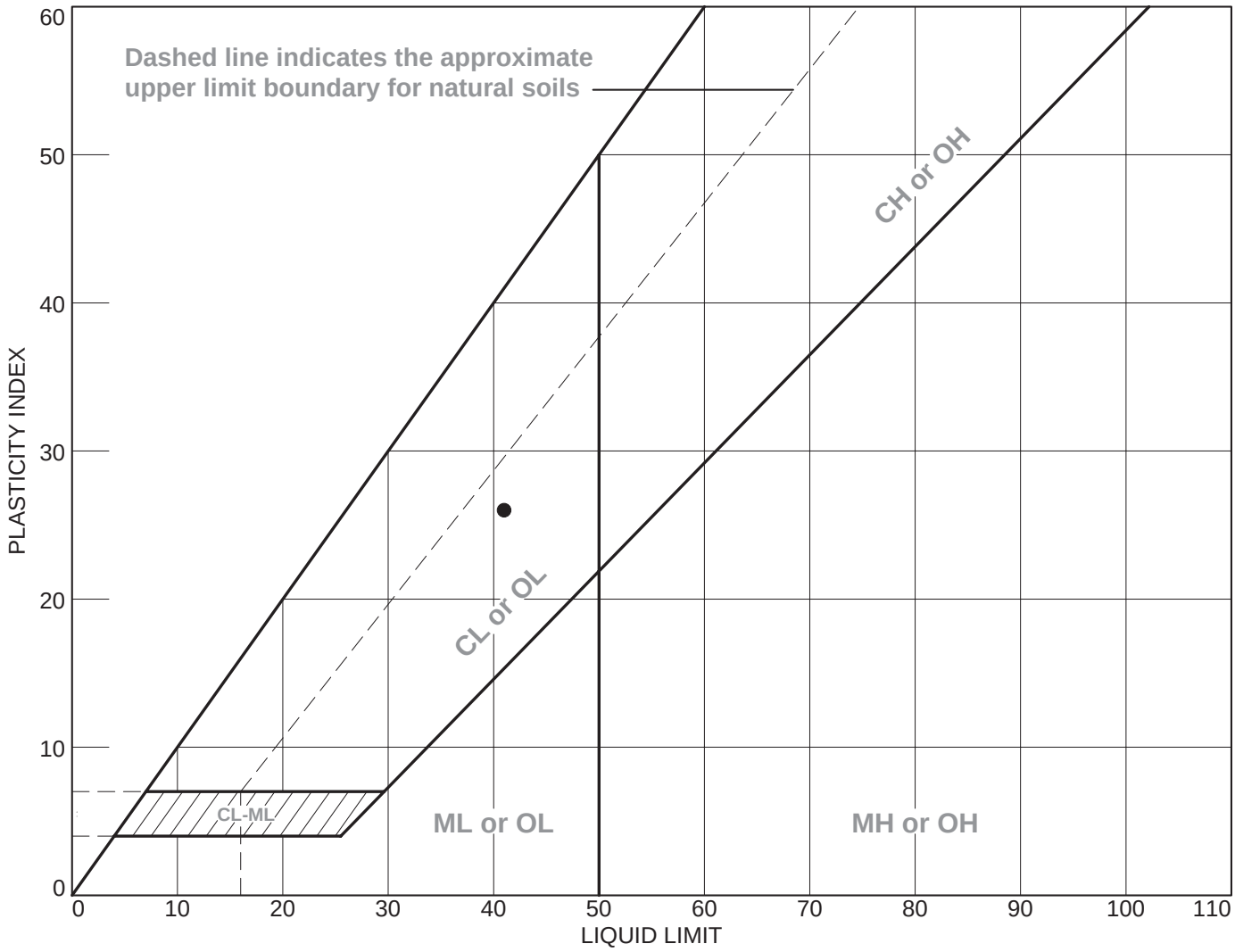
LABORATORY TESTS

Samples from the subsurface exploration were selected for tests to establish the physical and engineering properties of the soils. The tests performed are briefly described below.

Natural moisture content was determined on most samples and dry density on select samples recovered from the borings. The samples were initially trimmed to obtain volume and wet weight measurements and subsequently dried in accordance with ASTM D2216. After drying, the weight of each sample was obtained to determine the moisture content and dry density representative of field conditions and time the samples were collected. The results are presented on the boring logs at the appropriate sample depths.

The Atterberg Limits were determined on one sample in accordance with ASTM D 4318. The Atterberg limits are the moisture content within which the soil is workable or plastic. The results of this test are presented in Figure C-1 and on the boring logs, at the appropriate sample depth.

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring 1	1	0' to 2'	11.4	15	41	26	CL

MURRAY ENGINEERS INC
GEOTECHNICAL SERVICES

PROPOSED WATER TANK
APN: 612-07-019, CROTHERS ROAD
SANTA CLARA COUNTY, CALIFORNIA

LIQUID & PLASTIC LIMITS TEST REPORT

PROJECT NO. 451-2R1 | OCTOBER 2009 | FIGURE C-1

GEOTECHNICAL INVESTIGATION
NEW WATER TANK
APN 612-50-039
BON VISTA COURT
SANTA CLARA COUNTY, CALIFORNIA

THIS REPORT HAS BEEN PREPARED FOR:

ROSEVIEW HEIGHTS MUTUAL WATER COMPANY

ATTN: MR. TIM SCHACHER

10517 CROTHERS ROAD

SAN JOSE, CALIFORNIA 95127

MAY 2011

MURRAY ENGINEERS INC
GEOTECHNICAL SERVICES

May 18, 2011
Project No. 451-1R1

Roseview Heights Mutual Water Company
Attn: Mr. Tim Schacher, President
10517 Crothers Road
San Jose, California 95127

RE: GEOTECHNICAL INVESTIGATION, NEW WATER TANK, APN 612-50-039, BON VISTA COURT, SANTA CLARA COUNTY, CALIFORNIA

Dear Mr. Schacher:

We are pleased to present the results of our geotechnical investigation relating to the design and construction of a new water tank on the Roseview Heights Mutual Water Company property, APN 612-50-039, located on Bon Vista Court in an unincorporated area of Santa Clara County, California. This report summarizes the results of our field, laboratory, and engineering work, and presents conclusions and recommendations concerning the geologic and geotechnical engineering aspects of the project.

Our report is contingent upon our approval of the project plans and our observation and testing, as necessary, of the foundation, earthwork, and drainage aspects of the construction.

If you have any questions concerning our investigation, please call.

Very truly yours,
MURRAY ENGINEERS, INC.

Mark F. Baumann, C.E.G. 1787
Principal Engineering Geologist

John A. Stillman, G.E., C.E.G. 1868
Principal Engineer

JK:MFB:JAS

Copies: Addressee (6)

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Faulting & Seismicity

Geologists and seismologists recognize the San Francisco Bay Area as one of the most active seismic regions in the United States. There are three major faults that trend in a northwest direction through the Bay Area, which have generated about 12 earthquakes per century large enough to cause significant structural damage. The faults along which these earthquakes occur are part of the San Andreas fault system that extends for at least 700 miles along the California Coast, and includes the San Andreas, Hayward, and Calaveras faults. The site is located within the Hayward Fault zone, a broad zone of faulting that runs along the western margin of the Diablo Range. According to Dibblee (2005), traces of the Hayward fault are located approximately 1,200 feet southwest and northeast of the site. According to the State of California Special Studies Zones map for the Calaveras Reservoir Quadrangle (California Division of Mines and Geology, 1982), the nearest trace is located approximately 100 to 200 feet to the northeast of the site. The Calaveras fault is located approximately 2.4 miles northeast of the site and the main trace of the San Andreas fault is located approximately 16 miles southwest of the site. Due to its proximity to active traces of the Hayward Fault, the site is located within a State earthquake fault zone (formerly known as an Alquist-Priolo Special Studies Zone) (CDMG, 1982). In addition, the site is located within a Santa Clara County fault hazard zone (Santa Clara County, 2002) (see Figure A-5, Santa Clara County Fault Hazard Map).

Seismologic and geologic experts convened by the U. S. Geological Survey, California Geological Survey, and the Southern California Earthquake Center conclude that there is a 63 percent probability for at least one "large" earthquake of magnitude 6.7 or larger in the Bay Area before the year 2038. The northern portion of the San Andreas fault is estimated to have a 21 percent probability of producing a magnitude 6.7 or larger earthquake by the year 2038 (2007 Working Group on California Earthquake Probabilities, 2008). According to the Seismic Hazard Zone Report for the Calaveras Reservoir 7.5-minute Quadrangle(California Division of Mines and Geology, 2001), peak ground acceleration in the site vicinity is estimated at approximately 0.76 g for a 10% exceedance in 50 years for soft rock conditions based on a magnitude 7.1 earthquake located on the nearby Hayward fault.

SITE EXPLORATION AND RECONNAISSANCE

Exploration Program

An initial site reconnaissance was performed by our staff geologist on November 17, 2005. Subsequently our principal engineering geologist observed the site conditions on February 17, 2006. A recent site reconnaissance was performed by our staff engineer on April 4,

- Landsliding – Based on our investigation, we did not observe any evidence of landsliding on the property. Based on our site reconnaissance and our review of aerial photographs, it is our opinion that the area mapped as an ancient landslide by Dibblee, (2005) does not extend onto the site. In addition, the Vista Valle Court landslide does not extend onto the site.

  Based on the results of our seismic slope stability analysis, it is our opinion that the risk of a significant earthquake-induced landslide on the moderately steep cut slope adjacent to the northern boundary of the property is low. Our pseudo-static slope stability analysis yielded a critical failure surface with a factor of safety of approximately 1.9. As noted in the SCEC report, sites with seismic factors of safety greater than 1.0 pass the screening analysis.

  Because of the moderately steep natural slopes along the eastern and western boundaries of the site and the layer of relatively weak fill and colluvial soil blanketing these portions of the site it is our opinion that, the occurrence of a new shallow landslide in this area cannot be excluded. A new shallow landslide could be triggered by excessive precipitation or strong ground shaking associated with an earthquake. In our opinion, a new shallow landslide should not pose a significant hazard to the proposed improvements, provided that they are designed and constructed in accordance with the recommendations of this report.

  It should be noted that although our knowledge of the causes and mechanisms of landslides has greatly increased in recent years, it is not yet possible to predict with certainty exactly when and where all landslides will occur. At some time over the span of thousands of years, most hillsides will experience landslide movement as mountains are reduced to plains. Therefore, an unknown level of risk is always present to structures located in hilly terrain. Owners of property located in these areas must be aware of and be willing to accept this risk.

- Fault Rupture – Based on our site reconnaissance and our review of published maps and aerial photographs, it is our opinion that no active or potentially active faults cross the subject property. Therefore, in our opinion the potential for fault rupture to occur at the site is low.

- Ground Shaking - As noted in the Faulting & Seismicity section above, moderate to large earthquakes are probable along several active faults in the greater Bay Area. Therefore, strong ground shaking should be expected several times during the design life of the proposed improvements. In our opinion, there is a risk that strong ground shaking could cause the existing redwood water tank to topple or collapse. If

Roseview Heights Mutual Water Company
Water and Power Usage 1999, 2004 – 2012

The quantities listed were attained from PG&E and San Jose Water Company billing records and Roseview Heights Mutual historical water usage data. The figures show the effect of the December 2008 temporary repair performed on the main 70,000 gallon redwood water tank to stop the leakage which had begun to greatly increase in 2007/2008. The temporary repair consisted of installing an NSF61 poly liner into the redwood tank.

Year	CCF purchased SJ Water Co.	Gallons	KwH PG&E	CCFs billed to RHMWC users	CCF diff, % wasted/not billed
1999	15046	11,254,408	31,596 est.	unk	unk
2000–'03	records inc	records inc	records inc	records inc	unk
2004	14720	11,010,560	30,912 est.	unk	unk
2005	14766	11,044,968	31,008 est	records inc	unk
2006	17264	12,913,472	36254 est.	records inc	unk
2007	18266	13,662,968	38,358 est.	12062	(6204) (34%)
2008	18181	13,599,388	35,575	12255	(5926) (33%)
2009	11775	8,807,700	24,257	9286	(2489) (21%)
2010	10719	8,017,812	22,207	8444	(2275) (21%)
2011	10737	8,031,276	23,665	8817	(1920) (18%)
2012	10799	8,077,652	22,876	9452	(1347) (12%)

The records indicate a reduction of 6400+ CCF or ~5MG or ~15AF in the year following the temporary repair. Not all of this can be attributed to the repair. A single RHMWC user sold his home a few months prior to the tank repair. This user had been using ~2000 CCF/year. The new home owner uses ~100 CCF. RHMWC still does attribute ~4500CCF in reduction to the tank repair which is about a 25% water and energy savings. The reduction in energy use of about 9500KwH/year is due to less pumping of water required. It takes ~2.1Kwh to pump 1 CCF. 2012 rates of $2.70/CCF and $0.20/Kwh result in a savings of ~$12,150/yr water and ~$1900/yr power for a total annual savings of approximately $14,050.
Prior to the repair, approximately 1/3 of the water purchased from SJ Water by Roseview Heights Mutual Water Company was lost primarily via leakage. The continued improvement since the tank repair in lowering the discrepancy in purchased versus sold water can be attributed to replacement of known incorrectly reading water meters.

The repair is temporary. A low water event occurred in the main tank in late August of 2010. The lack of water in the tank allowed the liner to sag thereby causing a small hole to open in a seam of the liner. The effect was as if the liner didn't even exist. In the week prior to getting the liner repaired, RHMWC was pumping 80 to 85 CCF/day per daily meter readings taken during the event. This is equivalent to 20MG / year which would be wasting ~12MG or 35AF/year as a symptom of further deterioration of the 70,000 gallon redwood water tank.

The planned tank replacement will make the temporary repair permanent. Likewise the water & energy savings will be permanent and the water supply increased and more reliable.

Tim Schacher,
Board President, Roseview Heights Mutual Water Company January 19, 2013

Oro Loma Wet Weather Equalization, Treatment Wetland and Ecotone Demonstration Project

Restoring and demonstrating historical ecotone functions to provide for San Francisco Bay's future challenges - sea level rise, nutrient loadings, and contaminants of emerging concern

Initial Feasibility Study

ESA PWA with Dr. Peter Baye

July 29, 2012

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1 Introduction

The purpose of this memo is to examine the feasibility of developing a dual purpose facility for the Oro Loma Sanitary District (OLSD) that would serve as a wet-weather equalization facility for infrequent peak wet-weather flows and a demonstration project of an upland ecotone and wastewater treatment wetland/seepage levee to polish wastewater discharge. The proposed project site is a ten-acre parcel in San Lorenzo adjacent to the OLSD's wastewater treatment plant (WWTP). The proposed site is currently a vacant lot that supports about 2.2 acres of potential wetlands and a former railroad track (Figure 1).

Figure 1. Project location

The wet-weather equalization facility part of the project addresses a desire to reduce peak flows from the OLSD WWTP into the East Bay Dischargers Authority (EBDA) line. The demonstration part of the project addresses key management questions that will apply to OLSD and other water treatment facilities adjacent to the Bay over the next century:

1. How should wastewater plants prepare themselves for rising sea levels? How can wastewater help support historical habitat that no longer exists in the East and South Bay? What are the benefits and impediments to wastewater plants constructing seepage levees to help adapt to sea level rise?

2. What are the most cost effective ways for wastewater plants to lower their nutrient and contaminant discharges to the Bay?

and, in addition, addresses more general question related to ecosystem restoration and flood risk management for managers around the Bay:

3. How easily can moist grassland/baylands ecotone be reestablished in the East Bay? Will this upland ecotone successfully attract and provide refuge for the salt marsh harvest mouse and other endangered fauna?

2 Project Objectives

The project has a number of objectives, related to the present operation of the water treatment facility and to the future operation of the facility and the management of the Bayshore with rising sea levels.

1. Wet-weather equalization – a facility to provide temporary storage for infrequent peak treated wastewater flows associated with large storm events. The reduction of peak discharges into the EBDA pipe line would reduce operating costs and allow flexibility in plant maintenance activities. The proposed facility would need to provide:

   - capacity to store up to 8 million gallons of secondary treated wastewater for up to 6 hours;
   - capacity for more frequent peak flows which would require storage of up to 5 million gallons of wastewater for up to 6 hours for 3 to 5 events per year. This would also facilitate maintenance operations in the WWTP.

2. Demonstration of upland ecotone restoration - a demonstration of how treated wastewater may be discharged through seepage habitat levees to restore historical moist grassland/bayland ecotone while treating reclaimed wastewater and increasing resilience to sea level rise. The need for such projects is particularly acute in the South Bay: moist grassland/bayland ecotone is virtually non-existent and all the treatment plants are vulnerable to sea level rise. With 570 miles of levees and 42 wastewater treatment plants in the Bay Area, if only 25% were suitable for seepage habitat levees then up to 5,000 acres of moist grassland/baylands ecotone could be created as a result of a successful demonstration.

3. Demonstration of nutrient removal – a demonstration of a treatment wetland to treat a portion of OLSD's discharge through a variety of configurations with varying soil types, slopes, vegetation to help ascertain ideal configurations for larger future projects. Current dry weather discharge averages about 12 million gallons per day, with a total daily Nitrogen load of about 800 kg per day. The treatment capacity would be a function of the area of the treatment wetland and nutrient removal efficiencies of the wetland vegetation.

3 Concept

The concept is to construct an equalization facility for treated wastewater to divert peak flows, store them for a period of hours, and then return the stored volume to the WWTP following the peak (Figure 2). This will provide an additional safety factor to meet OLSD compliance objectives; including effluent quality and prevention of unpermitted discharges. As proposed, the basin will be designed to function as a treatment wetland to reduce nutrients in the OLSD's effluent during dry weather flows. Rather than building a containment tank that would be used only occasionally to hold eight million gallons for up to six hours, the storage basin will be able to treat a continuous low flow of treated wastewater. This wastewater will be held in place by containment berm and metered to a seepage habitat levee which will allow the treated wastewater to seep into the moist grasslands/baylands ecotone.

Figure 2. Conceptual oblique view

Native species will be planted on the seepage habitat levee, which will emulate natural alluvial fan substrate, topography, and subsurface discharge patterns that were once prevalent in San Francisco Bay but have been lost to due to historical diking, drainage, fill, and flood control (Goals Project 1999). The seepage levee will have a relatively flat 30H:1V slope. The slopes would be comprised of a variety of soils – low permeability silts supporting native grassland vegetation and coarser, high permeability, microaerobic alluvium that would support riparian scrub vegetation. Vegetation types would be targeted towards native species with relatively high treatment removal efficiencies.

3.1 Wet Weather Equalization Facility and Treatment Wetland

The wet weather equalization facility consists of a storage basin surrounded by a containment berm (Figure 3). The basin would serve as a wet-weather equalization facility to provide temporary storage of

secondary treated water during infrequent peak wastewater flows associated with large storm events. This will allow a reduction in peak flows discharged to the EBDA pipeline. The proposed facility would provide capacity to store up to 8 million gallons of secondary treated wastewater for up to 6 hours.

Figure 3 Conceptual plan view

The storage basin would include a perimeter containment levee constructed about 10 feet high with 3H:1V slopes (Figure 4). The perimeter levee would be about 2,080 feet in length and would create a storage basin that would contain about 3.2 acres on the project site. Depending up the engineering properties of the soils at the project site, the containment levee could be constructed with soils excavated from the project site or with imported materials if the onsite materials are not suitable for levee construction. A geotechnical investigation would be performed to assess the properties of the onsite soils for use as levee fill material and to develop recommendations for levee construction to address settlement, seepage, and other site-specific geotechnical criteria.

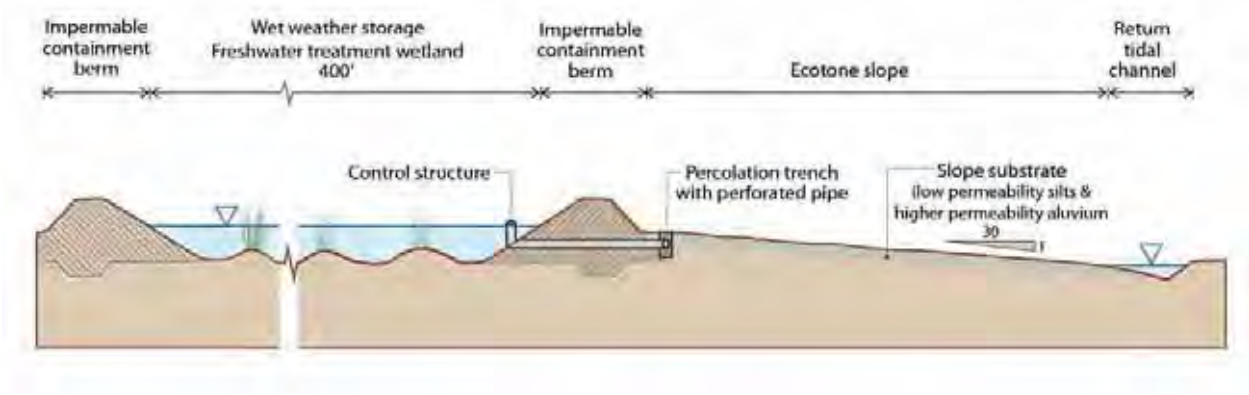

Figure 4 Conceptual cross section

Within the storage basin, the basin would be graded to maximize treatment wetland functions. Berms would be utilized to develop a complex flow path that maximizes flow length to treatment area. Within the flow path, micro-topography would be utilized to create alternating areas of deeper open water and shallow areas that would support dense wetland vegetation that serve denitrification functions. We have assumed that about three feet of grading would be required across the storage basin footprint for grading of micro-topography. We also anticipate that at least one-third of the treatment area would be planted with wetland species targeted for treatment functions. Vegetation is anticipated to expand naturally. Treatment efficiency within the wetlands is discussed in detail below.

Treated waste water would be routed to the wet weather equalization facility and treatment wetlands via a gravity fed pipeline from the WWTP's secondary treated discharge line, just after the secondary clarifier (Figure 5) prior to disinfection. Conceptually, this gravity line is assumed to require a 30-inch pipeline. Peak wet weather flows would be discharged directly into the wet weather equalization facility. Discharge from the wet weather equalization facility following the storm peak would be routed back to WWTP via a new pump station through a return pipeline. The return plumbing is conceptually assumed to require a 75 cfs pump station capacity and an 18-inch return pipeline.

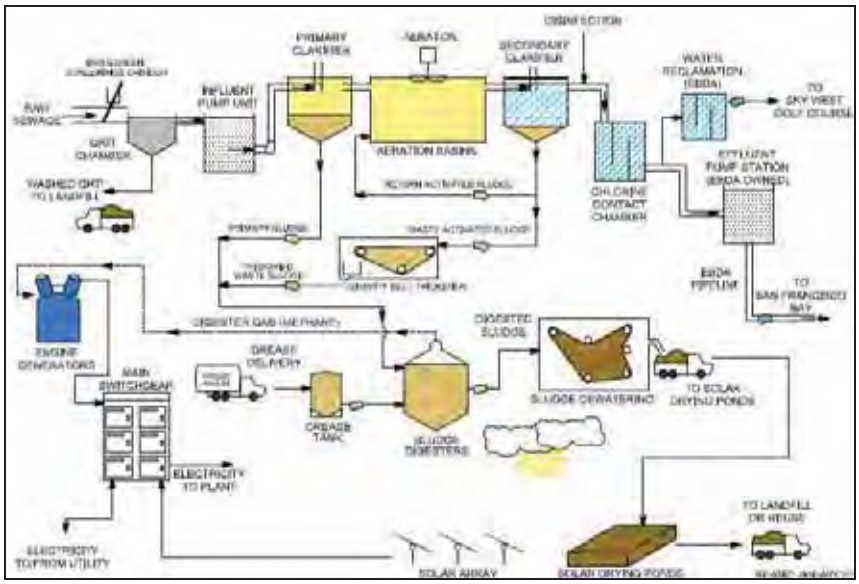

Figure 5. WWTP treatment plant process

For typical dry weather treatment wetland function, lower dry-weather flows would pass through either trickling filters or aerated subsurface wetlands to convert ammonia into nitrite and nitrate prior to discharge into the treatment wetlands. During typical dry weather treatment functions, water levels within the treatment wetlands would be controlled via a flashboard riser structure at the treatment wetlands outlet. The flashboard riser structure would discharge to a 12-inch pipeline fitted with a slide gate at the riser to prevent discharge of peak wet weather effluent. The 12-inch discharge line would pass effluent following treatment in the treatment wetlands through the containment berm to the ecotone slope described below. The 12-inch discharge line would connect to a perforated pipe in a gravel lined trench running the length of the ecotone slope to evenly discharge treated wastewater across the ecotone slope.

The existing stormwater channel that bisects the site from the north-east to south-west would be re-routed around the storage basin. The new stormwater channel would be designed as a bioswale based on the guidance for stormwater best management practices provided by the California stormwater quality task force. Bioswales incorporate a wide vegetated channel that conveys the runoff generated from small, frequent rainfall events with shallow depths (generally less than 4 inches). Larger events are conveyed with greater depths. The new stormwater channel would discharge to Bockman Canal at the location of the existing drainage gate.

3.2 Upland Ecotone Slope

The outside slope on the southern side of the containment berm is the focus of the demonstration project that is being proposed:

- to create an upland /transitional ecotone that is missing in many parts of the Bay due to diking;

- to create gently sloping upland between tidal marshes and existing flood risk management levees to act as buffers to sea level rise using broad, gently sloped gradients, with greater productivity to increase accretion rates;
- and to act as treatment wetlands to polish wastewater discharge during dry weather.

This vegetated slope is intended to emulate a natural alluvial fan – it will be graded at a much shallower 30H:1V slope, and be constructed from a variety of soils such as low permeability silts supporting native grassland vegetation and coarser, high permeability, microaerobic alluvium that would support riparian scrub vegetation. Vegetation types would be targeted towards native species with relatively high treatment removal efficiencies. During dry weather, water from the WWTP would be routed through the treatment wetland on the floor of the storage basin and then allowed to seep through the shallow outside slope via a perforated pipeline install along the upper end of the ecotone slope. Water that passes through the slope would be collected in a channel at the foot of the slope and returned to the WWTP via the existing gravity line. The demonstration would incorporate a portion of Oro Loma's discharge through a variety of ecotone and treatment wetland configurations that would offer varying soil types, slopes, and vegetation to help ascertain ideal configurations for larger future projects.

The proposed ecotone slope would be the first of its kind in San Francisco Bay to replicate an engineered equivalent of lowland floodplain moist grasslands vegetation (lowland wet grassland and sedge-rush meadows) of broad, flat alluvial fans that historically graded into the tidal marshes of most of the South Bay. Historically this moist grassland/bayland ecotone was predominant along the Estuary and in the San Lorenzo Watershed. The upland ecotone is an essential component of healthy, sustainable tidal marsh ecosystems and has been eliminated from the vast majority of the South San Francisco Bay. Successful restoration of upland transition zone habitat will provide numerous ecological services including tidal marsh ecosystem resiliency in the face of sea level rise. Upland ecotone restoration can substantially increase native plant species diversity in and adjacent to the tidal marsh zone. Restored marshes bordered by a diverse habitat mosaic of native moist grassland with upland forb species will provide critical high-tide refugia in the long term for a diversity of wildlife species such as the salt marsh harvest mouse (*Reithrodontomys raviventris*) and California clapper rail (*Rallus longirostris obsoletus*). Other species that may use this habitat include songbirds and small mammals. These areas also provide a buffer between public use and the sensitive wildlife that use the restored tidal marshes. Groundwater, soil, and vegetation interactions of wet meadows will support important carbon and biogeochemical nutrient transformation and sequestration processes that are currently excluded from diked baylands and tidal marshes disconnected from groundwater discharges.

The target plant community will be locally native moist grassland/seasonal wetland dominated by rhizomatous, spreading (sod-forming) species such as creeping wildrye (*Elymus triticoides*), saltgrass (*Distichlis spicata*), rushes (*Juncus sp.)*, and sedges *(Carex sp.).* Examples of additional grasses and forbs include meadow barley (*Hordeum brachyantherum*), marsh baccharis (*Baccharis glutinosa*), western goldenrod (*Euthamia occidentalis*), mugwort (*Artemisia douglasiana*), California aster (*Symphyotrichum chilense*),) and alkali heath (*Frankenia salina*).

If water quality objectives are met, then tidal water could be introduced at the toe of the slope, through Bockman Canal, to emulate tidal fluctuations found on a high marsh. Tidal flows into the return channel would be regulated with a slide-flap combination gate at the Bockman Canal.

With an increasing salinity gradient from the top of slope to the tidal influenced toe (lower elevations); the target topsoil conditions and plant communities will be designed to fit the appropriate salinity gradient in accordance with our understanding of the historical, natural vegetation of this zone. At lower elevation areas (at high tide line), the moist grassland/seasonal wetland community described above would transition with tidal salt marsh species including gumplant (*Grindelia stricta*), pickleweed (*Salicornia pacifica*), alkali heath, and marsh baccharis.

These broad transition zones also provide the opportunity to restore salt panne/seasonal wetland habitat which could be created by constructing shallow depressions in the slope just below the elevation of the spring tides. Woody debris could be added to provide additional marsh structure and cover for small mammals. Willow sausals (willow thicket patches) may potentially be restored where groundwater seepage occurs.

3.3 Wastewater Treatment Efficiency

Conventional engineered wastewater treatment wetlands functions are aimed at physical and biogeochemical processing of wastewater to minimize discharges of suspended organic solids, biological oxygen demand, dissolved organic carbon, nutrients, heavy metals and organic contaminants, microbial and viral pathogens, to receiving waters. Their basic designs usually include combinations of detention or settling ponds (bulk removal of solids), and variations of horizontal flow systems (surface flow or subsurface flow through saturated or flooded basins with tall emergent freshwater marsh vegetation and anaerobic permanently flooded soils) through excavated or diked lined artificial basins with engineered inlets and outlets.

Natural or semi-natural marshes with some engineered modifications can be utilized as intermediate discharge locations for wastewater effluent to provide nutrient polishing (removal) and other wastewater treatment and water quality functions, integrated with other public benefits of wetlands including wildlife habitat and public access for wildlife viewing. The Hayward Marsh, a perennial diked (non-tidal) brackish to saline marsh jointly managed by EBDA and EBRPD, for example, receives treated wastewater effluent primarily from Union Sanitary District. The Hayward Marsh was originally part of a tidal salt marsh and pan complex, and currently lies at an elevation at or slightly below modern sea level. The Hayward Marsh design is based on direct discharge of surface freshwater (wastewater) flows into the marsh, in contrast with the historical pattern of most historical East Bay streams, which did not directly connect to tidal sloughs, but spread out into broad alluvial fans, and discharged diffusely through overbank sheetflow, or subsurface (seepage) flows to the Bay.

Planning for adaptation of San Francisco Bay marshes to accelerated sea level rise has recently re-opened the wetland design of terrestrial edges with broad, gentle ecotone slopes, similar to alluvial fans. These gentle gradients also have potential for integration with wastewater treatment designs that

emulate a different natural wetland surface and subsurface flow model, aligned with patterns of streamflow discharges to the Bay through an ecotone of seasonal floodplain wetlands to estuarine wetlands.

Treatment wetlands are rich environments with several bio-chemical transformations occurring simultaneously, sometimes competing for the same resources. The complexities of these systems make it difficult to accurately predict treatment performance. Additionally, multiple factors (e.g. temperature, influent concentrations, background concentrations, etc.) that are not easily controlled affect treatment efficacy. Despite these uncertainties, predictive models have been developed based upon decades of data from dozens of treatment wetlands around the country. We used several of these tools to create a range of expected performance.

Nitrogen exists in several chemical and organic forms; solid (organic biomass), aqeous (ammonia [NH_4], nitrite [NO_2], nitrate [NO_3]), and gaseous (nitrogen gas [N_2], ammonia gas [NH_3]). The primary forms of nitrogen leaving an activated sludge treatment plant are ammonia and organic (dissolved and particulate). The predominant pathway for nitrogen removal from treatment plant effluent in treatment wetlands is through nitrification and denitrification. The nitrification step requires the addition of oxygen for bacteria-mediated transformation from ammonia to nitrite to nitrate. Denitrification requires a very low oxygen environment for bacteria to strip the oxygen from the nitrate to yield nitrogen gas.

Depending on design and environmental conditions, treatment wetlands can be effective in reducing concentrations of ammonia. Typically this requires open water to allow for natural surface aeration of the water column. The two main difficulties with relying on natural surface aeration are

1. the denitrification process requires a low oxygen environment, and lots of surface area, typically supplied by a dense stand of wetland vegetation;
2. mosquitos tend to proliferate in high ammonia waters and mosquito fish, which are very effective in keeping mosquito populations low, can be killed by high ammonia concentrations tend to shy away from waters with concentrations above 2 mg/l.

It is for these reasons that we recommend separating the process of nitrification from the main wetland function of denitrification. A variety of nitrification systems that range in complexity and cost would be suitable for the site. These include conventional nutrient removal systems, trickling filters, aerated subsurface wetlands, and an open air aeration channel.

Typical nitrification systems reduce ammonia concentrations to below 1 mg/l, and convert about 60% of the ammonia to nitrate. The remaining nitrogen is lost to the atmosphere in the process either by volatilization or denitrification. Table 1 summarizes current and expected nitrified effluent concentrations.

Table 1. Oro Loma effluent discharge and nitrogen concentrations

	Discharge	Secondary Effluent	Nitrified Effluent (expected)		
Source	Discharge (mgd)	Ammonia (mg/l)	Ammonia (mg/l)	NO_3 (mg/l)	Lost to atmosphere (mg/l)
Main Effluent	12	25	<1	15	9

Two scenarios were investigated regarding nitrogen removal. First, given the 3.2 acre area designated for the wet weather equalization facility, what is the nitrogen removal that can be expected? Second how big would the wetland need to be for OLSD to treat all of its effluent?

Two separate methods were used to estimate removal efficiency; one relied strictly on load reduction capacity (kg/day) of the treatment wetland, and the other looked at reaction rate kinetics. The parameters for determining nitrogen removal through traditional kinetic equations include hydraulic detention time, temperature, influent and background nutrient concentrations, and reaction rate constants. Table 2 summarizes the nitrogen removal efficiency, anticipated flow rate through the 3.2 acre site, and the size of wetland required to treat the full discharge. Since treatment efficiency is a function of temperature, flow rates treated in the wetlands and ecotone slope are anticipated to be higher in summer and lower in winter.

Table 2. Treatment wetland parameters, nitrogen removal efficiency, and sizing factors

	Flow rate through 3.2-acre wetland	Size of wetland to treat 12.1 mgd discharge
HRT	7 – 14 days	7-14 days
NO_3 In	15 – 18 mg/l	15 – 18 mg/l
NO_3 Out	5 – 9 mg/l	5 – 9 mg/l
% Removal	50 – 75%	50 – 75%
Flowrate	0.12 – 0.25 mgd	12.1 mgd
Area	3.2	140 – 320 Acres

The ecotone slope would provide additional denitrifcation treatment capacity over and above that of the treatment wetlands. At this time, it is difficult to estimate how much the additional treatment capacity could be provided by the ecotone slope. Over time, as the capacity of the ecotone slope is demonstrated, treatment flow rates may be increased over those provided exclusively through the treatment wetlands.

4 Work Plan:

The project consists of five major tasks: Design, Permitting, Monitoring, Science Advisory Committee and Outreach. These tasks are described below.

Task 1 Design

The design of the facility would be led by ESA PWA supported by a number of sub-consultants to provide specific design support. ESA PWA would develop grading plans and coordinate all input from sub-consultants. Sub-consultants would provide the following support:

- Geotechnical Engineer (Cal Engineering & Geology) to review soils conditions onsite to determine the suitability of onsite soils for use in the containment levee. In addition, the geotechnical engineer will provide guidance on levee construction to account to settlement and seepage given subsurface conditions on site.
- Civil Engineer (Whitley Burchett & Associates) to develop detailed designs for pump station, pipelines, plumbing and controls/valves to connect the proposed facility to the existing OLSD WWTP.
- Project ecologist (Dr. Peter Baye) to develop concepts for soils and plantings on ecotone slope.
- Treatment Wetlands Scientist (Dr. Alex Horne) to assist with treatment wetlands processes and design.

Preliminary Design

Preparation of the preliminary design documents (approximately 30%-completion level) will begin following agreement of the concept with OLSD. It is assumed that the preliminary design documents will contain sufficient detail to initiate the permit application process. The following elements will form the engineering design:

- Containment berm
- Associated hydraulic structures and piping
- Treatment wetland
- Ecotone slope
- Stormwater channel realignment
- Mitigation areas

The following 30%-complete design package will be developed for review and comment:

- Preliminary Design Report – describing the project elements and key constraints that are addressed by the proposed design
- 30%-complete drawings
- Draft outline of technical specifications
- Preliminary construction cost estimate

Working with OLSD, the preliminary construction cost estimate will be refined based on quotes from local contractors/suppliers.

Engineering Design

The design will be developed from preliminary design to final design documents (drawings, technical specifications and cost estimate). The detailed design will include the following main elements:

- Containment berm
- Piping
- Treatment Wetland
- Ecotone slope
- Stormwater channel realignment

Progress design submittals will be provided at the 60%- and 90% -completion levels for review and comment by OLSD. Each submittal will include drawings, specifications and cost estimates developed to appropriate levels of completion. Outline technical specifications will be submitted with the 60% submittals, and draft technical specifications and a list of Bid Items at the 90% submittal.

The final design submittal will consist of the following:

- Final signed and stamped drawings
- Technical specifications (following the OLSD format)
- Design calculations (e.g. hydraulic analysis, pipe sizing, etc.)
- List of bid items
- Engineer's estimate of likely construction costs
- Proposed construction schedule
- Operations and monitoring plan

For budgeting purposes, we have assumed that design drawings will consist of the following preliminary sheet list:

Table 3 Design drawing list

Description	Approx Number of Sheets	Design Lead
Title Sheet	1	ESAPWA
Grading Plans (1" = 40' scale)	3	ESAPWA
Typical Grading and Embankment Sections	3	ESAPWA
Hydraulic Structures – Typical Details	5	Whitley Burchett
Piping – Typical Details	3	Whitley Burchett
Planting/Erosion Control Plan	2	PWA/Peter Baye
Estimated Total	**17**	

The actual list of drawings will be refined as the design develops.

Bidding Assistance

This task will include bidding support services during the bid period including attending the pre-bid conference and responding to bidders' questions as requested by OLSD. At this stage, it is anticipated there could be one written bid addendum (without drawings) following the pre-bid conference.

Construction Support

This task will also include engineering support services as needed during construction. At this stage it is assume that OLSD will provide its own construction inspector/manager. The project designers will support the OLSD construction manager, with the following services:

- Attendance of pre-construction meeting
- Site visits
- Review of submittals
- Response to RFIs
- Preparation of change orders

Task 2 Permitting (more detail in Appendix A)

In order to construct the project, it needs to be analyzed pursuant to the California Environmental Quality Act (CEQA), as well as securing all necessary federal, state, and local permits and authorizations. Based on a current understanding of the proposed project and its associated impacts, these would include, but are not limited to, a Section 404 Individual Permit from the USACE, a Section 401

Certification from the RWQCB, a Streambed Alteration Agreement from the CDFG, a Major Permit from the BCDC, a Biological Opinion from the USFWS for species covered under the Federal Endangered Species Act, and an Incidental Take Permit from the CDFG for species covered under the California Endangered Species Act. Figure 6 shows the extent of potential wetlands within the project footprint.

Figure 6 Preliminary Wetland Delineation Map

While the project offers potential long term solutions to sea level rise and ecotonal habitat restoration, it may be viewed somewhat skeptically by state and federal resource agencies, because the demonstration project involves a degree of uncertainty and innovation, as well as because project construction would result in impacts to biological resources and jurisdictional waters and wetlands. However, it is expected that the project's anticipated social, economic, and ecological benefits, in both the near and especially the long term, would outweigh these impacts. Below are the key issues we anticipate with respect to the regulatory permitting process, the requirements which pertain to these issues, and the approaches we propose to address and overcome these issues.

Impacts to state and federally jurisdictional waters and wetlands (from project construction)

To obtain regulatory approval for impacts to jurisdictional waters and wetlands, there will need to be a demonstration of need for the project. For this project, this need may be 'dual' (WWTP and demonstration)

- WWTP – demonstrate need for facility (operational, significant reduction in cost, increase in efficiency or reliability, need to meet existing or expected demand, etc.)
- Demonstration– anticipated need for this type of solution throughout the SF Bay, to address sea level rise and long term (or historic?) habitat loss

The USACE and the RWQCB will require an Alternatives Analysis (AA) as a part of their permit evaluation and decision-making process; an AA must consider both off-site and on-site (i.e. design) alternatives that would meet the project purpose. The least environmentally damaging practicable alternative (LEDPA) which meets the project purpose must be selected. Typically this analysis is driven by a goal to reduce impacts to jurisdictional waters.

To support the AA as well as the development of an appropriate compensatory mitigation plan for the project's impacts, it will be critical to characterize the quality of the existing waters/wetlands, as well as the habitat suitability and utilization by sensitive species. This will enable the project team and the regulatory agencies to better quantify and qualify impacts to resources (especially if the existing quality is low/degraded), as well as to enable them to compare resource impacts with proposed mitigation features, for proper identification of adequate mitigation. This may also be important to justifying any type-conversion of waters/wetlands that may occur with project implementation and mitigation implementation.

Impacts to sensitive species and/or habitat (from project construction)

To obtain regulatory approval for impacts to sensitive species and/or habitat, there will need to be a characterization of the site's habitat and utilization by species, a rational for why impacts to these species/habitats is justified, as well as a need to identify suitable measures to mitigation for these impacts and ensure the survival of the species and/or preservation of habitat

The adequacy and appropriateness of mitigation strategies

It will be important to clearly demonstrate that the project can adequately offset (quantitatively and qualitatively) all agency-perceived impacts to existing resources, as well as provide confidence in the success of the mitigation, and finally provide a rationale for the impacts that is rooted in both the short term (WWTP) project need and in the long-term (sea level rise/restoration) project need

Approaches could include:

- Use of the California Rapid Assessment Method (CRAM, www.cramwetlands.org)or other widely-acceptable functional assessment methodology for aquatic resources, to assess existing waters/wetlands quality (as a design target to meet or exceed) and to measure mitigation feature success, in line with USACE and RWQCB guidance

- Include an analysis of existing versus mitigation site Beneficial Uses, to meet RWQCB Basin Plan objectives
- Develop a conceptual HMMP that includes quantitative and qualitative details to show adequacy of proposed mitigation for both waters/wetlands and sensitive species/habitats
- Provide rationale for likelihood of success
- Provide other reference sites or examples
- Provide argument justifying wetland or waters 'type conversion,' if anticipated with project implementation (i.e. restoration of historic habitat type, etc.)
- Provide arguments supporting the need for these types of projects in the long term throughout the Bay.

Task 3 Construction/ Maintenance

OLSD would hire a construction company, using a formal public bidding process to perform the following construction-related tasks: grading of containment berms; filling of ecotone slopes; planting of ecotone levee; grading of collector channel, grading of microtopography in treatment wetland; and installing drop inlets, pipes and valves to control water flow through treatment wetlands and the ecotone slope.

Establishment of the ecotone slope vegetation will involve careful topsoil preparation and active revegetation using techniques designed to 1) increase the rate of target native vegetation establishment and 2) inhibit potential weed establishment. Important topsoil characteristics include soil chemistry (e.g., salinity), organic matter content, texture, weed seed bank factors, and seed bed enhancement. Once the topsoil has been applied, plants will be applied as per the design palette. Creeping wildrye and saltgrass are the dominant species currently under consideration for the ecotone slope. Because neither of these species reproduce readily from seed, they will be strategically planted both to facilitate growth and to preempt the establishment of invasive weeds.

Once the ecotone is planted, the slope will be monitored regularly to ensure that weeds do not begin to dominate the slope. Methods to limit weed growth and establishment will be applied as needed. Treatments include the application of black plastic mulch, solarization, herbicide spot treatments, and mechanical and manual weed removal (Baye 2008).

Task 4 Monitoring

The goal of the project is to create a moist grassland ecotone that emulate historic habitat lost in the Bay and also provides water quality benefits. Given the experimental nature of the demonstration project, close monitoring of the containment basin and the ecotone slope are necessary to understand how they perform and also to provide guidance in optimizing their operation. An operations and monitoring plan will be developed as part of Task 1.

Monitoring will cover three main aspects:

- Hydraulic performance
- Plant establishment
- Water quality

Specific performance criteria will be established as part of the project design and these will be monitored at suitable locations and intervals. Initially the focus will be on understanding the hydraulic performance of the basin and slope; understanding how the seepage flow can be controlled and optimizing the throughput of water. As vegetation becomes established, the focus will switch to monitoring the quality and quantity of upland ecotone. Water quality benefits will be assessed following the establishment of the vegetation.

It is anticipated that the ecotone slope will be divided into between 6 and 8 strips parallel to the slope, each strip having a different treatment in terms of soil compaction, seepage rates, etc. Hydraulic and water quality parameters would be measured going in to the containment basin, as it leaves the wetland treatment area and enters the seepage slope and finally as it leaves the seepage slope. Piezeometer wells would be located along each strip to measure seepage rates and also provide samples for water quality analysis. The specific parameters will be developed as part of the operations and monitoring plan but will likely include:

- Water discharge/seepage rates
- Water quality variables such as dissolved oxygen, temperature, TSS, acidity, nitrogen

It is anticipated that the demonstration project will attract other research groups that have aligned interests. Interest in utilizing the ecotone slope for studies on plant productivity has been expressed by the USGS.

Monitoring results will be reported on a quarterly basis, although preliminary results will be used more frequently in the operation of the facility. Annual reports will be produced that will document the monitoring program and provide an analysis of the performance. Guidance and recommendations on the design and operation of the upland ecotone will be developed from this monitoring effort.

5 Cost Estimates

Table 4 presents a summary of preliminary construction, design and permitting cost estimates based on the conceptual design outlined in the preceding sections. Breakdowns of construction costs for the wet-weather equalization / treatment wetlands and for the ecotone slope portions of the project are provided in Tables 5 and 6.

At this stage, the design of the proposed project is expected to be refined considerably as details on the geotechnical conditions at the site are better understood, and more detailed designs for the plumbing, pump station, and ammonia treatment functions are developed. We have included a 25% contingency on estimated construction costs to account for these anticipated design refinements. The estimated contingency may be reduced, at each stage of the design process, as additional design details are worked out. As the project moves from the conceptual level to final designs we plan to work closely with the OLSD staff to develop a project design that can be easily integrated into the existing WWTP, and can be operated with as little additional operations and maintenance requirements for OLSD staff as possible. It will be critical that connections to the OLSD WWTP are designed to facilitate operation and maintenance functions at the plant.

Table 4 Summary of preliminary cost estimate

Oro Loma Ecotone Project

Summary Cost Estimate - Equalization Facility & Ecotone Slope

ESA PWA - March 2012

DESCRIPTION		TOTAL	
Wet Weather Equalization Facility - Earthwork & Planting		$1,314,700	
Wet Weather Equalization Facility - Plumbing		$217,400	
Ecotone Slope Demonstration - Earthwork & Planting		$355,900	
Ecotone Slope Demonstration - Plumbing		$266,800	
General Conditions (15%)		$323,200	
TOTAL DIRECT COST		**$2,478,000**	**57%**
Contingency (25%)		$619,500	
	Subtotal	**$3,097,500**	
General Contractor - Overhead & Profit (12%)		$371,700	
	Subtotal	**$3,469,200**	
Escalation - Construction in 2014 (6%)		$208,200	
	Subtotal	**$3,677,400**	
Sales Tax (9.75% of 50% of Plumbing Costs)		$23,600	
	Subtotal	**$3,701,000**	

Bid Market Allowance (0%)	$0	
TOTAL ESTIMATED CONSTRUCTION COST	**$3,701,000**	**86%**
Planning, Engineering, Legal, and Administration (15%)	$371,700	
EIR/Mit Neg Dec & Permitting (5%)	$123,900	
Owner's Reserve for Change Orders (5%)	$123,900	
Monitoring and Analysis		
TOTAL ESTIMATED PROJECT COST	**$4,320,500**	**100%**

Table 5 Wet weather equalization preliminary cost estimate

	Description	Quantity	Unit	Unit Cost	Total Cost	Notes
Earthwork & Plantings						
	Containment Berm	33,900	CY	$30	$1,017,000	10 feet high Berm w/ 3:1 slopes - Imported Material
	Forebay Berm	1,000	CY	$10	$10,000	5 feet high berm w/ 3:1 & 10:1 slopes - Onsite Material
	Fine Grading for Treatment Wetland	15,300	CY	$10	$153,000	~ 3 feet of grading combined cut / fill to create micro topography
	Reroute Stormwater Channel	2,000	CY	$10	$20,000	2 feet deep channel with 5:1 slopes
	Plantings (Wetland)	46,250	SF	$2	$92,500	Planting 1/3 of treatment wetland area
	Hydroseeding (Berm and Channel)	3.8	AC	$5,900	$22,200	Hydroseeding with native wetland species
Subtotal - Earthwork & Plantings					**$1,314,700**	
Plumbing						
	Secondary Discharge Line	250	LF	$300	$75,000	30-inch HDPE w/ fittings
	Peak Flow Return Line	180	LF	$180	$32,400	18-inch HDPE w/ fittings
	Upgrade Pumpstation	1	EA	$35,000	$35,000	New pump with 75 cfs capacity
	Control Valves	3	EA	$25,000	$75,000	30-inch & 18-inch valves for control of discharge and return flows
Subtotal - Plumbing					**$217,400**	
Total - Wet Weather Equalization Facility					**$1,532,100**	

Table 6 Ecotone slope demonstration preliminary estimate

Ecotone Slope Demonstration						
	Description	Quantity	Unit	Unit Cost	Total Cost	Notes
Earthwork & Plantings						
	30:1 Slope	7,500	CY	$20	$150,000	5 feet high berm w/ 30:1 slope - Imported & onsite materials
	Return Channel/Tidal Channel	1,040	CY	$10	$10,400	2 feet deep channel with 5:1 & 10:1 slopes
	Plantings (Ecotone)	90,000	SF	$2	$180,000	Planting all of Ecotone Area with native sprigs
	Hydroseeding (Ecotone & Channel)	2.6	AC	$5,900	$15,500	Hydroseeding with native wetland species
Subtotal - Earthwork & Plantings					**$355,900**	
Plumbing						
	Flashboard Riser Inlet Structure	1	EA	$24,000	$24,000	Concrete riser box with flashboard frame and sealed boards
	Slide Gate	1	EA	$10,000	$10,000	12-inch slide gate mounted in riser box
	Pipe	50	LF	$120	$6,000	12-inch HDPE w/ fittings
	Perforated Pipe	600	LF	$120	$72,000	12-inch HDPE perforated pipe w/ fittings (in gravel trench)
	Valve to control return flows	1	EA	$25,000	$25,000	18-inch valves for control of discharge and return flows
	Return Line	300	LF	$180	$54,000	18-inch HDPE w/ fittings
	Discharge line to Bockman Canal	150	LF	$180	$27,000	18-inch HDPE w/ fittings
	Slide Flap Combo Gate	1	EA	$18,000	$18,000	18-inch Slide/Flap combo gate on piles
	Support Piles	6	EA	$3,000	$18,000	Piles to support Slide/flap gate and gangway
	Gangway	150	SF	$85	$12,800	Gangway to Slide/Flap gate at Bockman Canal
Subtotal - Plumbing					**$266,800**	
Total - Ecotone Slope Demonstation					**$622,700**	

6 Preliminary Schedule

Table 7 Preliminary schedule

Task	Outputs/Deliverables	Schedule
Task 1 Design		
A Preliminiary Design, 30% Design and Permitting Support	30% Design Package	Months 0-6
B Engineering Design	90% Engineering Drawings and Specs	Months 6-12
C Bidding Assistance	Memos, site visits	Months 12-18
D Construction Support	Memos, site visits	Months 12-18
Task 2 Permitting		
A. Environmental Baseline Studies	General Biotic Assessment, Cultural Survey	Months 0-3
B. CEQA IS/MND	Admin Draft, Public Draft, Final IS/MND	Months 3-12
C. Permitting	Various permit applications	Months 0-12
Task 3 Construction & Maintenance		
A. Construction of Equalization Facility		Months 12-18
B. Construction of Ecotone Slope		Months 12-18
C. Planting of Ecotone Slope		Months 12-18
D. Plumbing of Ecotone Slope		Months 12-18
Task 4 Monitoring		
A. Conduct Monitoring	Quarterly monitoring reports	Months 18-48
B. Final Monitoring Report	Final Monitoring report	Month 42-48

7 Preliminary Design Report & 30% Engineering Design

As a first step to progress the project, we recommend that the Oro Loma Sanitary District begin work on the Preliminary Design Report and 30% Engineering Design. The Preliminary Design Report would provide sufficient detail to support permit applications with regulatory agencies. In addition, the Report would provide documentation of the project to support funding requests with agencies such as the Environmental Protection Agency grant program or the Regional Water Quality Control Board's IRWMP program.

The Preliminary Design Report would document the design approach for all project elements including:

- Containment berm – The Geotechnical Subconsultant (Cal Engineering & Geology) would review existing soils data collected at Oro Loma Sanitary District to determine if they expect that the existing soils would be suitable for use as the impermeable core for the containment berm. Cal Engineering would provide preliminary recommendations on the use of onsite materials, the need for over-excavation/subgrade preparation, settlement, anticipated density and volume

changes, and other key geotechnical considerations. Cal Engineering would provide recommendations for additional work required to develop final designs for the project including the need for additional geotechnical investigations and analysis of geologic hazards, seepage, stability, etc. ESA PWA would develop preliminary designs for the containment berm based on recommendations from Cal Engineering and hydraulic containment requirements.

- Treatment Wetlands – The treatment wetlands subconsultant, Dr. Alex Horne would work with ESA PWA to develop conceptual designs for the treatment wetlands processes including nitrification processes to convert ammonia to nitrite and nitrate and denitrification processes within the planned treatment wetland. The Civil Engineering subconsultant (Whitley Barchett & Associates) would work with ESA PWA to determine the appropriate engineering design parameters for the nitrification processes. ESA PWA would develop preliminary grading plans for the treatment wetlands taking into account existing grades, recommended treatment depths, and the containment/wet weather equalization capacity. Alex Horne and Peter Baye would provide guidance on the appropriate plantings for the treatment wetlands.
- Hydraulic structures and piping – Whitley Barchett would work with ESA PWA and OLSD to develop a plumbing plan for the Wet Weather Equalization Facility and the Treatment Wetlands. Whitley Barchett would work with OLSD to identify points of connection to deliver treated wastewater to the Wet Weather Equalization Facility / Treatment Wetlands and to return polished wastewater to the OLSD plant following treatment in the wetlands and ecotone slope. Whitley Barchett would develop preliminary plans for pipe alignments, sizes, valving, pump and stations, and provide preliminary control logic and cost estimates.
- Ecotone slope – ESA PWA would develop preliminary designs for the ecotone slope in consultation with Dr. Peter Baye. ESA PWA would consider recommendations from Cal Engineering regarding settlement and onsite soils for the ecotone slopes. We anticipate that the ecotone slopes would require some import of coarse alluvium material. Dr. Peter Baye would provide conceptual planting plans and recommendations.
- Stormwater channel realignment – ESA PWA would develop preliminary designs for the realignment of the existing stormwater channel that bisects the site. We anticipate utilizing guidelines for bio-swales to provide stormwater treatment. In addition, we would work with OLSD to determine if stormwater during smaller events could be routed through the OLSD treatment plant for additional treatment to address RWQCB concerns related to urban runoff.
- Mitigation areas – ESA PWA would work with Dr. Peter Baye to develop preliminary plans to mitigate impacts to the existing (degraded) wetlands that would be impacted by the construction of the Wet Weather Equalization Facility/ Treatment Wetlands and ecotone slope. We anticipate that existing uplands along the shoreline adjacent to the OLSD wastewater treatment plant can be regraded to provide superior mitigation habitat to address any regulatory concerns with loss of wetland habitat onsite.

The 30% Engineering Design would accompany the Preliminary Design Report. The 30% Design would include preliminary design drawings, outline level technical specifications, and quantity and cost estimates. The design drawings would include preliminary grading plans and sections, schematic diagrams of piping, valves, and pump stations, and plant lists for the treatment wetlands, ecotone slope, and stormwater channel. The technical specifications would outline key specification sections and provide bullets on key design and construction requirements. Quantity and cost estimates would be

provided based on the preliminary design and geotechnical recommendations regarding the use of onsite materials.

The estimated budget for the ESA PWA team to prepare the Preliminary Design Report and 30% Engineering Design is $104,000. Table 8 below provides a breakdown of the proposed budget. ESA PWA will invoice monthly for actual time and materials according to our standard rate schedule in effect at the time the work is performed (see attached).

We anticipate that the Preliminary Design Report and 30% Engineering Design can be completed within about six months of receiving Notice to Proceed. We would provide a draft submittal within about four to five months, and finalize the submittal within about one month of receiving comments from OLSD. We would anticipate three to four meetings with OLSD staff to review design details as we develop the Preliminary Design Report.

Table 8 Preliminary Design Report and 30% Engineering Budget.

ESA PWA	
Preliminary Design Report	$ 48,000
30% Engineering Design	$ 27,000
Cal Engineering & Geology (Geotech)	$ 10,000
Whitley Barchett & Associates (Civil)	$ 10,000
Dr. Peter Baye (Ecologist)	$ 4,000
Dr. Alex Horne (Treatment Wetlands)	$ 4,000
Expenses (Reproduction & Site Visits)	$ 1,000
Total	**$104,000**

8 References

Baye, P. 2008

Cooper, J.A.G. 2002. The role of extreme floods in estuary-coastal behaviour: contrasts between river and tide dominated microtidqal estuaries. *Sedimentary Geology*, 150: 123-137.

Defina, A., Carniello, L., Fagherazzi, S. and D'Alaos, L.D. 2007. Self-organization of shallow basins in tidal flats and salt marshes. *Journal of Geophysical Research*. 112. F03001.

Fagherazzi, S., Palermo, C., Rulli, M.C., Carniello, L. and Defina, 2007. Wind waves in shallow microtidal basins and the dynamic equilibrium of tidal flats. *Journal of Geophysical Research.* 112, F02024.

Goals Project. 1999. *Baylands Ecosystem Habitat Goals*.

Appendix A: Permitting

The following are the tasks needed to complete environmental compliance, secure permits and authorizations, and to move forward to project implementation.

While the project offers potential long term solutions to sea level rise and ecotonal habitat restoration, it may be viewed somewhat skeptically by state and federal resource agencies, because the demonstration project involves a degree of uncertainty and innovation, as well as because project construction would result in impacts to biological resources (including wetlands). However, it is expected that the project's anticipated social, economic, and ecological benefits, in both the near and especially the long term, would outweigh these impacts.

It will be necessary to engage the regulatory and resource agencies early in the environmental review process, to identify the potential obstacles and necessary steps to completing environmental review and compliance documentation, and to prepare the permit applications required to gain project approvals and permits in order to facilitate project implementation. In addition, this environmental compliance and permitting process could be used, together with the early results of the demonstration project, to engage the regulatory and resource agency staff in a higher level dialogue focused on the long-term implications and benefits of such a project for addressing sea level rise and upland/transitional ecotone restoration in the San Francisco Bay.

Key issues for project analysis could include:

1. construction related impacts to state and federally jurisdictional waters and wetlands ,
2. construction related impacts to sensitive species, and
3. permit acquisition from regulatory and land use agencies, including: Corps, USFWS, CDFG, RWQCB, BCDC and State Lands Commission.

Task 1 – Conduct Environmental Surveys and Prepare Environmental Studies for CEQA Documentation

Prepare the necessary environmental background studies in support of the environmental review process and acquisition of regulatory permits for resource topics that could present project constraints and feasibility issues. Based on a preliminary understanding of the resources, environmental concerns and constraints associated with the project area and proposed project activities, background studies would be prepared to identify and evaluate biological resources and cultural resources. The findings of the surveys would be presented in technical memoranda or reports for each issue evaluated. Data obtained during field surveys would be presented in geographic information systems (GIS) format, as appropriate. The approach to biological resources and cultural resources studies are described below.

Task 1.1 General Biotic Assessment

A general biotic assessment will be conducted to identify biological resources that are potentially present in the project area and for which there is a potential for project construction and/or operation to result in impacts. It is understood, previous studies have documented the presence of federally jurisdictional waters and wetlands on the site. In addition, sensitive species including the salt marsh harvest mouse and clapper rail are known to occur in the general vicinity of the site.

As part of the initial CEQA effort, a preliminary biological resources assessment and report would be prepared. The report will include a review of existing biological studies relating to the project area, including special-status wildlife and plant species identified by the California Natural Diversity Database, California Native Plant Society Rare Plant Inventory, and the U.S. Fish and Wildlife Service as documented in or potentially occurring in the project site vicinity. Information from additional reports that include the project area, such as the Baylands Ecosystem Goals Report, will also be integrated into the assessment, as applicable. Site visits by biologists would characterize existing vegetation communities and wildlife habitats, and determine the potential for occurrence of special status species within the project area, including the federal and state-listed salt marsh harvest mouse and California clapper rail. The site visits would also be used to gather the needed information to support the development of the USFWS Biological Assessment and CDFG Incidental Take Permit (see Tasks 3.8 and 3.9, below). Biological resources will be mapped for the purposes of the CEQA document as well as permitting documents.

Assumptions:

Utilize and build upon existing information regarding jurisdictional waters and wetlands and related resources included in the Approved Jurisdictional Delineation Determination Form for the OLSD, dated December 28, 2011 (USACE File No. 1994-190250S), as well as information developed by Monk & Associates in their 2011 study for the OLSD. If available, the OLSD will provide these biological resource data in electronic format for use in calculating resource extent and potential project impacts.

Task 1.2 Cultural Resources Survey

A cultural resources assessment will be conducted to identify the potential for historic, archaeological, or cultural resources on the project site, which could be disturbed during project construction and/or operation. In the recent past the area was use for sludge storage and drying; the area was filled, excavated and cleared multiple times between 1911 and 1968. It should be noted that no sensitive elements have been discovered in any other excavations of the OLSD site.

Conduct archival research at the appropriate California Historical Resources Information System (CHRIS) Information Center, to identify previous cultural investigations and previously recorded cultural resources within a 1-mile radius of the project site, if recorded. Also request a Sacred Lands File (SLF) check from the California Native American Heritage Commission (NAHC) in order to solicit information on sensitive or undocumented traditional/cultural sites in the vicinity of the project. Native American representatives identified by the NAHC as having affiliation with the area will be contacted to assist in identifying any locations of cultural sensitivity. Following a review of this information, conduct

pedestrian surveys of the area anticipated to be impacted by project activities (i.e., area where earth disturbing activities would occur).

Prepare a Phase I Cultural Resources Report, which addresses CEQA requirements and compliance with the National Historic Preservation Act. The report will follow the guidelines in Archaeological Resource Management Reports (ARMR): Recommended Contents and Format, Department of Parks and Recreation (DPR), Office of Historic Preservation, State of California, 1990. The report will provide background contexts for the project area, present the methods and results of the study, provide recommendations regarding further treatment of any potentially significant resources identified as a result of the study, and address the likelihood of encountering subsurface intact archaeological resources during construction.

Task 2 – Prepare CEQA Document (anticipated IS/MND)

The following scope describes the subtasks involved in completing an Initial Study/Mitigated Negative Declaration (IS/MND) for compliance with the California Environmental Quality Act (CEQA) for the Oro Loma Ecotone Project.

This scope of work is based on preliminary review of the project information and would be subject to confirmation following site reconnaissance, completion of the environmental studies conducted under Task 1 above, and more detailed review of project information and design plans. In the event that a potentially significant and unavoidable environmental impact is expected to result from the project, it would be necessary to undertake an Environmental Impact Report (EIR).

Task 2.1 Prepare Administrative Draft IS/MND

Prepare the project description at the appropriate level of detail needed to support the CEQA impact analysis. Coordinate with the OLSD and project team and review available existing documents relevant to the proposed project. Conduct a site reconnaissance, as necessary, and incorporate the information gathered into the Project Description and the IS/MND as applicable. As part of the Administrative Draft IS/MND, prepare analyses of the potential project impacts and the changes from the existing conditions resulting from the proposed project, and developed project specific measures to avoid and minimize any environmental impacts as necessary. The IS/MND will include analysis of resources such as land use and agriculture; visual resources; biological and cultural resources; geology and soils; hydrology and water quality; hazardous materials; traffic and transportation; air quality; noise; public services and utilities; and recreation.

If, during the course of investigating environmental impacts, one or more potentially significant impacts are identified that cannot be avoided through implementation of mitigation measures within the OLSD's control, these need to be brought to the attention of the OLSD. If implementation of the project generates an impact that is significant and cannot be avoided or reduced to a less-than-significant level through design modifications or mitigation measures, then an EIR would need to be prepared.

Task 2.2 Prepare Public Draft IS/MND

Incorporate any comments on the Administrative Draft IS/MND and prepare the Public Draft IS/MND. Use the distribution list provided by the OLSD for circulating the Draft IS/MND. Also prepare the Notice of Availability/Notice of Intent to Adopt a Mitigated Negative Declaration and a Notice of Completion, for submittal to the appropriate agencies. Copies of the IS/MND should be provided to the State Clearinghouse and County Clerk.

Task 2.3 Response to Comments, MMRP, and Project Approval

Organize and summarize the comments received during the public review period; coordinate with the OLSD and project team as necessary to discuss response strategies and responsibilities and prepare a Response to Comments Technical Memorandum. Assume a total of 15 comment letters in need of response; additional resources may be necessary depending upon the level of comments received. Submit an Administrative Draft of the document, incorporate the OLSD's comments and prepare the Final Response to Comments Technical Memorandum. Distribute the Response to Comments document by mail using an approved mailing list which will be updated to include agencies and/or persons that commented on the Draft IS/MND and/or attended any public meetings held for the project. Prepare the Mitigation Monitoring and Reporting Program (MMRP) that will include details on the implementation procedures for mitigation measures listed in the Draft IS/MND. Provide a Notice of Determination (NOD) form to the OLSD for review. OLSD staff will take the item for approval.

CEQA Assumptions

The following assumptions were made while developing the scope of work and the cost estimate.:

- Preparation of one Final CEQA document that includes one Administrative Draft IS/MND and one Public Draft IS/MND. The submittals will be in electronic format unless otherwise noted in the scope.
- This scope assumes one (1) single consolidated set of comments for all CEQA document review.
- The impacts of the proposed project would remain within the scope of the analysis anticipated for the proposed IS/MND. If potentially significant and unavoidable environmental impacts are identified during the course of this scope of work, it will be necessary to develop a separate scope of work for an Environmental Impact Report (EIR).
- The project will not change substantially once environmental impact evaluation is underway.
- This scope of work does not include participation at a public meeting.
- This scope does not include detailed subsurface investigation for cultural resources, protocol-level surveys for biological resources, or a new/revised wetland delineation.
- The project assumes that no cultural resources will be encountered as a result of this study.
- A distribution list will be needed for circulating the Draft IS/MND

Task 3 Regulatory Permitting

The OLSD and project team will need assistance in obtaining the required regulatory permits for the project, including a Section 404 Individual Permit, Section 401 Water Quality Certification, Streambed Alteration Agreement, BCDC Permit, and permit from the State Lands Commission, as needed. Information and guidance will be needed by the OLSD to avoid potential impacts to sensitive and regulated biological resources on the project site during scientific investigation and testing activities. Based upon the innovative nature of the project, unfamiliarity to the regulatory and resource agencies, and potentially controversial nature, a pre-application interagency meeting would be conducted, to present the project at a conceptual level, outline the vision of this demonstration aspects of this project, identify anticipated benefits and potential issues, and solicit substantive and project specific input from the regulatory and resource agencies. The need for the development of additional information to support regulatory permit applications, the identification of specific permitting requirements, and early agency involvement and support, will be some of the beneficial outcomes of such a pre-application meeting.

Task 3.1 Avoidance Plan for Scientific Investigation and Testing

The OLSD and project team will need guidance and documentation in order to avoid potential impacts to sensitive and regulated resources on the project site during scientific investigation and testing activities. These activities may be necessary to further assess project feasibility and develop site specific project design, and would include minimally disturbing activities such as soil testing and coring. Identify the location, nature, and extent of known resources on the site (as identified in existing information and the results of studies conducted in Task 1), as well as develop avoidance and minimization measures that ensure protection of these resources, thereby assisting the OLSD and project team in obviating the need for regulatory or resource agency permits during these early investigation activities. Likely inclusions in the Plan would be temporal restrictions on work to avoid clapper rail breeding season and a requirement for biological monitoring during ground disturbing activities to avoid potential impacts to salt-marsh harvest mouse.

Task 3.2 Interagency Pre-Application Meeting

Coordinate with the required regulatory and resource agencies to arrange a pre-application meeting, frequently hosted by the USACE during their standing monthly pre-application meetings, to describe the proposed project at a conceptual level. Preliminary findings with respect to anticipated project impacts on waters and wetlands, sensitive species or habitats, and anticipated project benefits including habitat creation, wastewater treatment, and sea level rise protection, will be presented for review and discussion. The major goals of the pre-application meeting will be to educate regulatory and resource agency staff, invite input and suggestions, indentify potential challenges and key issues, and further define the required regulatory permitting processes. Another goal of the meeting will be to initiate a higher-level dialogue with the agencies about the long-term implications and benefits of such a project for addressing sea level rise and upland/transitional ecotone restoration in the San Francisco Bay.

Task 3.3 USACE 404 Individual Permit

Based on the previously documented presence of federally jurisdictional waters and/or wetlands on the project site, combined with anticipated project impacts to these federal waters and/or wetlands, a Section 404 permit from the U.S. Army Corps of Engineers (USACE) is expected to be required.

Prepare an application package for an Individual Permit (IP) under Section 404 of the Clean Water Act, for submittal to the USACE on behalf of the OLSD. Incorporate the recommendations and requests from the Interagency Pre-Application meeting into the development of a complete application package for the USACE. Overlay the proposed project impact footprint on the wetlands delineated and mapped as occurring on site, to calculate the estimated project impacts to jurisdictional waters and wetlands; also estimate the potential for the project site to support created waters and wetlands, as mitigation for these impacts. The project is assumed to require an Individual Permit, as permanent impacts to waters of the U.S. are expected to exceed ½ acre/300 linear feet. The USACE 404 Individual Permit application package would include the project description, areas of waters of the U.S. that would be impacted by the project, project design details and specifications, proposed construction schedule and duration, and any other pertinent information on the project

In addition to the above, a Section 404 Individual Permit also requires the preparation of a 404(b)(1) Alternatives Analysis that provides information about how the project has avoided and minimized impacts to jurisdictional waters to the extent practicable. The 404(b)(1) Guidelines specify the circumstance under which filling of wetlands, streams or other waters of the U.S. may be permitted. More specifically, Section 404(b)(1) Guidelines prohibit all discharges of fill material into regulated waters of the United States, unless a discharge, as proposed, constitutes the least environmentally damaging practicable alternative (LEDPA) that will achieve the basic project purpose. Information included in the 404(b)(1) Alternatives Analysis includes a discussion of project alternatives, including alternative sites, alternative configurations or alignments, reduced project duration or extent, etc. Also included in the analysis will be measures to avoid and minimize effects to waters of the U.S. and measures that will mitigate for unavoidable effects to waters on the U.S. A description and evaluation of the functions and values of the existing aquatic features and the functions and values after mitigation will also be included as per the Guidelines.

Finally, based upon a preliminary review of existing information and the potential for impacts to federally listed species or habitat, our scope of work assumes that an informal consultation between the USACE and U.S. Fish and Wildlife Service (USFWS), pursuant to Section 7 of the Endangered Species Act, would be required prior to USACE issuance of an Individual Permit. Therefore, the Individual Permit application package will include a Biological Assessment prepared for the USFWS, as discussed in Task 3.8 below.

Task 3.4 RWQCB 401 Water Quality Certification

A Section 404 Clean Water Act permit issued by the USACE must also comply with state water quality standards under Section 401 of the Clean Water Act. In addition to the previously-documented federally

jurisdictional waters and/or wetlands on the project site, the site may also support waters of the State. Therefore, permits from the State Water Resources Control Board and/or the Regional Water Quality Control Board (RWQCB) under Section 401 of the Clean Water Act and the Porter-Cologne Water Quality Control Act would be required for project impacts to federal and state waters.

Prepare a Request for Water Quality Certification and submit to the San Francisco Bay Regional Water Quality Control Board (RWQCB). Incorporate the recommendations and requests from the Interagency Pre-Application meeting into the development of a complete application package for the RWQCB. Information contained in the application is similar to the information contained in the USACE application, and would include the wetland delineation, project description, engineering drawings and calculation of fill in and impacts to waters of the State.

The San Francisco Bay Regional Water Quality Board adopted the U.S. EPA's Section 404(b)(1) Guidelines (discussed in the USACE 404 Individual Permit Task, above) in its Basin Plan, for determining the circumstance under which filling of wetlands, streams or other waters of the State may be permitted. Therefore, the 404(b)(1) Alternatives Analysis developed for the USACE 404 Individual Permit can also be utilized, with the inclusion of a section in which the project is evaluated for impacts to Beneficial Uses under the RWQCB's Basin plan, to support the request for a Section 401 Water Quality Certification from the RWQCB.

Task 3.5 Section 1600 Lake and Streambed Alteration Agreement

Based on the previously documented presence of federally jurisdictional waters and/or wetlands on the project site, it is assumed that some aquatic resources on the site are also subject to regulation by the California Department of Fish and Game (CDFG), a state agency responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. Based on anticipated project impacts to state waters, a 1600 Streambed Alteration Agreement (SAA) will be required from the CDFG for construction activities that result in the substantial modification of a river, stream, or lake, including flow diversion or the deposition of material into state waters.

Coordinate with the California Department of Fish and Game (CDFG) in the preparation of a 1600 Streambed Alteration Agreement (SAA) application package. Incorporate the recommendations and requests from the Interagency Pre-Application meeting into the development of a complete application package for the CDFG. Information contained in the SAA application is similar to the USACE and RWQCB applications and, if applicable, will also include information regarding plant and wildlife species potentially present within the project area.

Task 3.6 BCDC Permit Review and Application

The project area is adjacent to San Francisco Bay and therefore must comply with all Bay Conservation and Development Commission (BCDC) permit requirements, including conformity with the California Coastal Act, The McAteer-Petris Act, and the San Francisco Bay Plan. It is necessary to obtain a BCDC permit or permit amendment prior to undertaking most work in the Bay or within 100 feet of the

shoreline, including filling, dredging, shoreline development and other work. There are several different types of permit applications, depending on the size, location, and impacts of a project. Based on the nature of this project, it is assumed a major permit may be required from the BCDC. A major permit is issued for work that is more extensive than a minor repair or improvement. A public hearing is held on an application for a major permit and the application may be reviewed at hearings held by the engineers and designers who advise the Commission. The application will also likely be reviewed by the BCDC's Design Review Board, which assists in evaluating the appearance, design and provision of maximum feasible public access.

Coordinate with the BCDC in the preparation and submittal of a draft and final Permit Application to the BCDC, on behalf of the project. Incorporate the recommendations and requests from the Interagency Pre-Application meeting into the development of a complete application package for the BCDC. Some information required in the BCDC application is similar to that included in the USACE 404 application and RWQCB 401 certification request, but some information is specific to the provision of public access and the appearance and design of structures that are visible and accessible to the public.

Task 3.7 State Lands Commission Lease

The project site is adjacent to San Francisco Bay and may be within California State Lands Commission (Commission) jurisdiction. The Commission has jurisdiction and management control over certain public lands of the State, which include the beds of California's navigable rivers, lakes and streams, as well as the state's tide and submerged lands along the State's coastline and offshore islands from the mean high tide line to three nautical miles offshore. The Commission holds its sovereign lands for the benefit of all the people of the State, subject to the Public Trust for water related commerce, navigation, fisheries, recreation, open space and other recognized Public Trust uses. Projects which may be within any lands described above may be within the Commission's jurisdiction, and therefore must submit an inquiry to the Commission's Title Unit, which reviews its files and information submitted to determine the extent of the State's property interest in the project site.

If staff determines that the proposed project is within the Commission's jurisdiction, an application must be submitted, accompanied by a Filing Fee and the appropriate Minimum Expense Deposit. The issuance by the Commission of any lease, permit or other entitlement for use of State lands is reviewed for compliance with the provisions of the California Environmental Quality Act (CEQA).

Submit an inquiry to the Commission to determine the extent of California State Lands property interest within the project site. If California State Lands property occurs within the project site, prepare and submit a draft and final application for lease of state lands. Once the application has been submitted, work with the Commission to provide any additional information requested to support their review and approval process.

Note: a lease application will likely require the submittal of a title report (preliminary report of title or title policy) to the Commission. Preparation of a title report would need to be subcontracted to a qualified surveying company, and would be the subject of a separate scope.

Task 3.8 USFWS Biological Assessment

The Oro Loma project site is located in the general vicinity of known habitat for the salt marsh harvest mouse and California clapper rail, and the proposed project site supports cordgrass and pickleweed, which may provide habitat for these species. Furthermore, previous studies have documented the presence of federally jurisdictional waters and wetlands, which could support sensitive species, on the project site. The project would also include habitat creation for such species, as mitigation for project impacts. Therefore, it is expected that some form of consultation with the USFWS under Section 7 of the Endangered Species Act would be required to address potential impacts to federally protected species.

For this Task, prepare a draft and final Biological Assessment (BA), to be submitted to the USACE in support of the 404 Individual Permit Application, to identify the potential for project impacts to federally listed species or habitat. The BA will build upon existing studies and information, including the information developed in the general level study conducted under Task 1.1. To complete this work, qualified biologists will review available background information and, if needed, conduct a reconnaissance-level field survey. The purpose of the background review will be to identify special-status terrestrial species, focusing on federal threatened, endangered, and proposed threatened or endangered species, with the potential to occur in the general project vicinity. A field survey will then be conducted to evaluate the potential for occurrence of these special-status species within project area based on the habitat requirements of each species relative to the conditions observed during the survey. The BA will characterize the habitat in the project area, summarize the effects of the proposed project on any species or habitat present, and identify reasonable and prudent measures to minimize incidental take.

The BA will be suitable for use by the USACE in their interagency coordination with the USFWS under Section 7 of the Endangered Species Act. If anticipated project impacts to protected species can be adequately avoided or minimized, the BA will be the basis of an informal consultation and a concurrence statement by the USFWS. If the level of impact cannot be adequately reduced for an informal consultation, the BA will be the basis of a formal consultation, terminating in the issuance of a Biological Opinion (BO) and incidental take statement (ITS) for the project by the USFWS. For the purposes of this scope, assume a formal consultation with the USFWS will be required.

Task 3.9 CDFG Incidental Take Permit Application

As discussed in Task 3.8 above, previous studies suggest that the Oro Loma project site may support sensitive species or habitat. The project would also include habitat creation for such species, as mitigation for project impacts. It is anticipated that project construction and operations may affect species or habitat that is protected under state law, as administered by the California Department of Fish and Game (CDFG). Therefore, it is expected that some form of consultation with the CDFG under Section 2080.1/2081 of the California Endangered Species Act and Fish and Game Code would be required to address potential impacts to state protected species.

For this Task, prepare a draft and final Incidental Take Permit (ITP) application, to be submitted to the CDFG, to identify the potential for project impacts to state listed species or habitat. The information in the ITP may rely upon some information developed in the USFWS BA, but may also include information specific to species that are listed at the state level only, and not the federal level. The ITP will also will build upon existing studies and information, including the information developed in the general level study conducted under Task 1.1. The ITP will characterize the habitat in the project area, summarize the effects of the proposed project on any species or habitat present, and identify reasonable and prudent measures to minimize incidental take. Prior to preparation of the ITP, and concurrently with other biological study tasks if possible, qualified biologists will visit the project site and review project information, in order to verify existing conditions and review current project designs to assess the potential for the project to result in take of protected species or habitat. This site work can be combined with the work necessary for the BA in Task 3.8.

Regulatory Permitting Assumptions:

- This Regulatory Permitting scope assumes one Pre-Application Interagency meeting, and one Interagency site visit. It also assumes attendance at one Public Hearing associated with the BCDC Permit application process.

- The scope of work assumes that the project will require a Section 404 Individual Permit from the U.S. Army Corps of Engineers, as permanent impacts to waters of the U.S. are expected to exceed ½ acre/300 linear feet (which are the typical limits for authorization under the USACE's Nationwide Permit Program)

- It is assumed that no Section 408 Coordination with the USACE is required. Section 408 (33 U.S.C. 408) allows the Secretary of the Army to grant permission for the alteration of a USACE public work project (such as a USACE levee or dam) so long as it is not injurious to the public interest and does not impair the usefulness of the work. Because as the proposed project would not result in any changes to existing levees on or near the project site, and because the levees adjacent to the project site are not maintained by the USACE, they are not subject to Section 408 requirements.

- It is assumed that the RWQCB will authorize all aspects of the project, including construction, under the 401 Water Quality Certification, and that, if determined necessary by the RWQCB, a waiver of Waste Discharge Requirements (WDRs) will be issued in conjunction with the 401 Certification based upon the information submitted in the 401 Certification application.

- Based upon the known presence of sensitive species in the project vicinity, as well as documented presence of waters and wetlands on the project site, it is assumed a formal consultation with the USFWS, to address some level of unavoidable impact to protected species, will be necessary. It is also assumed that an Incidental Take Permit, to address impacts to state listed species, will also be necessary.

- It is assumed that regulatory permit application fees, which are typically based on project cost or the extent of impacts to regulated resources, will be paid by the OLSD.

Appendix B: Preliminary Design - Subconsultants Scope & Budget

Scope and budget for the Civil Engineering Subconsultant (Whitley Barchett & Associates) and Geotechnical Engineering Subconsultant (Cal Engineering & Geology) are attached.

CE&G
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13 July 2012

Mark Lindley, P.E.
Senior Engineer
ESA PWA | Environmental Hydrology
550 Kearny Street, Suite 900
San Francisco, CA 94108

RE: Geotechnical Services - Estimated Scope of Work and Projected Cost
Preliminary Geotechnical Evaluation
Wet-weather Equalization and Upland Ecotone Restoration at
Ora Loma Sanitary District Wastewater Treatment Plant
2655 Grant Avenue, San Lorenzo, CA 94580

Dear Mr. Lindley:

At your request, we have prepared an estimated scope of work and projected cost to provide geotechnical services for preliminary design recommendations for the proposed wet weather equalization and upland ecotone restoration project to be completed at the Ora Loma Sanitary District ("District") wastewater treatment plant located at 2655 Grant Avenue in San Lorenzo, California.

Based upon our conversations and the information provided via email, it is our understanding that the proposed project will consist of the construction of an equalization facility for treated wastewater to divert peak flows, store the water for a period of hours, and then return the stored volume to the waste water treatment plant. The project would require an approximate 10 foot tall earth levee which would be designed for containment but also allow seepage to allow the treated wastewater to seep into the moist grassland/baylands ecotone. Monitoring would be performed to assess the ability of the native species to treat the water and of the project to attract wetland animal species.

REQUESTED SCOPE OF WORK

It is our understanding that PWA ESA has requested that Cal Engineering & Geology:

1. Review existing logs of borings completed around the perimeter of the OLSD WWTP (next door to the project site) and possibly a couple completed on the project site.
2. Provide preliminary design recommendations based upon the existing data regarding:
   a. the suitability of on-site material for levee construction;
   b. the potential for settlement and estimated amount and rate of settlement;
   c. density and volume change in material due to excavation and compaction;
   d. the geometry of the proposed levee (cross-section, key dimensions, and earth material to be used),
3. Provide recommendations for additional work required through completion of bid documents for the project. These items include:
   a. sources of additional existing information;
   b. additional investigation work;
   c. geologic hazards;
   d. seepage and stability, etc.

In addition to the scope requested by ESA PWA, CE&G proposes to:

- visit the site to observe the site and surrounding area;
- review published soils and geologic maps and reports contained within our office
- review geologic hazard maps of the area;
- prepare a geotechnical evaluation memorandum summarizing our effort, findings, preliminary recommendations, and recommendations for additional work to be completed prior to preparation of construction documents.
- meet with ESA PWA and Ora Loma Sanitary District to discuss our findings;

ESTIMATED LEVEL OF EFFORT AND COST

The estimated level of effort and projected costs to complete the work described above are indicated in Tables 1 and 2.

EXCLUSIONS

This work described above does not include subsurface investigation work and does not address the potential presence of any hazardous material at the site. It is our understanding that subsurface exploration, if requested, will be completed under a separate authorization. If requested, we can provide a scope of work and cost for these services. If sampling and testing are needed to be complete to address the potential for hazardous materials, we can provide these services through a subcontractor at an additional cost.

CLOSURE

We trust that this proposed scope of work provides you with the information needed to proceed at this time. If you have any questions regarding this proposal please call at your convenience.

Sincerely,

CAL ENGINEERING & GEOLOGY, INC.

Mark W. Myers, P.E., G.E.
Senior Engineer

Attachments: Tables 1 and 2

CAL ENGINEERING & GEOLOGY, INC.

PRELIMINARY GEOTECHNICAL SERVICES - ESA PWA Ora Loma Wet Weather Equilization Project

TABLE 1 - ESTIMATED LEVEL OF EFFORT

PHASE AND TASK	STAFFING (hours)					REIMBURSABLE				
	Principal Engineer	Senior Eng or Geol	Project Eng or Geo	Technician	TOTAL HOURS	Exploratory Drilling (days)	Drill Cuttings Disposal (per hole)	CPT Sounding (days)	Lab Testing	Mileage
Preliminary Design Evaluation based on Existing OLSD Data										
a. Evaluation of Existing Geotechnical Data Provided by OLSD	1	12	3	0	16	0	0	0	0	0
b. Conceptual Engineering Analyses	1	8	8	0	17	0	0	0	0	0
c. Development of Preliminary Recommendations	2	4	0	0	6	0	0	0	0	0
d. Geotechnical Evaluation Memorandum	2	16	4	4	26	0	0	0	0	0
e. Site Visit/Meetings	4	6	0	0	10	0	0	0	0	62
total	10	46	15	4	75	0	0	0	0	62

TABLE 2 - ESTIMATED COST

PHASE AND TASK	STAFFING COSTS					REIMBURSABLE COSTS						
	Principal Engineer ($175/hour)	Senior Engineer ($125/hour)	Staff Geologist ($98/hr)	Technician ($75/hour)	STAFFING TOTAL	Exploratory Drilling ($3500/day)	Drill Cuttings Disposal ($1000/hole)	CPT Soundings ($3500/day)	Lab Testing ($1000/hole)	Mileage($0.65/mile)	REIMBURSABLE TOTAL	PROJECT TOTAL
Preliminary Design Evaluation based on Existing OLSD Data												
a. Evaluation of Existing Geotechnical Data Provided by OLSD	$175	$1,500	$294	$0	$1,969	$0	$0	$0	$0	$0	$0	$1,969
b. Conceptual Engineering Analyses	$175	$1,000	$784	$0	$1,959	$0	$0	$0	$0	$0	$0	$1,959
c. Development of Preliminary Recommendations	$350	$500	$0	$0	$850	$0	$0	$0	$0	$0	$0	$850
d. Preliminary Design Memorandum	$350	$2,000	$392	$300	$3,042	$0	$0	$0	$0	$0	$0	$3,042
e. Site Visit/Meetings	$700	$750	$0	$0	$1,450	$0	$0	$0	$0	$40	$40	$1,490
total	$1,750	$5,750	$1,470	$300	$9,270	$0	$0	$0	$0	$40	$40	$9,310

WHITLEY BURCHETT & Associates

July 13, 2012

Mark Lindley, P.E.
Senior Engineer
ESA PWA
550 Kearny Street, Suite 900
San Francisco, CA 94108

Subject: **Proposal for Civil Engineering Support Services – Preliminary Design for the Oro Loma Sanitary District Wet Weather Equalization and Treatment Wetlands Project**

Dear Mr. Lindley:

WHITLEY BURCHETT & ASSOCIATES (WBA) is pleased to submit this proposal for providing professional engineering services to your team for the proposal to Oro Loma Sanitary District (OLSD, "District") for development of a Preliminary Design Report for the Wet Weather Equalization and Treatment Wetlands project. We propose a small, experienced team to cost-effectively and efficiently provide civil engineering services in support of the development of a Preliminary Design Report to be prepared by the ESA PWA team. This proposal is based on our understanding of the project requirements as developed from our conversation and review of the provided Conceptual Study memorandum (dated June 6, 2012). This proposal includes the services needed to take the memo concepts to the next stage of development to include the Preliminary Design for the piping, valves, and pump stations required to connect the proposed project facilities to the OLSD wastewater treatment plant.

Scope of Services

We understand from the preliminary concept memo that the project will have a dual purpose: wet weather flow equalization, and demonstration of treatment wetlands and upland ecotone slopes. The concept memo describes the features of the facility, including the demonstration treatment wetlands and upland ecotone slopes. The memo proposes the wet weather flow storage will be sized for up to eight million gallons of treated secondary effluent for up to six hours. The memo describes conceptually the plumbing needed to include a 30-inch diameter gravity pipe from the OLSD treatment plant secondary treated discharge line to the new flow equalization basin, and a new approximately 75 cfs pump station and 18-inch diameter force main returning the flow after a storm back to the OLSD plant. As this will be a demonstration project, the facility will need to accept treated secondary effluent from OLSD's treatment plant, process through the wetlands or store in the equalization basin, and then return the flow to the treatment plant for retreatment or disinfection and disposal. Allowance for future flow paths to instead discharge to a realigned stormwater channel will also be provided. At least two pump stations will likely be needed to move the water to and from the wetlands/storage facility.

Civil/Environmental Engineers
1777 Oakland Blvd Suite 200 • Walnut Creek • California • 94596-7022
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Our Scope of Services will include civil engineering services to develop the overall concepts for transferring water to and from the facility, including but not limited to the following main elements:

- investigation on the OLSD treatment plant site for points of connection and potential alignment conflicts
- preliminary pipe alignments
- preliminary pipe sizing
- preliminary location and type of valves
- preliminary pump station siting
- preliminary pump sizing and pump type selection
- conceptual pump control logic
- planning-level costs for the piping, valves, and pump stations.

We will also review the conceptual plans and offer input with respect to maintaining temporary operations during the construction phase as well as long term operational and maintenance features.

Our work will be summarized with the preparation of schematic figures and accompanying text describing the civil features. The deliverables will be suitable for inclusion in ESA PWA's Preliminary Design Report.

Assumptions:

- Overall project concept will be prepared by ESA PWA, generally consistent with the Conceptual Study report.
- Geotechnical engineering, electrical engineering, survey, and wetlands and treatment process design will be provided by others.
- Perimeter levees and berm design is not included in WBA's scope.
- Flow rates both to and from the wetlands/storage facility will be provided to WBA to be used for pipe and pump sizing.

Deliverables

Our deliverables will include two schematic diagrams, sized 8 ½ x 11 or 11 x 17 inches, that will show the intended process flows and features of the system. Similar to a P&ID Diagram, the schematic figure will indicate general relationships between the facilities and include pipe runs, pipe sizes, location of pump stations, and general sizing of pumps. In addition, a second figure will be prepared as an overlay to an aerial map. We propose to use Google Earth maps or a figure provided by ESA PWA as a background. This aerial figure will show the same facilities (pump stations and pipe runs) as they relate to the existing facilities. Additionally, we will prepare and provide a

narrative describing the facilities and sizing criteria for the hydraulic and site/civil portions of the Preliminary Design Report.

Deliverables:

- Draft Schematic Diagrams and Narrative for Preliminary Design Report
- Final Schematic Diagrams and Narrative for Preliminary Design Report
- Meeting attendance (Project Kickoff and Site Visit, Review Meeting)

Schedule

The schedule for this work can be refined to match ESA PWA's needs for the project. Using assumptions for the level of effort needed to complete the work, we anticipate the scope of services can be completed in as short as six weeks and comfortably in eight weeks. If required, our team has the availability to meet a more aggressive project schedule. We would like to work with ESA PWA in establishing the schedule goals.

Estimated Fee

The estimated fee for providing Civil Engineering services as described herein is $10,000. A detailed breakdown of the hours and tasks are provided on the attached Fee Estimate table. We prepared the fee estimate using assumptions for the level of effort and number of meetings. We are willing to hold further discussions with ESA PWA and the District to finalize the scope, level of effort, schedule, and fee.

Attached is our Standard Fee Schedule. If additional services are needed, we propose to perform those services when authorized on a time and materials basis in accordance with the attached Fee Schedule.

The Agreement

We have not discussed the form of agreement for consulting services. We assume that we would enter into a Subconsultant Agreement with ESA PWA, and the terms of the prime agreement with OLSD will be passed through to us as a subconsultant. WBA has contracted with OLSD in the past and foresees no issues with the standard terms typical of the District's agreements. We reserve the right to review the Prime Agreement and Subconsultant Agreement and provide comments if needed. Having contracted with many Special Districts and consulting firms in the past, we are confident that we can come to agreement on the contract terms.

We appreciate this opportunity to propose our services and look forward to working with you on this very interesting and challenging project.

Sincerely,
WHITLEY BURCHETT & *Associates*

Elizabeth A. Hirschhorn, P.E.
President

Attachment

OLSD Treatment Wetlands - Civil Design Support - Preliminary Design Proposal

Fee Estimate

TASK	DESCRIPTION	HOURS				FEE ESTIMATE		
		Project Manager and QA/QC, Liz Hirschhorn	Project Civil Engineer, Kevin O'Toole	Drafting	HOURS TOTAL	WBA TOTAL LABOR	WBA Expenses	TOTAL FEE[1]
	OLSD TREATMENT WETLANDS - CIVIL DESIGN SUPPORT - PRELIMINARY DESIGN							
1	**Project Kickoff Meeting**	2	2		4	$826	$50	$876
2	**Site Investigation / Coord with OLSD**		2		2	$390	$50	$440
3	**Develop Preliminary Concept for Designs - Piping, Pump Stations**	2	24		26	$5,116		$5,116
4	**Prepare Draft Figures and Writeup for Preliminary Design Report**		6	6	12	$1,920		$1,920
5	**Review Meeting to Address Comments**		2		2	$390	$50	$440
6	**Prepare Final Figures and Writeup for Preliminary Design Report**		2	2	4	$640		$640
7	**Project Management (Prepare and Submit Monthly Progress Reports and Invoices)**	2	2		4	$826		$826
	Totals - Tasks 1-7	6	40	8	**54**	$10,108	$150	**$10,258**

say, **$10,000**

1. WBA may reallocate compensation between tasks, provided total compensation is not exceeded.

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WHITLEY, BURCHETT & *Associates*, Inc.
Year 2012 Schedule of Fees

WBA's Services are provided on a time-and-materials basis in accordance with this Schedule of Fees unless other methods of compensation are contained in explicit contract language. The following rates shall be in effect through December 31, 2012 at which time they will be subject to change each subsequent year.

Labor Category	Labor Rates $/Hour
Executive Engineer	235.00
Managing Engineer	218.00
Emeritus Engineer	225.00
Supervising Engineer	210.00
Principal Engineer	195.00
Senior Engineer	180.00
Engineer	160.00
Associate Engineer	140.00
Senior Construction Inspector	130.00
Assistant Engineer	120.00
Construction Inspector	110.00
Senior CADD Operator	110.00
CADD Operator	95.00
Administrative Support	100.00

Other Direct Costs:

Labor Rates for WBA staff include normal business overhead costs like office rent, phones, letter postage, computers, office software, convenience copying and similar expenses not identified with a specific project. All these normal business costs are included in our Invoice Labor Rates. We do not add separate charges for our labor hours to reflect project accountants, computers, communications, postage or other normal office equipment usage.

Costs for project specific items like outside printing or scanning, overnight delivery, shipping and special software purchased for a specific project will be invoiced at cost.

Travel costs for project related travel will be invoiced at-cost; local automobile mileage will be invoiced at current IRS rates.

Subconsultants will be invoiced at cost plus ten percent.

STAFF REPORT

Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline

Approved on
October 6, 2011

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ACKNOWLEDGMENTS

his report assesses the vulnerabilit of San Francisco a and its shoreline to the impacts of climate change, identifies information needs for future vulnerabilit assessments, and suggests near-term and long-term strategies to address climate change impacts. Where feasible, those strategies are incorporated into recommended findings and polic revisions to the *San Francisco Bay Plan*. he preparation of this report was supported b a grant from the ational ceanographic Atmospheric Administration, ffice of Coastal esource anagement.

he California nerg Commission s ublic Interest nerg esearch rogram (I) provided funding to the nited States eologic Surve (S S) to develop the IS data on which this anal sis was based. We are grateful to uido Franco at I for his foresight in identif ing climate change information needs and his guidance in approaching this pro ect. We than oah nowles for developing the IS data, ma ing it available for our anal sis, and ma ing himself available to review and comment on our approach.

I , with support from the etropolitan ransportation Commission, provided funding to the acific Institute to assess the cost of sea level rise using the data provided b S S. he acific Institute s report provided vital information for our assessment. We than eter leic and the staff at the acific Institute, eather Coole and atthew eberger, for coordinating with us throughout the writing of this report.

Special than s to our technical and agenc reviewers and citi en s advisor committee members for ta ing the time to provide tremendousl helpful comments and suggestions: ohn Andrew from the epartment of Water esources, Amanda abson from the .S. nvironmental rotection Agenc , i risson from the etropolitan ransportation Commission, ob rown of our Citi en s Advisor Committee, ohn Callawa from niversit of San Francisco, an Ca an from S S and Scripps, osh Collins from the San Francisco stuar Institute, esle wing from the California Coastal Commission, ara ansen from coAdapt, i e ossel n of our Citi en s Advisor Committee, erem owe and hil Williams from hilip Williams and Associates, ruce iordan from the oint olic Committee, ichele odri ue from lanning Sustainable Communities, and arbara Sal man of our Citi en s Advisor Committee.

Special than s to our intern avier del Castillo for lending his expertise and time to s etch the t pical shoreline cross-sections that appear throughout the report.

Finall , we gratefull ac nowledge the members of the public, agencies and organi ations who provided invaluable feedbac through the public hearing process to refine the content of the report and strengthen the foundation on which the Commission s a lan policies rest.

Executive Summary

San Francisco a is a national treasure that helps sustain the econom of the western nited States, provides wonderful opportunities for recreation, nourishes fish and wildlife, provides unparalleled scenic splendor, and in countless other wa s enriches our lives. he a is the principal visual icon of our region, whether seen when traveling b car or rail along the shoreline, landing at an airport, strolling along the shoreline, or watching the fog stream in on a summer s da . anaging the threats to the a and shoreline development from sea level rise will be one of the defining challenges we face in the 21st centur .

A richl varied composite of urbani ation and nature exists in and around San Francisco a . rban waterfronts, critical habitat areas, industrial areas and residential neighborhoods coexist within wal ing distance of each other. verlaid on these shoreline places is a vital s stem of public infrastructure, including freewa s, seaports, railroads and airports, which nit the shoreline communities together and connect them to the rest of the region, California and the world. his tapestr helps ma e the beaut of the a Area world-renowned and underpins its econom , the health of its natural s stems and the ualit of life of its inhabitants. ver the past 150 ears, the productive use of the a s shoreline has become the cornerstone of the region s prosperit and forged an inseparable bond between the people of the a Area and the a itself.

he nine-count San Francisco a Area is home to approximatel seven million people ma ing the a one of the world s most urbani ed estuaries. Climate change has the potential to dramaticall impact the econom , environment and ualit of life in the a Area. Changes in personal behavior, institutional actions, and government policies are needed to reduce greenhouse gas emissions, moderate temperature increases attributed to global warming, and mitigate climate change. o some extent, the choice to alter lifest les and institutional priorities now will reduce the degree to which the world must adapt to the effects of climate change. owever, no matter how effectivel the world reduces greenhouse gas emissions, oceans have alread warmed, sea levels are alread rising at accelerated rates, and are li el to accelerate further. herefore, while mitigating climate change b reducing greenhouse gas emissions is essential, adapting to climate change and its impacts is unavoidable.

ocal governments and land management agencies alread face challenging issues, such as dealing with competing land uses, ensuring that ade uate shoreline areas remain available for water-dependent uses, upgrading aged infrastructure, reducing traffic congestion, protecting

habitat and water ualit , maintaining flood protection, and providing public shoreline access. Shoreline vulnerabilit assessments can help government agencies and the public understand how existing planning and management challenges will be exacerbated b climate change and assist in developing strategies for dealing with these challenges.

The Vulnerability Assessment

wo sea level rise pro ections were selected as the basis for the vulnerabilit assessment in this report: a 16-inch (40 cm) sea level rise b mid-centur and a 55-inch (140 cm) rise in sea level b the end of the centur . When C C initiated its effort to amend the a lan to address climate change in 2009, the State of California was still in the process of formulating statewide polic direction for adapting to sea level rise. In 2010 the Coastal and cean Wor ing roup of the California Climate Action eam (C -CA) developed a Sea evel ise Interim uidance document that advises the use of pro ections (relative to sea level in 2000) for the state that range from 10 to 1 inches b 2050, 1 to 32 inches b 20 0, and 31 to 69 inches at the end of the centur (based on wor b ermeer and amstorf, 2009). his document was endorsed b a resolution of the California cean rotection Council in 2011. he pro ections used in C C s report fall within the ranges suggested b the C -CA s Sea evel ise Interim uidance document. he C -CA has recogni ed that it ma not be appropriate to set definitive sea level rise pro ections, and, based on a variet of factors, state agencies ma use different sea level rise pro ections. Although the C -CA values are generall recogni ed as the best science-based sea level rise pro ections for California, scientific uncertaint remains regarding the pace and amount of sea level rise. oreover, melting of the reenland and Antarctic ice sheets ma not be reflected well in current sea level rise pro ections. he interim guidance will be updated consistent with the ational Academ of Sciences sea level rise assessment report, expected in 2012, and other forthcoming studies.

sing the two sea level rise pro ections, the vulnerabilit assessment focused on three planning areas or s stems: shoreline development, the a ecos stem, and governance. e sectors within each s stem, such as land uses or subregions of the a , were used to assess their sensitivit , adaptive capacit and, ultimatel , their vulnerabilit .

1. Shoreline Development

esidents, businesses and entire industries that currentl thrive on the shoreline will be at ris of flooding b the middle of the centur , and probabl earlier, if nothing is done to protect, elevate or relocate them. A 16-inch rise (relative to sea level in 2000) would potentiall expose

2 1 s uare miles of a shoreline to flooding, and a 55-inch rise would potentiall expose 333 s uare miles to flooding. If no adaptation measures were ta en, a 55-inch rise in sea level would place an estimated 2 0,000 people in the a Area at ris from flooding, 9 percent more than are currentl at ris . he economic value of a Area shoreline development (buildings and their contents) at ris from a 55-inch rise in sea level is estimated at 62 billion two-thirds of all the estimated value of development vulnerable to sea level rise along California s entire coastline. In those areas where lives and propert are not directl vulnerable, the secondar and cumulative impacts of sea level rise will affect public health, economic securit and ualit of life. Additionall , changes in climate ma cause increased storm activit , which in combination with higher sea level, ma cause even greater flooding. It is expected that extreme storm events will cause most of the shoreline damage from flooding.

Shoreline development located in an area potentiall exposed to a 100- ear high water event in 2000 could be potentiall exposed to regular tidal inundation b mid-centur , not ta ing existing and planned shoreline protection into account. Approximatel half of that development is residential, totaling 103 s uare miles. ver 12 s uare miles of residential development is at ris of flooding b the end of the centur . Where residents are not directl at ris of flooding, access to important services such as commercial centers, health care, and schools would li el be impeded b flooding of the service centers or the transportation infrastructure that lin s them. ising sea levels could impact the deliver of petroleum products, electricit , and drin ing water to a Area residents and businesses. ealing with this range of impacts will be more difficult for low-income residents because the have less financial flexibilit and fewer resources to pursue alternative housing and transportation.

opulations ma suffer if wastewater treatment is compromised b inundation from rising sea levels, given that a number of treatment plants discharge to the a . Impaired water ualit and higher temperatures can result in algal blooms and a higher potential for the spread of water-born disease vectors.

arge commercial and industrial areas are at ris of flooding, especiall in San Francisco, Silicon alle , and a land. Approximatel 2 percent of each of the San Francisco and a land Airports is at ris from a 16-inch sea level rise and about 93 percent of each is at ris from a 55-inch sea level rise, which could disrupt as man as 30 million airline passengers annuall and approximatel one million metric tons of cargo. Flooding of highwa segments in the regional transportation networ could disrupt the movement of goods from ports, which

handled approximatel 25 million metric tons of cargo in 200 -200 . ther water-related industries would be similarl affected. Flooding of the rail s stem would be particularl serious, because multiple carriers share a single line in most locations around the a .

Waterfront par s and public access provide opportunities to en o the a and remind us of its place in the region. here are 36 s uare miles of waterfront par s, of which 14 percent are at ris under the lower scenario and 1 percent at ris under the higher scenario. Fift -seven percent of the public access re uired b C C is at ris under the low scenario and percent at ris under the high scenario. he decline of waterfront recreational opportunities would impact the ualit of life in the a Area.

o address widespread flooding from storm activit and sea level rise, ris assessments and adaptive strategies will be needed. is assessments should use the best available science-based pro ection for sea level rise at the end of the centur and should identif all t pes of potential flooding, degrees of uncertaint , conse uences of defense failure, and ris s to existing habitat from proposed flood protection devices. Approaches for ensuring public safet in developed vulnerable shoreline areas through adaptive management include, but are not limited to: (1) protecting existing and planned appropriate infill development (2) accommodating flooding b building or renovating structures or infrastructure s stems that are resilient or adaptable over time (3) discouraging permanent new development when adaptive management strategies cannot protect public safet (4) allowing onl new uses that can be removed or phased out if adaptive management strategies are not available as inundation threats increase and (5) where feasible and appropriate, removing existing development where public safet cannot otherwise be ensured. etermining the appropriate approach and financing structure re uires weighing various policies and is best done through a collaborative approach that directl involves the affected communities and other governmental agencies with authorit or urisdiction. Some adaptive management strategies ma re uire action and financing on the regional or sub-regional level across urisdictions.

Where shoreline protection is necessar to protect development, it should be constructed to provide protection for a 100- ear flood that ta es future sea level rise into account. Shoreline protection can be structural, natural, or a combination of both. Choosing the appropriate form of shoreline protection one that both protects public safet and minimi es ecos stem impacts is criticall important. In the long-term, the region needs to engage in an open and vigorous public dialogue to ma e the difficult decisions about where and how existing

development should be protected and infill development encouraged, where new development should or should not be permitted, and where existing development should eventuall be removed to allow the a to migrate inland.

2. The Bay

he numerous plants and animals that inhabit the a provide man benefits to humans. For example, tidal wetlands provide critical flood protection, improve water ualit , and se uester carbon. he brac ish marshes in the orth a and Suisun arsh contain a great diversit of species and provide an important resting place along the acific Fl wa . he impacts of climate change are expected to substantiall alter the a ecos stem b inundating or eroding wetlands and transitional habitats, altering species composition, changing freshwater inflow, and impairing water ualit . Changes in salinit from reduced freshwater inflow ma adversel affect fish, wildlife and other a uatic organisms in intertidal and subtidal habitats. he highl developed a shoreline constrains the abilit of tidal marshes to migrate landward, while the declining sediment suppl in the a reduces the abilit of tidal marshes to grow upward as sea level rises.

he a will continue to evolve in response to the climatic forces that enabled it to come into being. istoric modification of the ecos stem, through filling, di ing, and building on the shoreline and reducing freshwater inflow, as well as ongoing stressors such as pollution and invasive species, have resulted in the decline of man native species and increased the vulnerabilit of surrounding communities to damaging floods. Substantial progress has been made in restoring the a ecos stem b returning di ed areas to tidal action and reducing pollution, while efforts to increase freshwater inflow have been less successful. Future efforts to restore the a ecos stem can benefit from careful design that accounts for the nown processes affecting formation of habitats in the a , the constraints imposed b existing stressors, and the future vulnerabilities associated with climate change.

e uestions that resource managers must address regarding climate change include: identif ing opportunities for tidal wetlands and tidal flats to migrate landward, managing and maintaining ade uate volumes of sediment for marsh sedimentation, developing and planning for natural flood protection, and maintaining sufficient upland buffer areas around tidal wetlands. Furthermore, rare and valuable habitats, li e beaches, should be high priorit for restoration and conservation.

eveloping effective strategies to protect tidal wetlands from sea level rise is extremel challenging because the pro ections of future sea level rise continuall change. Since the 19 0s, when widespread scientific concern about climate change and sea level rise emerged, pro ections for sea level rise have varied widel . his range of variation, based on different climate models and emission scenarios, creates a great deal of uncertaint for decision-ma ers therefore, wetland protection strategies must be adaptable to changing conditions.

As the rate of sea level rise accelerates and the potential for shoreline flooding increases, the demand for new shoreline protection pro ects will li el increase. ost structural shoreline protection pro ects involve some fill, which can adversel affect the natural resources of the a . Structural shoreline protection can also cause erosion of tidal marshes and tidal flats, prevent wetland migration to accommodate sea level rise, and create a barrier to ph sical and visual public access to the a . Shoreline protection also has cumulative impacts. In some instances, it ma be possible to combine habitat restoration, enhancement or protection with structural approaches to provide protection from flooding and control shoreline erosion, thereb minimi ing the impacts of shoreline protection on natural resources.

Cumulative impacts of structural shoreline protection can have far reaching adverse impacts to the a ecos stem. lanning for sea level rise at a regional level can reduce those impacts and address difficult issues, such as the desire to provide shoreline protection for undeveloped shoreline areas.

3. Governance

he a Area faces a range of vulnerabilities in its s stems of governance that reduce the region s abilit to adapt to sea level rise and other climate change impacts on the a and shoreline. A loo at the region s overall governance s stem suggests that existing challenges to regional planning caused b the patchwor of federal, state, regional and local government authorities in the a region will be exacerbated b climate change impacts.

C C faces governance vulnerabilities in its laws and policies. he Commission s urisdiction on the shoreline is limited to 100 feet landward of the mean high tide line, and within this area, C C s authorit is limited to re uiring maximum feasible public access and consistenc with designated priorit land uses. he Commission s law is based on the principles of the public trust doctrine, which ma move inland as sea level rises. Furthermore, because C C implements its authorit on a permit-b -permit basis, the Commission is limited in its abilit to address the cumulative impacts of individual shoreline protection pro ects. he

existing framewor of C C s laws and policies that focus on preventing the a from shrin ing is an overarching constraint to the Commission s abilit to effectivel plan for and adapt to climate change impacts.

ocal governments and other management agencies, especiall in cities and counties, have broad authorit over shoreline land use. owever, the lac polic incentives, resources and regional guidance for addressing climate change impacts in land use planning. o address these gaps, local governments need information about a -related impacts of climate change that is region-specific and site-specific. he information should include a regional model that pro ects 50 and 100 ears into the future. he pro ections should be developed through a public, inclusive process in order to be widel accepted and used throughout the region. he s stem most commonl used b local governments for anal ing information is IS. owever, local planners and resource managers can benefit from guidance documents, such as sample ordinances.

ac of staff and ade uate financial resources are the primar barriers to planning for impacts of climate change, both statewide and in the a Area. An assistance to local governments and public management agencies must address this issue either b providing more staff and financial resources or b providing information that is easil integrated into existing operations, planning tools, guidance documents and planning processes (e.g., eneral lan updates).

Adaptation Strategies

Adapting to climate change on the San Francisco a shoreline is critical to the region s economic stabilit , safet and public health. Flooding from sea level rise alone threatens the long-term viabilit of our neighborhoods, ob centers, transportation, water and wastewater infrastructure, schools and fire stations and vital ecos stem services on which our ualit of life and the regional and state economies depend.

o integrate rapidl advancing scientific nowledge about the impacts of climate change, adaptation planning for the a and shoreline must be a flexible and iterative process. Shoreline planning will be increasingl challenging as the line between uplands and a lands becomes more d namic, thereb re uiring a creative planning approach that integrates both the natural and the built environment. An ecos stem-based, adaptive management approach would integrate the human component of ecos stems into ecos stem management b bringing sta eholders into decision-ma ing processes, promoting interagenc collaboration, and providing direction through those processes.

his report presents a framewor for selecting adaptation strategies to address e vulnerabilities and ris s at various scales and timeframes. In the near term, the Commission can re uire applicants to develop resilient designs and adaptation strategies when planning shoreline areas or designing larger shoreline pro ects within C C s limited urisdiction. ltimatel , effective adaptation will re uire strategies that integrate climate mitigation and adaptation efforts regionall . he Commission can help facilitate a collaborative process to develop a regional strateg to deal effectivel with sea level rise and other adaptation challenges in the a Area.

Proposed Bay Plan Amendment

Adaptation to climate change should be incorporated into the a lan in the following manner:

1. Create a climate change polic section of the a lan that addresses the following:
   a. Incorporating sea level rise pro ection ranges in pro ect design and planning and using them in the permitting process
   b. eveloping a long-term strateg to address sea level rise and storm activit and other a -related impacts of climate change in a wa that protects the shoreline and the a and allows for appropriate, well-planned development that responds to the impacts of climate change and future sea level rise
   c. Wor ing with the oint olic Committee (C) and other agencies to integrate mitigation and adaptation strategies at a regional scale, to coordinate the adaptation responses of multiple government agencies, to anal e and address social e uit issues, and to support research that provides useful climate change information and tools
   d. roviding recommendations and re uirements to guide planning and permitting of development in areas vulnerable to sea level rise and
   e. Including policies that promote wetland protection, creation, enhancement and migration.
2. Amend findings and policies on tidal marshes and tidal flats to ensure that buffer ones are incorporated into restoration pro ects where feasible and sediment issues related to sustaining tidal marshes are addressed.

3. Amend the policies on safet of fills b updating the findings and policies on sea level rise and moving some to the new climate change section of the a lan.
4. Amend the policies on protection of the shoreline to address protection from future flooding.
5. Amend findings and policies on public access to ensure that public access is sited, designed and managed to avoid significant adverse impacts from sea level rise and to ensure long-term maintenance of public access areas through site-specific adaptive management strategies.

CHAPTER 1
Causes of Sea Level Rise

reenhouse gas ( ) emissions have alread contributed to an increase in average global temperature and ma trigger irreversible impacts from continued global warming. A rise in global temperature is expected to be accompanied b other climatic changes and impacts, such as increased fre uenc of temperature extremes changes in precipitation patterns reduced soil moisture content melting of polar ice caps, land-based ice sheets and glaciers ocean warming and conse uent changes in sea level and water circulation. etrimental impacts to ecos stems will li el affect public health and the econom . his chapter explains the causes of climate change, the nited ations Intergovernmental anel on Climate Change (I CC) scenarios, the California Climate Action eam s scenarios, and the a Area s contributions to and efforts to mitigate emissions. It further explains the causes of sea level rise, increased storm activit , and sea level rise scenarios that should be used to minimi e ris s on the shoreline. Finall , this chapter describes the approach to the vulnerabilit assessment in Chapters 2-4 and discusses shoreline protection options.

The Greenhouse Effect and Global Warming

he greenhouse effect is a natural s stem that controls the arth s temperature. Water vapor, carbon dioxide (C_2), methane (C_4) and nitrous oxide ($_2$), residing in the arth s atmosphere, absorb heat emitted from the arth s surface and radiate heat bac to the surface. he arth s surface temperature would be about 61 F (34 C) colder than it is now without this natural heat trapping s stem (CA 2006).

he arth s climate is d namic and constantl changing. owever, recent observations and modeling indicate that the rate and magnitude of change occurring toda is unprecedented for the most recent geologic period (the uaternar period or last 2 million ears). Ice core samples provide information about historic concentrations of s and provide information about human contributions to global climate change. Concentrations of C_2 in the samples correlate to recent observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. he I CC reported in its Fourth Assessment eport (A 4) that the current observed global average temperature increase is about 0.36°F (0.2 °C) per decade (I CC 200).

here are both human and natural causes of climate change. adiative forcing is a measure of how the balance of incoming and outgoing energ in the arth-atmosphere s stem is influenced b factors that alter the climate s stem, such as changes in the amount of s in the atmosphere, in solar radiation, and in land surface. adiative forcing is studied to anal e how much various human and natural factors contribute to warming or cooling (I CC 200). he I CC A 4 examined radiative forcing from human and natural factors and concluded that: (1) it is extremel unli el that global climate change of the past 50 ears can be explained without human contributions of s (2) carbon dioxide is the most important human contribution to greenhouse gases and (3) the primar source of the increased C_2 is from fossil fuel use with land-use change as another significant, but smaller contribution. here is a broad consensus in the scientific communit that climate change is occurring and the release of s caused b human activities is accelerating this change.

Emissions Scenarios. While scientists agree that the planet is warming, the amount and timing of this change is less certain and li el will remain so for some time. In order to predict future climate change, it is necessar to now how much s will be produced in the future. It is difficult to predict future emissions without nowing how global development will proceed. he I CC addressed this uncertaint b developing future global development scenarios, which are included in a Special eport on missions Scenarios (S S). For each scenario, the e activities that influence global development rates were altered to produce a range of future development patterns. Specific variables, such as population, economic growth, technological change, resource availabilit , and land-use changes were considered in order to uantif emissions relative to each scenario (I CC 2000). Four scenarios were developed to cover a wide range of variables: the A1 scenario brea s into four sub-scenarios, one of which (A1FI) has the highest emissions of all the scenarios the A2 scenario also has high emissions 1 has the lowest emissions and 2 is a middle-range emissions scenario.

he S S was published in 2000 and the scenarios continue to be widel used in assessments of future climate change. In A 4, a warming of about 0.36 F (0.2 C) per decade is pro ected for a range of S S emission scenarios. ven if the concentrations of all greenhouse gases and aerosols (small particles in the atmosphere that absorb and scatter radiation, such as smo e or dust) were ept constant at 2000 levels, a further warming of about 0.2 F (0.1 C) per decade would be expected (I CC 200). he pro ected global temperature increase at the end of the centur in the range of S S is between 3.2 F and 6. F (1. ° C and 3. ° C) (able 1.1). itigating or reducing emissions is critical to slow climate change, but mitigation will not stop changes that are alread underwa . herefore, adapting to climate change is e uall critical as mitigating climate change.

Table 1.1. Projected Global Average Surface Warming at the End of the Century

Scenario	Temperature Change (Degrees at 2090-2099 relative to 1980-1999)			
	Best Estimate		Likely Range	
	F	C	F	C
Constant year 2000 concentrations	1.1	0.6	0.5 1.6	0.3-0.9
B1	3.2	1.8	2.0 5.2	1.1 - 2.9
B2	4.3	2.4	2.5 6.8	1.4 3.8
A2	6.1	3.4	3.6 9.72	2.0 5.4
A1F	6.8	3.8	4.3 11.5	2.4 6.4

Adapted from PCC 2007.

The California Climate Action Team. While the PCC assessments of climate change rely on global models adapting to climate change requires an understanding of how climate change will impact specific regions so that planning can take place at the state and regional levels. The California Climate Action Team (CAT) relies on the PCC emissions scenarios for assessing the primary impacts of climate change on a regional level namely changes in the frequency and intensity of precipitation and temperature increases (Cayan et al. 2006 (a) Cayan et al. 2006 (b) and Cayan et al. 2009).

For its 2009 California climate change assessment the CAT chose two PCC scenarios to evaluate: A2 (a medium-high emissions scenario) and B1 (a low emissions scenario). Researchers used the A2 and B1 scenarios to run multiple global climate computer models and performed additional research to project specific climate changes in California (Cayan et al. 2009).

The CAT projects that temperatures will get higher in the inland areas of California than on the coast. Overall the projected warming is consistent with PCC projections: between 1.8°F and 5.4°F (1°C and 3°C) by mid century and between 3.6°F and 9°F (2°C and 5°C) by the end of the century (Cayan et al. 2009). Temperature increases in the lower range of warming are projected to be similar to the difference in average annual temperature between Monterey and Salinas. n the upper range of projected warming the temperature difference would be closer to that between San Francisco and San ose (Cayan et al. 2006 (a)).

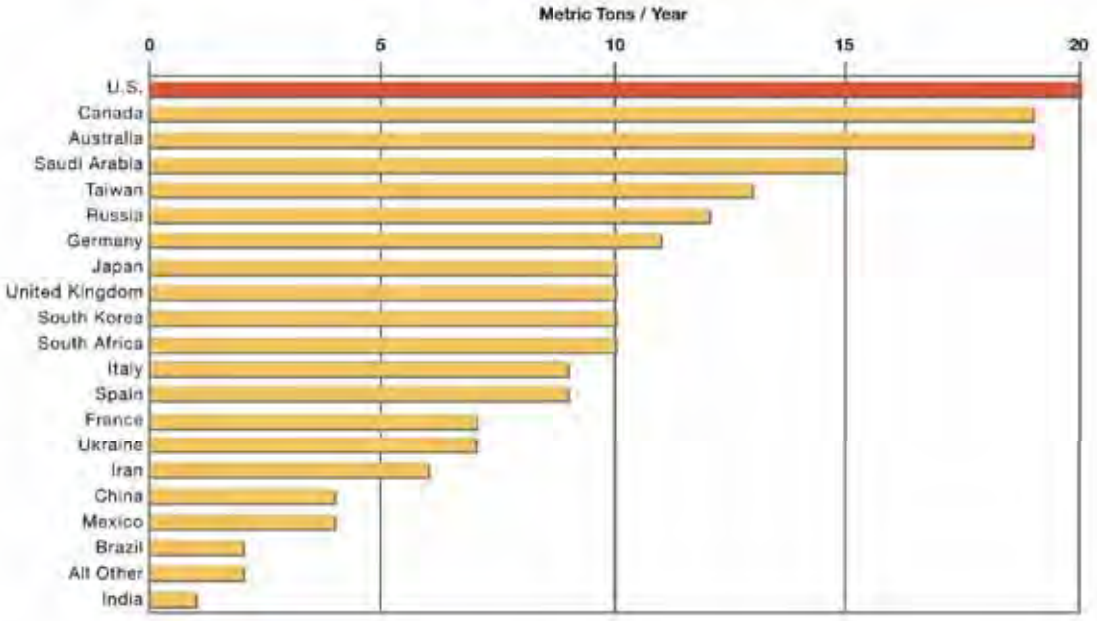
The CAT findings regarding precipitation were similar to findings for the globe with a tendency toward drier conditions at the end of the century (Cayan et al. 2009). Generally even a small decline in precipitation can be problematic for California because demand for water for environmental urban and agricultural purposes already exceeds supply. Furthermore about one third of California s water currently falls as snow in the Sierra Nevada Mountains and much of the water stored in the Sierra snowpack and reservoirs is used in the Central alley

the a Area and Southern California during the spring and summer. As temperatures rise, the snowpac will melt earlier and less precipitation will fall as snow, further hampering California s abilit to store enough water and provide it to agricultural fields and growing populations. Changes in the amount and timing of fresh water that flows to the a from the Sierra evada watershed will directl affect the a ecos stem.

As an example of the scope of the impacts within one economic sector, California s 30 billion agriculture industr currentl uses almost 0 percent of developed water in the state (W 2006). owever, in addition to adverse impacts stemming from changes in the state s water management s stem, some of the state s most lucrative crops, such as wine grapes, fruits and nuts could falter under higher temperatures. Furthermore, high temperatures can stress dair cows, severel hampering what is currentl a 3 billion industr .

Figure 1.1 U.S. Contribution To Global CO_2 Emissions (per Capita)

Source: U.S. Energy Information Administration; Bay Area Air Quality Management District, 2007



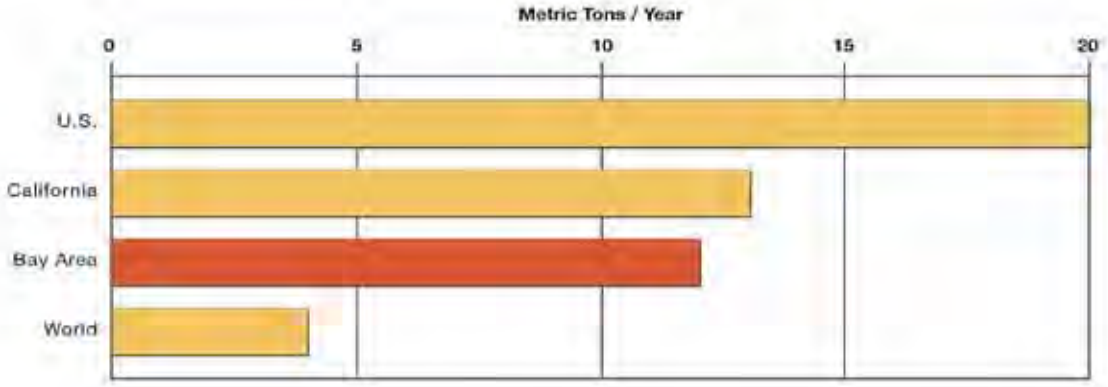
With so much at ris for California, on une 1, 2005, the overnor issued an xecutive rder establishing emission targets for the state. California strengthened its commitment to address climate change with the passage of Assembl ill 32 (A 32), the lobal Warming Solutions Act of 2006. A 32 re uires the state to reduce emissions to 1990 levels b 2020 and to 0 percent below 1990 levels b 2050 (CA 200).

n August 25, 200 , the State Assembl passed S 3 5 and the overnor signed it into law on September 30th, 200 . he bill mandates an integrated regional land-use-and-transportation-planning approach to reducing emissions from automobiles and light truc s, principall b reducing vehicle miles traveled. Within the a Area, the bill assigns responsibilities to the Association of a Area overnments (A A) and to the etropolitan ransportation Commission (C). oth agencies are members of the oint olic Committee (C), which also includes the a Area Air ualit anagement istrict and C C. he C developed a polic document to guide A A and C in fulfilling their responsibilities in collaboration with their C partners (C 2009).

Bay Area GHG Contributions. he a Area is a ma or contributor of emissions. In order to understand how the a Area fits into the global emissions scheme, some context is necessar . he nited States produces more C_2 emissions per capita than an other countr in the world and twice the emissions of most developed countries (Figure 1.1). California is the twelfth largest source of climate change pollutants in the world, ran ed between South orea and Ital , and emits more s than most nations. When C_2 is measured in per capita metric tons/ ear, the a Area is onl slightl below the statewide average (Figure 1.2).

Figure 1.2 Bay Area Contribution to CO_2 Emissions (per Capita)

Source: USEIA, CA Climate Action Team, BAAQMD, Bay Area Air Quality Management District, 2007

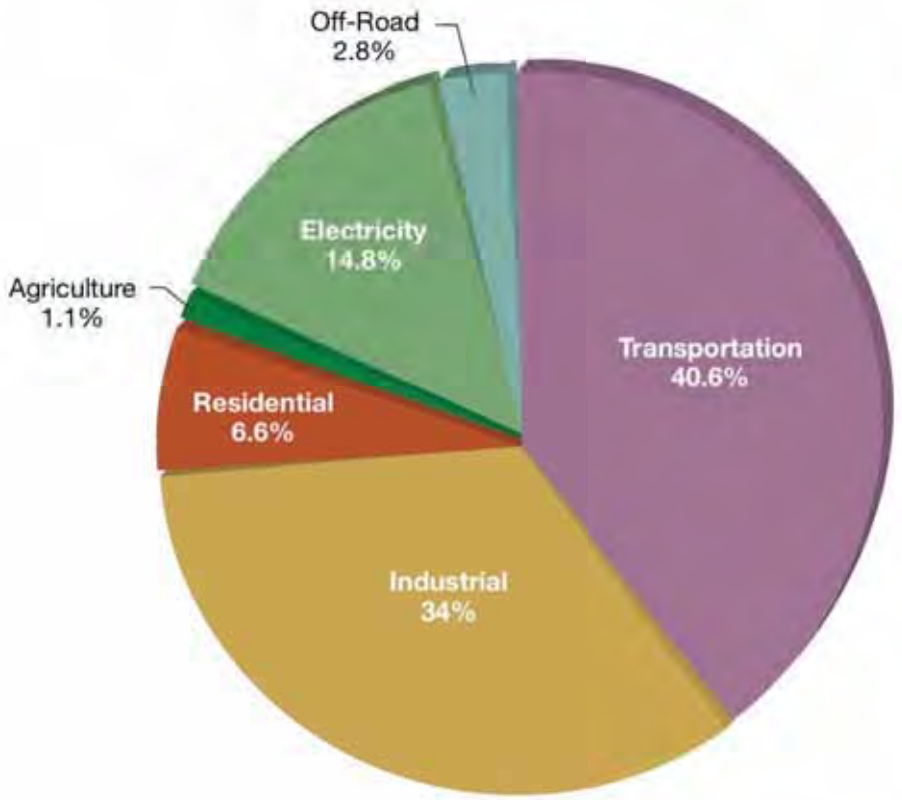


California s climate change emissions come primaril from fossil fuel combustion in the transportation sector, which ma es up 41.2 percent of the state s emissions. nerg production and industrial uses are other ma or contributors.

he a Area Air ualit anagement istrict reports the a Area brea down of climate change emissions is similar to the statewide brea down. he two sectors with the highest emissions are transportation and industrial, which ma e up 40.6 and 34 percent of the total emissions respectivel (Figure 1.3).

Figure 1.3 Bay Area GHG Sources

Source: BAAQMD, 2007



he C developed a strateg to address climate change, which reflects the diverse responsibilities of the four regional agencies that ma e up the C: the a Area Air ualit anagement istrict, the Association of a Area overnments, the etropolitan ransportation Commission, and C C. iven that transportation is the primar source of emissions in the a Area, the C s climate change strateg includes numerous ob ectives

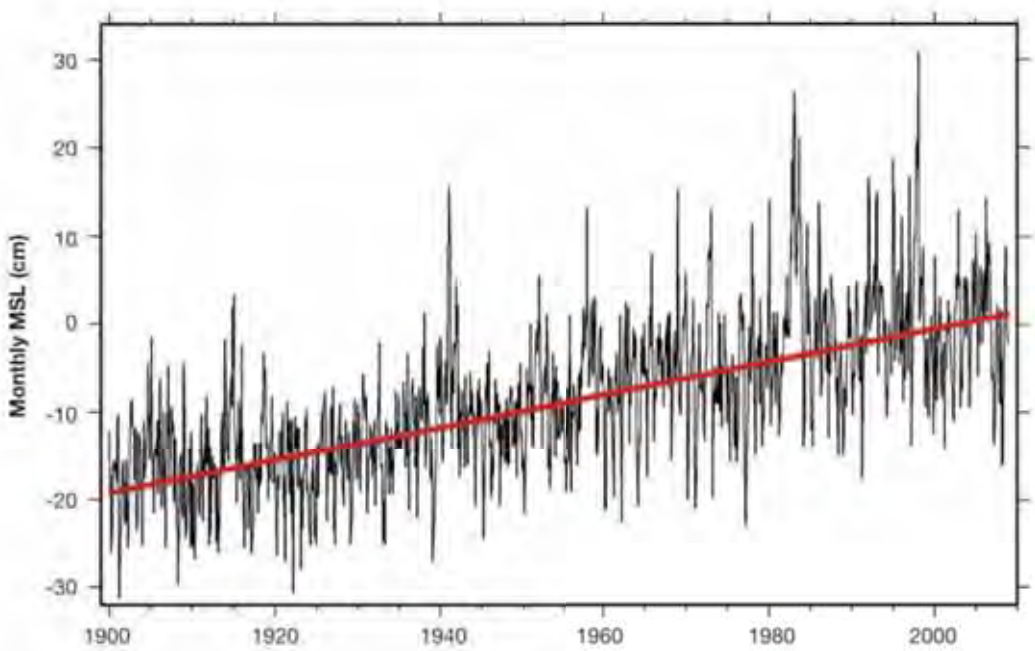
aimed at reducing driving through a variet of methods, including focused growth and transit-oriented development and public transportation funding strategies, which all reduce the need to drive. C C is responsible for carr ing out the elements of the strateg that address adapting to sea level rise and other a -related impacts of climate change.

Sea Level Rise

Warming of the planet causes sea level to rise and increases the potential for damaging floods that will affect coastal communities around the world. here are two ma or processes that contribute to global mean sea level rise, primaril b increasing the volume of water in the global ocean. hose processes are: (1) the addition of water from glaciers and ice sheets (land-based ice) (indoff et al. 200) and (2) thermal expansion, which is when water expands as it warms, causing sea level to rise. hese processes are complex and difficult to pro ect into the future. While the melting of floating sea ice (e.g., icebergs) has significant adverse environmental impacts, it does not contribute additional water to the oceans and, therefore, does not directl contribute to global sea level rise.

Figure 1.4 Sea Level Rise in San Francisco Bay

Source: Cayan et. al. 2006: San Francisco Tide Gauge

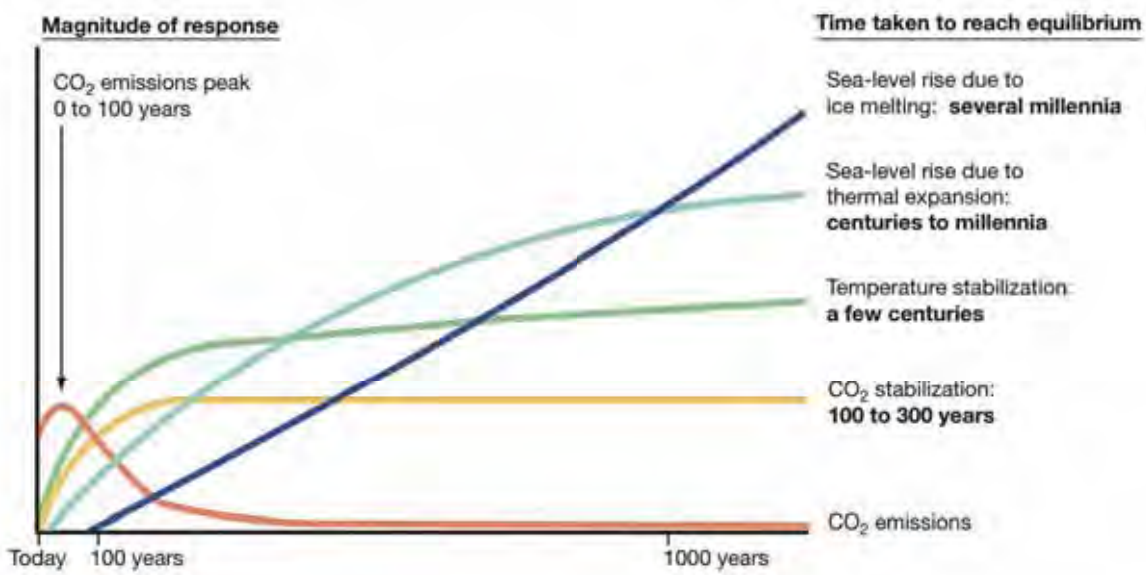


he San Francisco tide gauge at Fort oint is the longest continuall monitored gauge in the nited States. Sea level rise trends measured at this tide gauge and two other long-running tide gauges on the west coast show sea level rise of nearl .9 inches (19 cm) per centur or 0.0 inches (2 mm) per ear (Figure 1.4) (Ca an et al. 2006(b)). his rate of sea level rise is consistent with global sea level rise.

he rate of global sea level rise is increasing. he 20th centur rise was estimated to be 6. inches (1 cm) or 0.06 inches (1. mm) per ear on average. From 1961 to 2003, emissions had been accumulating long enough to increase the rate of rise to 0.0 inches (1. mm) per ear (I CC 200). Anal ses of observed sea level rise over the last approximatel 15 ears show that the rate of rise increased significantl above that of previous decades (Church and White 2006). he I CC concluded that from 1993-2003, the rate of sea level rise increased to about 0.12 inches (3.1 mm) per ear (I CC 200), demonstrating the li el effect of human-induced warming on sea level.

Figure 1.5 Long Term Trend in Sea Level Rise

Source: Intergovernmental Panel on Climate Change; Department of Water Resource, based on IPCC



o matter how effectivel the world mitigates emissions, oceans have alread warmed, sea levels are alread rising at accelerated rates, and are li el to continue rising. he ocean has been absorbing more than 0 percent of the heat added to the climate s stem and has alread warmed to depths of at least 9, 43 feet (3000 m) (I CC 200). erhaps the most notable finding from the I CC is that the effects of emissions will continue long after emissions are reduced. he I CC pro ects that global temperature will continue rising for a few centuries before stabili ing. Sea level rise from thermal expansion will continue for centuries to millennia. Sea level rise from ice-sheet melting will continue for several millennia (Figure 1.5) (I CC 200).

Ice-Sheet Melting and Uncertainty. here is a great deal of uncertaint surrounding the future contributions to global sea level rise from the melting of the reenland and Antarctic ice sheets. ost scientists agree that the rate of ice-sheet melt will accelerate as melt-water seeps through crac s in the ice sheet and causes further acceleration of melting and movement of the ice sheet toward the sea. he I CC concluded that losses from the ice sheets have ver li el contributed to sea level rise from 1993 to 2003. (In I CC terminolog , ver li el means a greater than 90 percent probabilit of occurring.) owever, there is no scientific consensus on how to model or pro ect future rates of ice-sheet melt.

he nature of ice-sheet melt is not full understood. bservations show that as ice melts, the melt water runs over ice and causes it to melt at a faster rate, carving deep crevices and wea ening the ice. Further, the meltwater runs under the ice sheets and wea ens buttressing ice shelves, which can cause large portions of ice sheets to collapse. he central uestion is whether ice-sheet melting will accelerate b an order of magnitude and whether this could occur in a timeframe of hundreds or thousands of ears (ppenheimer 2006).

Warming of 3.6-5.4° F (2-3° C) could cause melting that would induce multiple positive feedbac s, including reduced surface albedo, loss of buttressing ice shelves, and d namical response of ice streams to increased melt-water (ansen 2006). Surface albedo is a ratio of incoming radiation that is reflected to that which is absorbed. White ice has a high albedo it reflects most solar radiation, which means that as sea-ice melts, the oceans absorb more heat from radiation. ue to these feedbac effects, some scientists believe that the ice sheet response could move be ond a point of e uilibrium within a few centuries (ansen 2006). owever, even with ice-sheet melt, sea level rise is ver unli el to exceed 6.6 feet (200 cm) b 2100 (feffer et al. 200).

Although numerical modeling remains inade uate to pro ect future ice-sheet melt, additional studies of the last interglacial period confirm that the warming needed to cause shrin age of the reenland Ice Sheet averaged less than 6.3° F (3.5° C) (verpec et al. 2006). Further, recent observations and innovations have improved modeling of ice-sheet behavior,

but models still do not assess feedbac loops and, therefore, fail to factor the interrelatedness of ice-sheet melting, ocean circulation, and climate change (Alle et al. 2005). he A 4 pro ections for warming in the ears 2090-2099 ranged from 3.2° F (1. ° C) for the lowest emissions scenario (1) to .2° F (4° C) for the highest emissions scenario (A1FI). herefore, mid and higher emissions scenarios produce temperature increases b the end of the centur that would, at a minimum accelerate ice-sheet melt.

Sea Level Rise Scenarios

here is broad scientific consensus that the rate of sea level rise has increased with higher global surface temperatures. he point of debate is what the rate of sea level rise will be in the future. Similar to the approach used to evaluate global warming, using scenarios of future sea level rise enable us to understand the ris s and develop a strateg that will support the appropriate responses. Scenarios of future sea level rise enable us to understand the ris s and develop a framewor now that will support the appropriate responses.

In 200 , erman scientist, Stefan ahmstorf developed an empirical approach to pro ecting future sea level rise b calculating the relationship between sea level rise and global mean surface temperature. ahmstorf first determined the historic trend in the relationship and then pro ected that trend into the future using the I CC s pro ected temperature increases associated with the S S scenarios: 2.5°F (1.4° C) for the lowest emissions scenario to 10.4° F (5. ° C) for the highest emissions scenario (ahmstorf 200). ahmstorf s corresponding estimates of sea level rise b 2100 range from 20 inches (50 cm) to 55 inches (140 cm) respectivel .

esearch funded b the CA for the 2009 report to the overnor used the A2 and 1 scenarios and ahmstorf s methodolog to pro ect sea level rise in California in 2050 and 2099. hese sea level rise pro ections are also ad usted to include the effects of dams on sea level rise (Ca an et al. 2009). ast construction of dams and reservoirs ma have stored enough water worldwide to mas acceleration in the rate of sea level rise prior to the notable acceleration detected in 1993. ost dams were constructed during the 1950s through the 19 0s. uilding of dams for additional upland water storage has since slowed, which means that sea level rise ma now be accelerating faster than the I CC and scientists have predicted (Chao 200). he CA -funded research estimated that sea level would increase between 12 and 1 inches (30 and 45 cm) b 2050 and between 20 and 55 inches (50 and 140 cm) b 2099.

he elta ision lue ibbon as Force established b overnor Schwar enegger to develop a strategic management plan for the California elta, emplo ed an Independent Science oard (IS) to review literature and provide recommendations on sea level rise. he IS found that: (1) the current I CC pro ections are conservative and underestimate recentl

measured SLR (2) empirical models such as Rahmstorf s empirical method yield significantly higher estimates of sea level over next few decades and are better for short to mid-term planning and (3) neither the PCC nor Rahmstorf account for accelerating contributions from ice sheet melting which will likely contribute significantly to future sea level rise with the potential for very rapid increases of up to a meter by 2100. Based on these findings the SB recommended adopting an estimated rise in sea level of 55 inches (140 cm) by 2100 and recommended adopting a sea level rise estimate for 2050 as well.

On November 14 2008 the Governor issued Executive Order S-13-08 that in part directed state agencies to consider a range of sea level rise scenarios for the years 2050 and 2100 to assess project vulnerability reduce expected risks and increase resiliency to sea level rise. The order also directed agencies to request that the National Academy of Sciences convene an independent panel to prepare a California Sea Level Rise Assessment Report. n advance of the National Academy of Sciences report in 2010 senior staff from 16 state agencies of the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) reached agreement on a Sea-Level Rise nterim Guidance Document with science-based input from the California Ocean Protection Council s Science Advisory Team and the California Ocean Science Trust. The CO-CAT recommended that state agencies use the ranges of sea level rise (SLR) presented in a paper by ermeer and Rahmstorf (2009) adjusted to use 2000 rather than 1990 as the baseline as a starting point (Table 1.2) and select SLR values based on agency and context-specific considerations of risk tolerance and adaptive capacity.

Table 1.2. CO-CAT Sea Level Rise Scenarios using 2000 as the Baseline

Year		Average of Models	Range of Models
2030		7 in (18 cm)	5-8 in (13-21 cm)
2050		14 in (36 cm)	10-17 in (26-43 cm)
2070	**Low**	23 in (59 cm)	17-27 in (43-70 cm)
	Medium	24 in (62 cm)	18-29 in (46-74 cm)
	High	27 in (69 cm)	20-32 in (51-81 cm)
2100	**Low**	40 in (101 cm)	31-50 in (78-128 cm)
	Medium	47 in (121 cm)	37-60 in (95-152 cm)
	High	55 in (140 cm)	43-69 in (110-176 cm)

he table was published with the following note: hese pro ections do not account for catastrophic ice melting, so the ma underestimate actual S . he S pro ections included in this table do not include a safet factor to ensure against underestimating future S . For dates after 2050, three different values for S are shown based on low, medium, and high future greenhouse gas emission scenarios. hese values are based on the Intergovernmental anel on Climate Change emission scenarios as follows: 1 for the low pro ections, A2 for the medium pro ections and A1FI for the high pro ections. he C -CA s Sea evel ise Interim uidance document was endorsed b a resolution of the California cean rotection Council in 2011. he interim guidance will be updated consistent with the ational Academ of Sciences 2012 report, and other forthcoming studies.

Sea Level Rise and Extreme Events. ost shoreline damage from flooding will occur as a result of storm activit in combination with higher sea level. Climate change-induced sea level rise will combine with the e factors that currentl contribute to coastal flooding: high tides, storm surge, high waves and high runoff from rivers and cree s (Ca an et al. 2009).

Storms and flooding in California occur during the winter from ovember to April and are influenced b several climate patterns, most prominentl the l i o Southern scillation (S) (iller 2003, Ca an et al. 200). ver two to seven ears, S alternates between two phases, a i a and l i o. In contrast to a i a, l i o ears generall result in persistentl low air pressure, greater rainfall, and high winds (Ca an et al. 200), all of which contribute greatl to coastal flooding ha ards.

ow air pressure causes an instantaneous rise in sea level above predicted tides, referred to as storm surge (Ca an et al. 200). uring storms with high rainfall, a tributaries flood, elevating flood stage in cree s and rivers be ond the initial storm surge, and low air pressure increases wind activit , generating erosive waves superimposed on the alread high sea level (romirs i and Flic 200). his combination of factors, during an l i o event in the winter of 19 2- 3, caused over 500 million in damage in the San Francisco a Area (A A 2006).

As sea level rises, storm-induced flooding will become more fre uent and more ha ardous to public health and safet . ver the recent period of accelerated sea level rise (1993 to 2003), there was an increase in both the number of storm surge events and high tides exceeding previousl observed extremes. his increase in storm activit and extreme tides is pro ected to continue into the future (Ca an et al. 200 , romirs i and Flic 200). Should the state s water reservoirs lac capacit to capture rainfall and earlier Sierra snow melt, water managers will need to release flows through the elta during winter months, resulting in even higher water levels in the elta and Suisun arsh (nowles and Ca an 2002, Ca an et al. 200).

ifferent regions of the a ma be more vulnerable to these floods than others (see Figure 1.6 for a regions). ides in the South a are higher than the ocean and other areas of the a , which will amplif storm surge events (WA 2005). he combined effects of sea level rise, storm surge and river flooding ma result in water levels elevated as high as 51 inches for a period of 10 to 12 hours in the elta and Suisun arsh region (romirs i and Flic 200), an area where much of the land is alread below mean tide elevation and is surrounded b fragile levees (W and F , 200).

herefore, significant flooding impacts from sea level rise can be expected during the earl part of this centur , due to winter storms and sea level rise.

BCDC Policy Analysis. ost of the permit applications that C C receives are for pro ects with a lifespan of at least 50 90 ears. For the purposes of this polic anal sis and to provide timeframes that are most relevant to the Commission s regulator and planning functions, a mid-centur and end-of-centur sea level rise pro ection are used. he shorter timeframe is most applicable for pro ects, such as institutional or commercial development. he longer timeframe attempts to anticipate future impacts within a reasonable degree of certaint for large-scale pro ects with longer life c cles, such as new neighborhoods or ma or public infrastructure pro ects. While these are onl pro ections, not predictions, the necessar response to rising sea level ma be similar whether sea level rises more slowl or more uic l . he primar difference will be in the scale and speed of response that will be re uired.

When C C initiated its effort to amend the a lan to address climate change in 2009, the State of California was still in the process of formulating statewide polic direction for adapting to sea level rise, as described above. his report assesses vulnerabilit using 16 inches of sea level rise at mid-centur and 55 inches at the end of the centur because: (1) given the potential for sea level rise to threaten lives and damage propert and natural resources in the a , it is prudent to use a conservative scenario and (2) it is consistent with other state efforts. he sea level rise pro ections used in this report fall within the ranges that were subse uentl endorsed b the California cean rotection Council in 2011, i.e., 10-1 inches at mid-centur and 31-69 inches at end of centur . A number of terms that are common in discussions of adaptation are defined in ox 1.1.

Box 1.1. Definitions

Resilience: he abilit of a s stem to absorb and rebound from the impacts from weather extremes, climate variabilit , or change and to continue functioning (uers and oser)

Adaptation: Actions in response to potential or experienced impacts of climate change that lead to a reduction in ris s or a reali ation of benefits.

Mitigation: Actions that reduce the emission of greenhouse gases into the atmosphere or enhance their se uestration and thereb reduce the probabilit of reaching a given level of climate change.

Vulnerability: he extent to which a natural or social s stem is susceptible to the adverse effects of climate change, climate variabilit and extremes a function of ris and adaptive capacit .

Adaptive Capacity: he abilit of a s stem to ad ust or respond to climate change, climate variabilit and extremes, to accomplish the following: (1) moderate potential damages (2) ta e advantage of new opportunities arising from climate change or (3) accommodate the impacts.

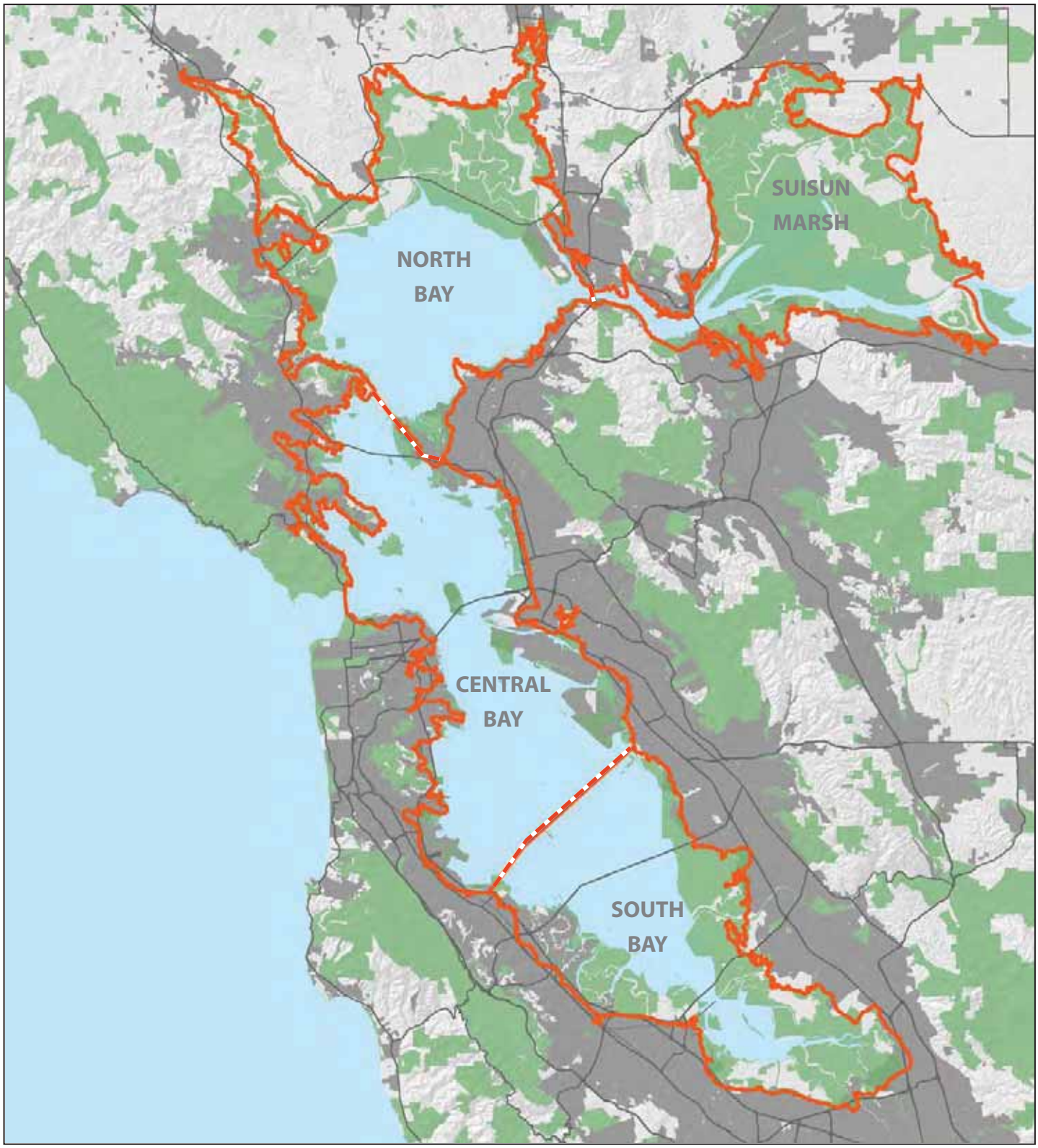
Figure 1.6

Bay Area Land Uses and Bay Subregions

Open Space
Private Undeveloped
Urban Area
Historic Shoreline
Major roads and highways

0 4 8 MILES

NORTH



SOURCE: Urban and open space (GreenInfo 2004), Regions (EcoAtlas 2009)

Vulnerability Assessment

he following three chapters describe the vulnerabilit assessment performed for this report. he assessment is both ualitative and uantitative, including a review of literature and original anal sis using IS sea level rise data. It focuses on three planning areas or s stems: the shoreline environment, the a ecos stem, and governance. e sectors within each s stem are identified and anal ed to ascertain their current and expected challenges and pro ected climate change impacts. ased on the information available, which in some cases is limited, and recogni ing the general uncertaint involved in pro ecting climate change impacts, a vulnerabilit assessment is performed that identifies the degree of sensitivit , adaptive capacit , and vulnerabilit . his assessment is summari ed at the end of each chapter based on a standard methodolog developed through he Climate ro ect for ing Count in Washington (he Climate ro ect 200).

he emphasis of this assessment is regional, which ma limit its application to specific pro ects or limited areas, such as the shoreline within an given cit . While the assessment is valuable, it is limited b the information available and the uncertaint regarding future change. o ma e the assessment feasible, C C wor ed with the California nerg Commission s ublic Interest in nerg esearch (I) program to commission the development of sea level rise data and a cost assessment of potential impacts from sea level rise.

he sea level rise data were provided b the nited States eologic Surve (S S), which used a h drod namic computer model to identif areas at ris in two scenarios, 16 inches and 55 inches of sea level rise. he S S assembled the best available digital elevation data for the a shoreline into a regional grid. istoric (1996-200) tidal data were used to determine the highest average monthl tide, then the sea level rise estimates were integrated into the tidal datum (nowles 200)[1].

While the data are the best available for mapping and anal sis of shoreline areas that ma be exposed to sea level rise, there are limitations for their use. he data were developed using an average of the highest tide in each month, which captures most storm surge within a ear. owever, the data do not include wave activit that occurs during storms, nor the highest tides.

---

[1] he data for this assessment was developed b S S anal ing the area vulnerable to inundation from the average highest monthl tide, factoring in 16 and 55 inches (40 and 140 cm) of sea level rise. he data used b nowles and the acific Institute in two recent reports on sea level rise in San Francisco a are based on an average highest earl tide, factoring in the same two scenarios. owever, the difference between these data is insignificant. Although the average earl high tide inundates an area approximatel 1 (2,000 acres) greater than the average monthl high tide, the additional areas affected are evenl distributed around the a and are barel distinguishable on maps. Furthermore, the difference ma li el be attributable to the resolution of the elevation data upon which the S S wor is based. Consultation with S S and other experts confirmed that the difference is well within the range of uncertaint of the data and the anal ses.

Conse uentl , an area that floods from wave activit during winter storms, such as the mbarcadero in San Francisco, is not considered exposed. Importantl , where the elevation of land is below the water level, it is shown as potentiall exposed to sea level rise, whether or not shoreline protection exists. his is because ade uate information was not available on levee heights or location. Additionall , the data does not indicate the depth of flooding. ow-l ing land or depressions in upland areas ma also appear to be exposed to inundation, even if there is no path for water to reach the isolated, low-l ing area. espite these limitations, the data is useful for drawing general conclusions about the region s vulnerabilit to sea level rise and storm surge.

Anal sis using the data shows that approximatel 1 0,000 acres (2 1 s uare miles) of shoreline are potentiall exposed to more flooding or permanent inundation with 16 inches (40 cm) of sea level rise and approximatel 213,000 acres (332 s uare miles) are vulnerable at 55 inches (140 cm) (Figures 1. -1.1). With 55 inches of sea level rise, an additional 33,000 acres (51 s uare miles) are potentiall exposed. hese additional areas are scattered around the perimeter of the shoreline potentiall exposed to flooding or more fre uent inundation under the 16-inch sea level rise scenario.

he area inundated in the 16-inch pro ection is alread sub ect to some degree of flood ris . Anal sis performed b S S indicates that the area inundated under the lower pro ection is roughl e uivalent to the area exposed to a 100- ear high water event in 2000, not ta ing existing and planned shoreline protection into account (nowles 200). In other words, the area exposed to toda s extreme flood event is roughl e uivalent to the area potentiall exposed to regular tidal inundation b mid-centur (Figure 1.19).

Vulnerability from Subsidence. elative sea level rise, rather than global sea level rise alone, provides the most accurate measure of water level along the a shoreline. elative sea level rise is the sum of global sea level rise and the change in vertical land motion. hus, if sea level rises and the shoreline subsides[2], the relative rise in sea level could be greater than the global rise. For man ears the South a shoreline, including urbani ed areas and salt ponds, experienced high rates of subsidence from groundwater depletion, which has now apparentl stopped. Where subsidence continues, such as in areas where peat soils oxidi e, relative sea level rise could cause more significant shoreline flooding in those areas than it would if the

[2] Subsidence, or sin ing of the land surface, is generall caused b : vertical motion along a fault line, appl ing loads to incompetent soils, oxidation of organic matter in soils, or groundwater withdrawal from the subsurface of the land resulting from compaction.

shoreline land mass remained at a constant level, or rose (C C 19). As rates of global sea level continue to increase with climate change, at some point, the rate of vertical land movement in the a Area will become less significant in determining the impact of sea level rise. owever, areas that have subsided ma be particularl vulnerable to sea level rise and extreme events.

he Suisun arsh is one area of the a where relative sea level rise is significant, due to ongoing subsidence. When managed wetlands (wetlands behind levees) such as those located in the Suisun arsh are allowed to dr out, the organic matter in the soil oxidi es. oss of this organic matter ma lead to local and regional ground subsidence. he continuing subsidence of managed wetlands can affect levee stabilit and increase the ris of failure (W , 1995 ount and wiss, 2005). evee failure during floods in the Suisun arsh and the elta will cause saltwater intrusion into groundwater a uifers, saltwater contamination of agricultural lands, and changes to the salinit of freshwater and brac ish ecos stems.

Figure 1.7

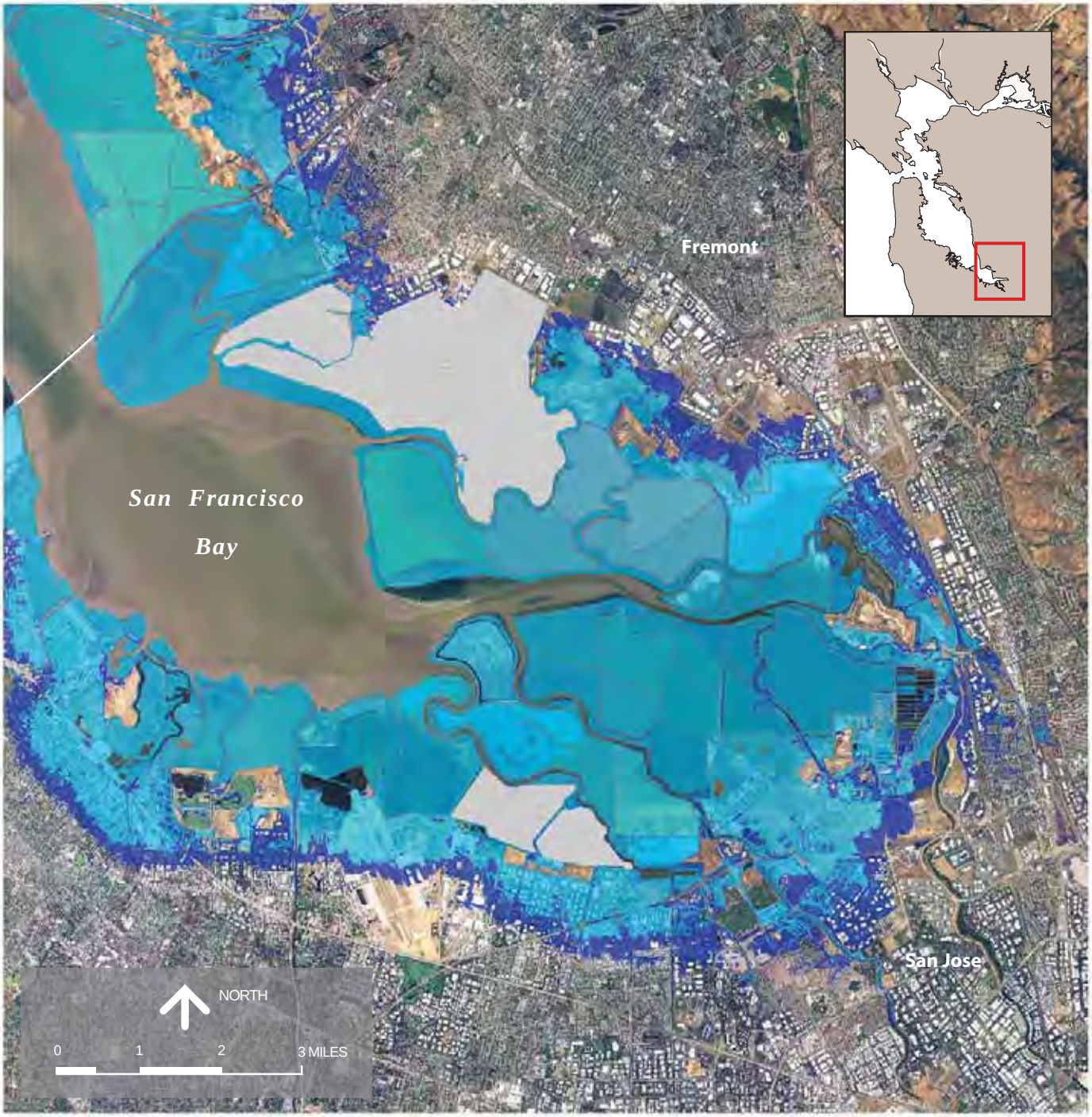
Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

No data

South Bay
Shoreline Areas Potentially Exposed to Sea Level Rise

DISCLAIMER: *The inundation data used in these maps do not account for shoreline protection or wave activity. These maps are for informational purposes only. Users agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with the use of the maps. The maps and data shall not be used to assess actual coastal hazards,insurance requirements, or property values or be used in lieu of Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).*



Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.8

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

No data

Central Bay South Shoreline Areas Potentially Exposed to Sea Level Rise

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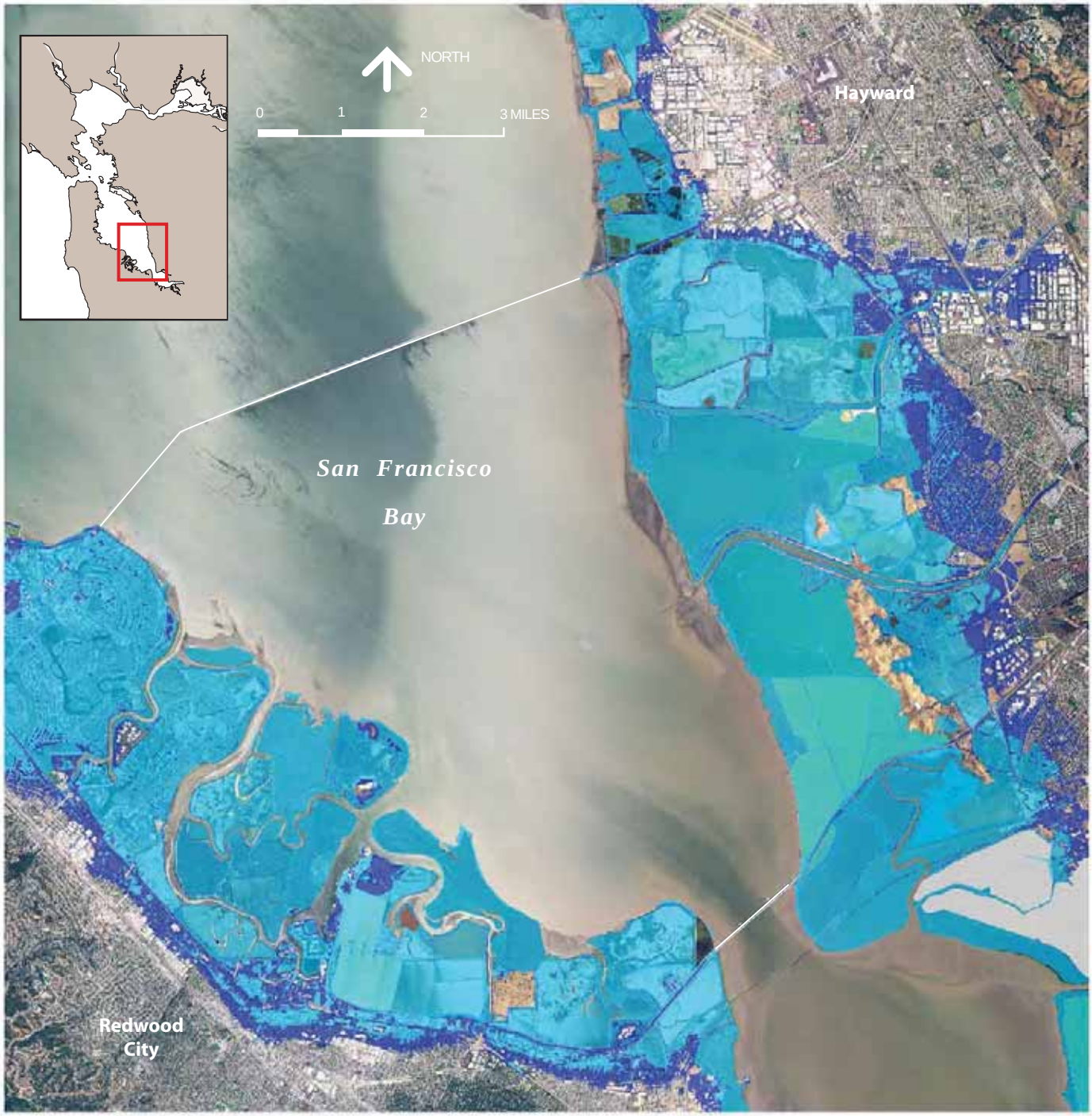

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.9

Central Bay West Shore Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.10

Central Bay East Shore Shoreline Areas Potentially Exposed To Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.11

Central Bay
Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.12

Central Bay North
Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.13

Petaluma River
Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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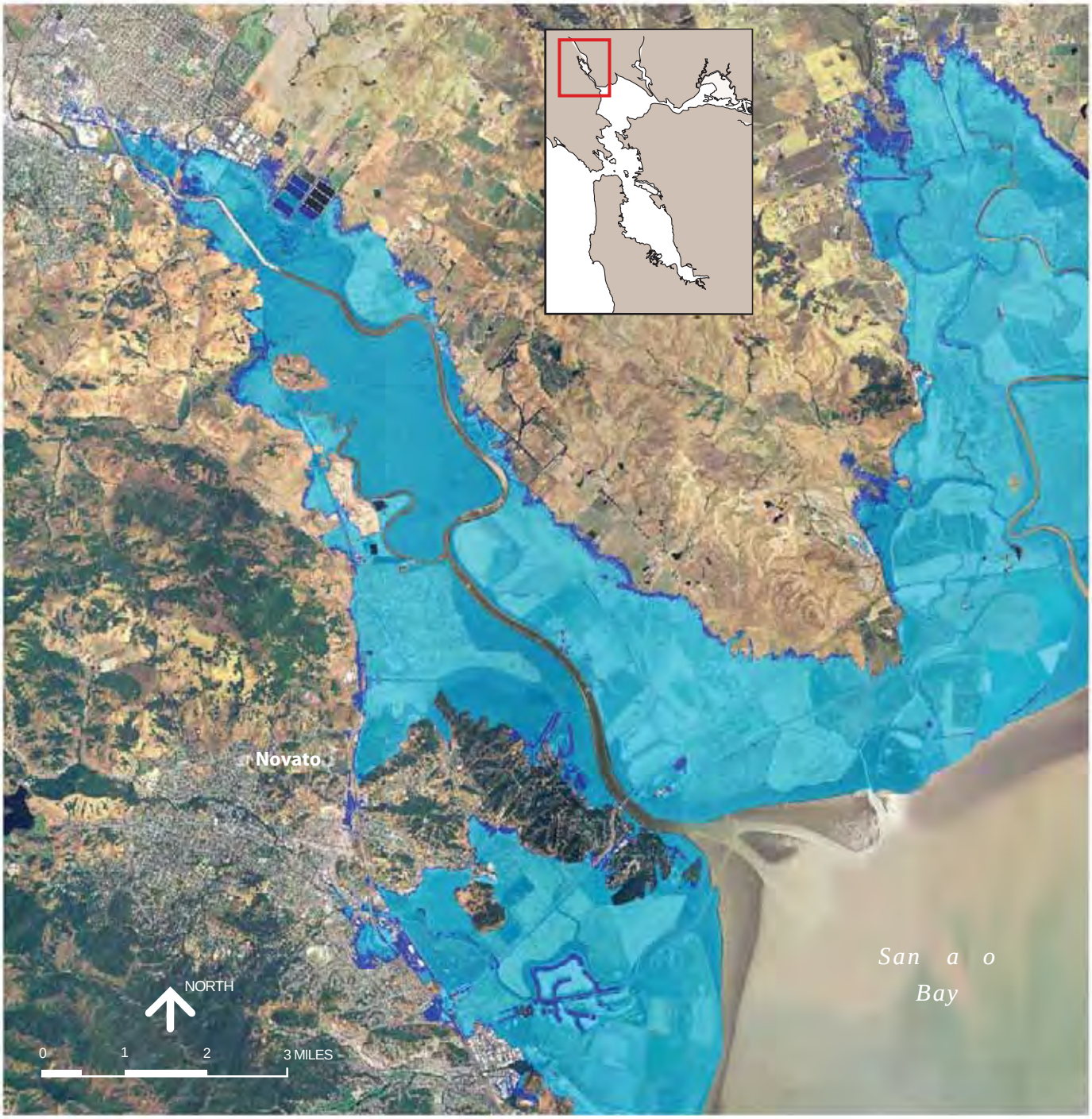

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Napa River
Shoreline Areas Potentially Exposed to Sea Level Rise

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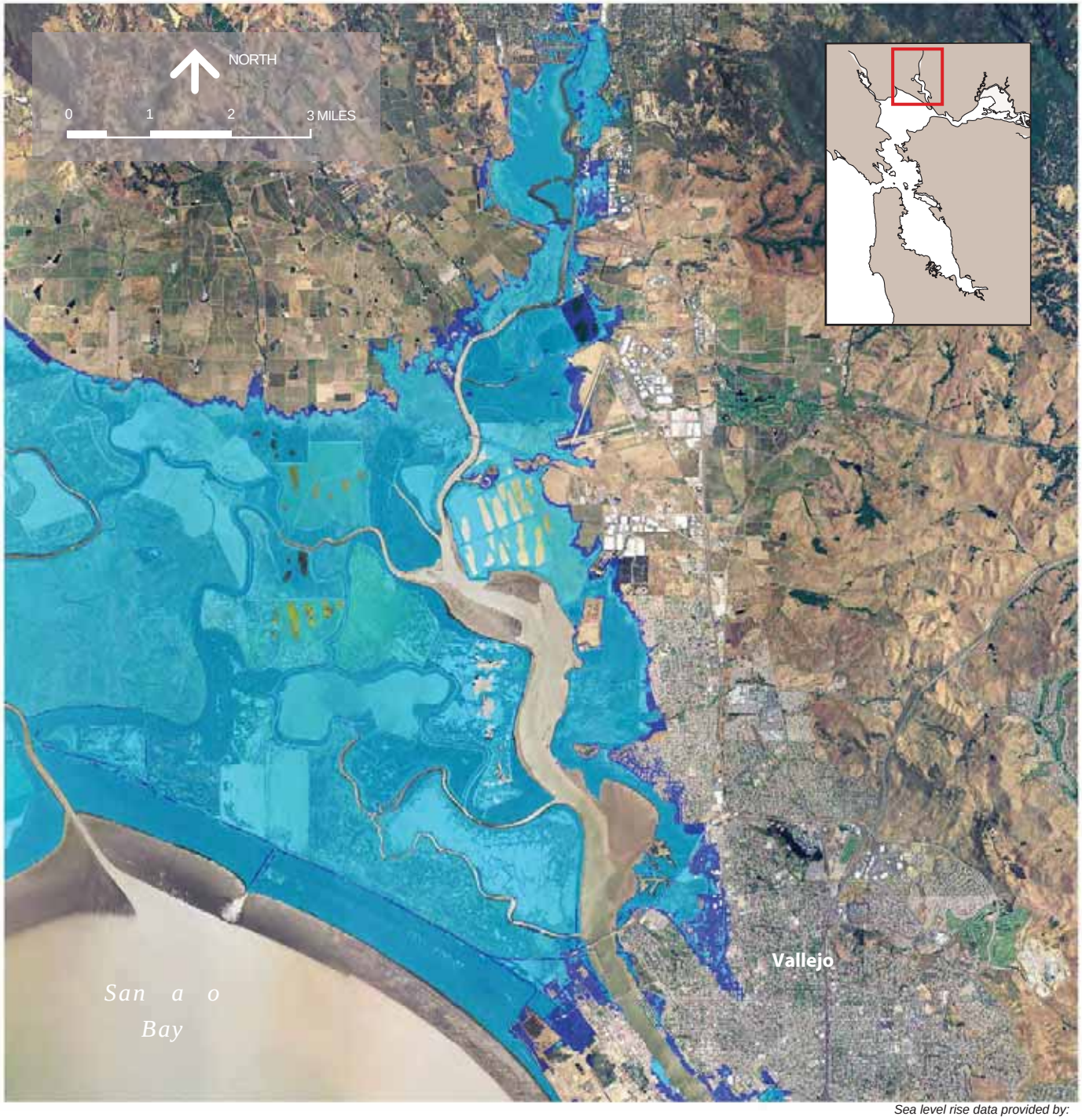

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.15

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

San Pablo Bay/Carquinez Strait Shoreline Areas Potentially Exposed to Sea Level Rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.16

Grizzly Bay
Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

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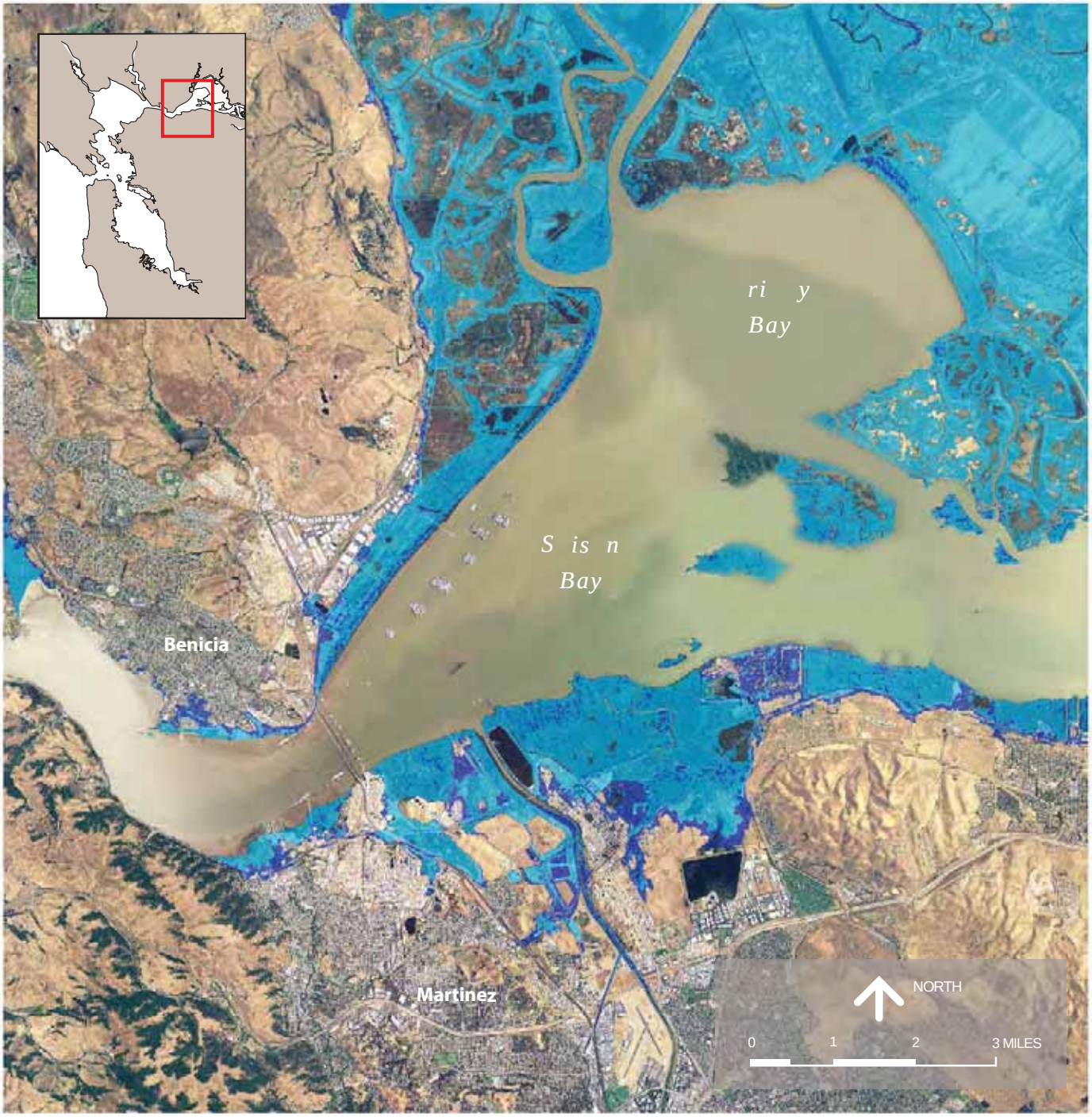


Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

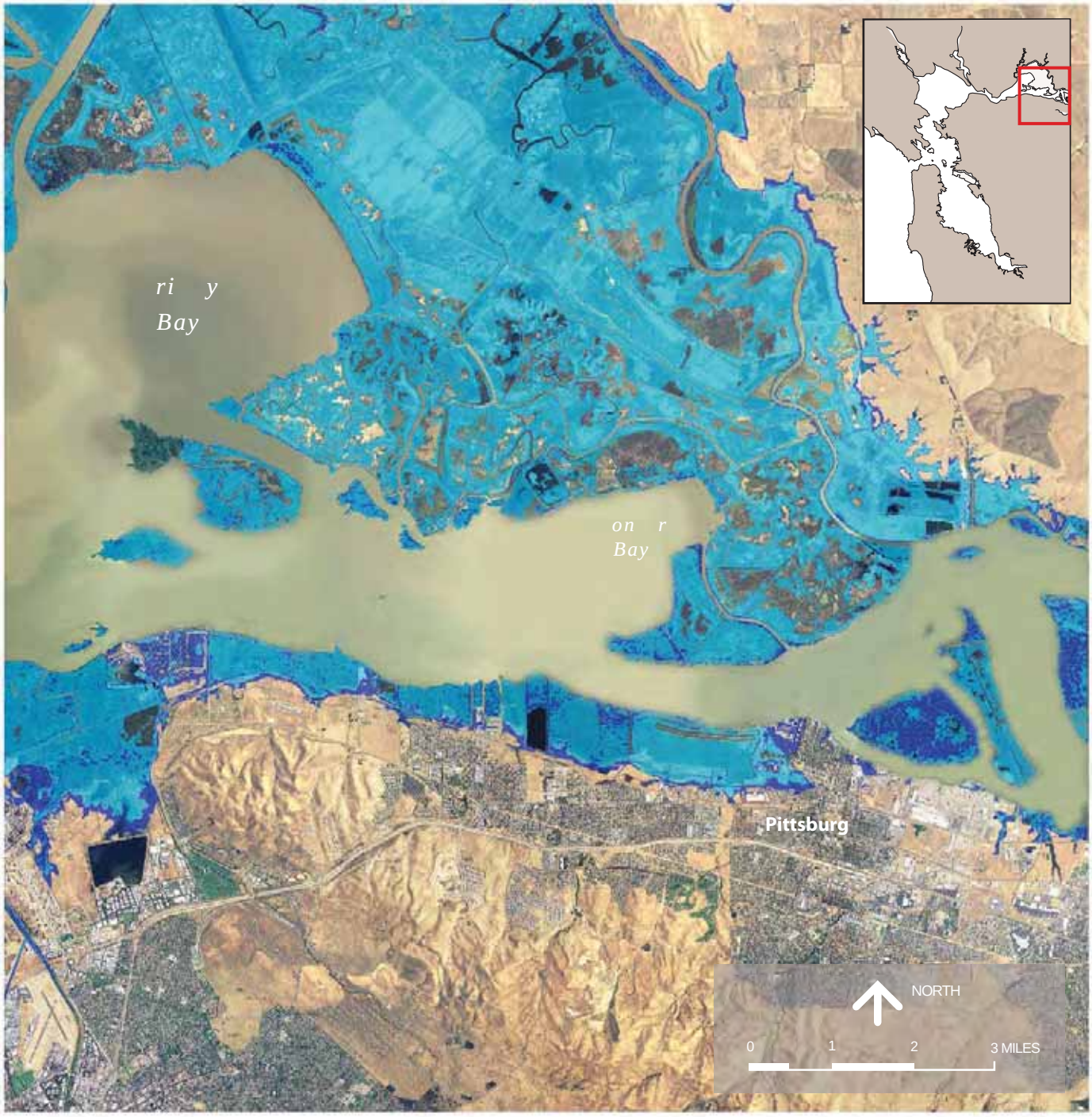
Figure 1.17

Honker Bay
Shoreline Areas Potentially Exposed to Sea Level Rise

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

DISCLAIMER: The inundation data used in these maps do not account for shoreline protection or wave activity. These maps are for informational purposes only. Users agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with the use of the maps. The maps and data shall not be used to assess actual coastal hazards,insurance requirements, or property values or be used in lieu of Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).



Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

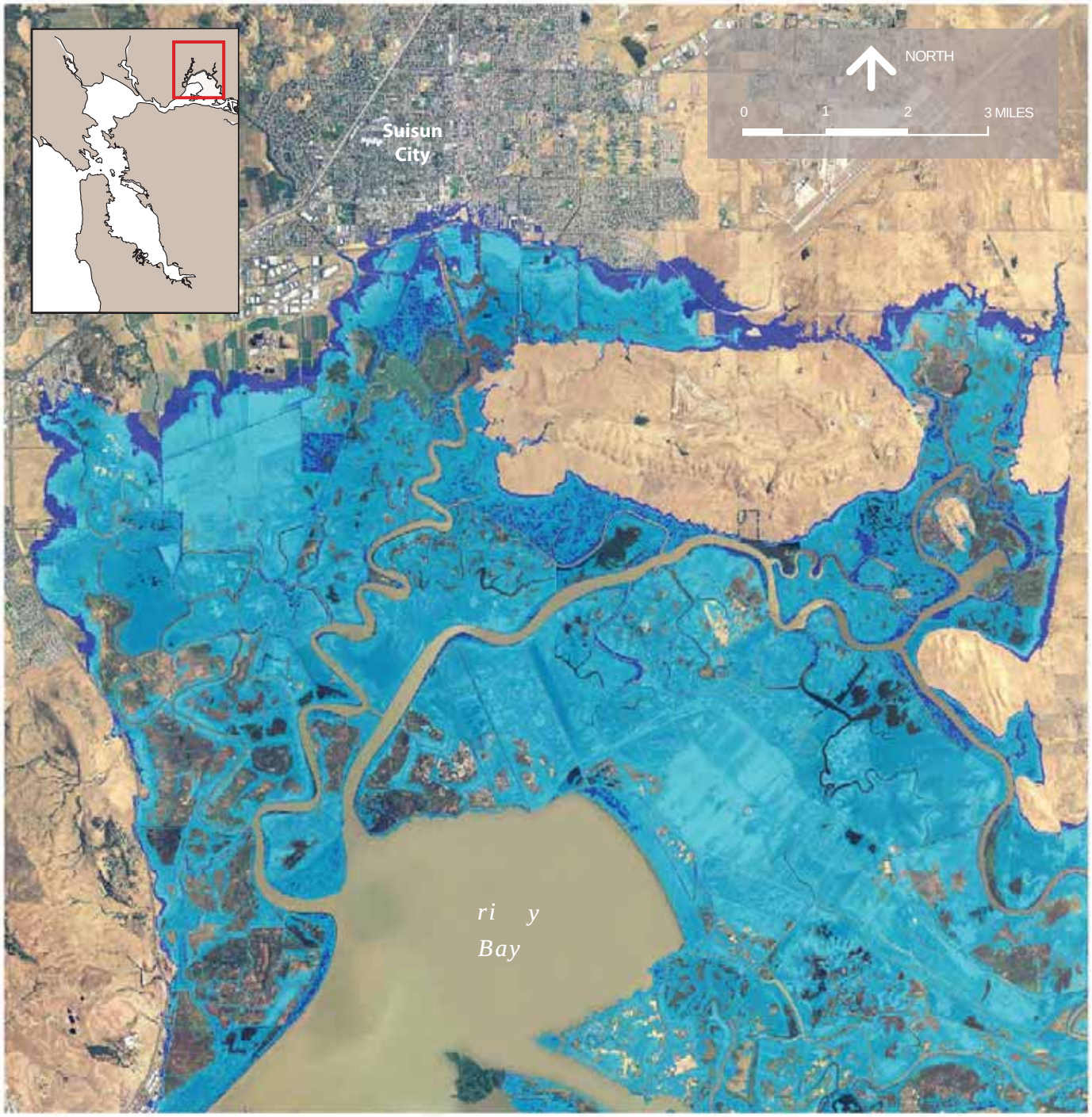
Figure 1.18

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Suisun Marsh
Shoreline Areas Potentially Exposed to Sea Level Rise

DISCLAIMER: The inundation data used in these maps do not account for shoreline protection or wave activity. These maps are for informational purposes only. Users agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with the use of the maps. The maps and data shall not be used to assess actual coastal hazards,insurance requirements, or property values or be used in lieu of Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).



Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Figure 1.19

Area potentially exposed to a 100-year high water event

Area potentially exposed to an approximate 16-inch sea level rise

Comparison of Current 100-Year High Water Event and Average High Tide at Mid-Century

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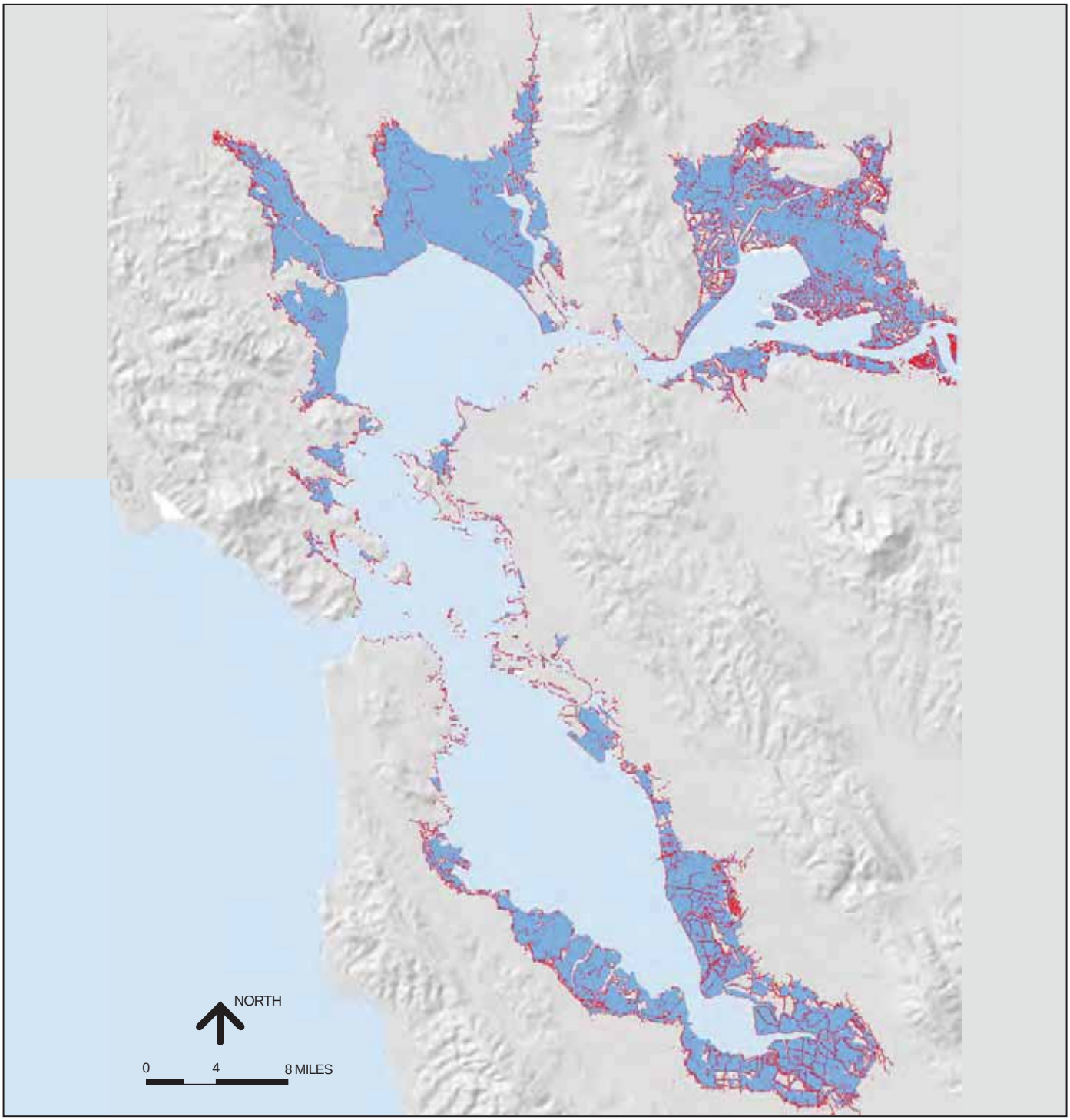


Sea level rise data provided by:

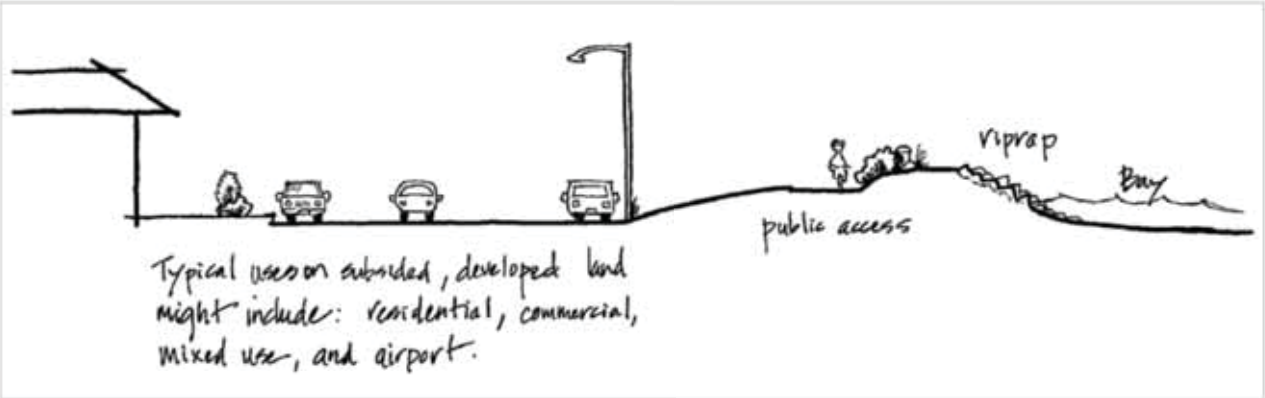
SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002.

Shoreline Protection

San Francisco a and the shoreline support some of the densest urban development in the nited States as well as ample open space and some of the most extensive tidal wetland habitats (Figure 1.6). Shoreline development, public safet , and the a ecos stem are at ris from current flooding and increased future flooding and storm activit . ublic infrastructure and shoreline development that are critical to the region s health, safet and welfare will re uire protection. Wetlands must be sustained to continue providing important habitat and health functioning of the a ecos stem as well as flood protection and carbon se uestration. A variet of shoreline features and development exist around the a , some of which are more vulnerable than others, and all present uni ue challenges for protection and adaptation to sea level rise[3]. iscovering wa s to protect shoreline development and wetlands is one of the ma or challenges in adapting to future sea level rise.

Figure 1.20 Typical Section: Subsided Land with Structural Shoreline Protection

Source: BCDC



Sea level rise and flooding on the a shoreline will lead to a greater ris of erosion, causing local governments and landowners to evaluate protection techni ues and strategies. Currentl , static structures or structural protection, such as seawalls, riprap revetments and levees, are the most common form of protection against flooding and erosion along the shoreline (Figures 1.20-1.22). Although expensive, these structures are attractive options because the engineering

[3] A series of figures showing t pical shoreline conditions are included to further an understanding of the variet of shoreline conditions discussed here and in future chapters.

standards for their design and implementation are full developed and widel used (C C 19 a, Smits et al. 2006). Static structures on the edge of a d namic a shoreline can result in erosion of ad acent tidal flats or marshes and eventuall the flood protection itself (Williams 2001, owe and Williams 200 , Schoellhammer et al. 2005, Smits et al. 2006, eberger et al. 200).

Figure 1.21 Typical Section: Urban Shoreline with Bulkhead

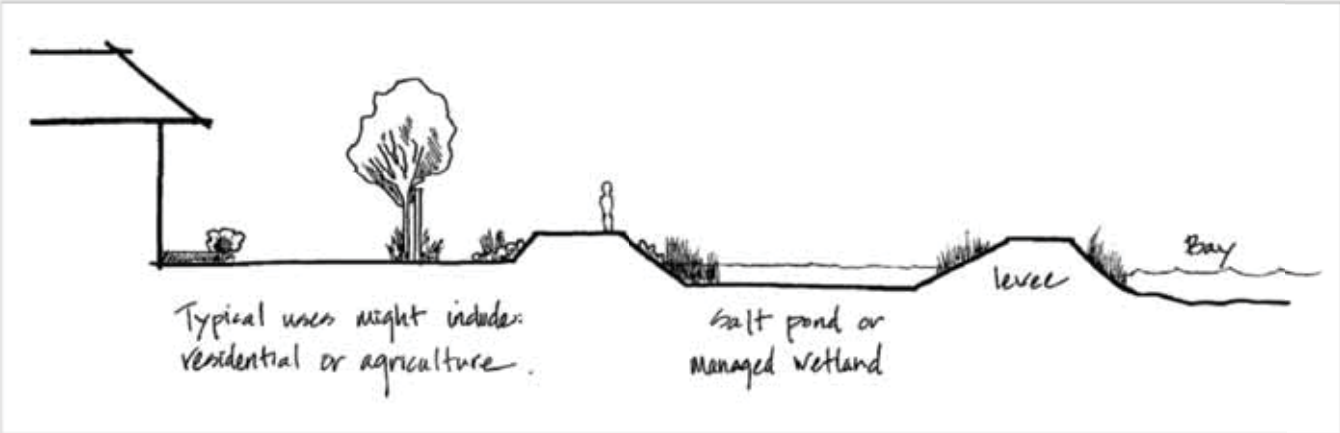
Source: BCDC

Construction and maintenance of shoreline protection t picall re uires fill in the a (C C 19 a). From 19 to 19 , C C authori ed nearl 300,000 cubic ards of fill for shoreline protection, most of which was used to construct riprap revetments (C C 19 a). an of these revetments degraded tidal flats that provide important habitat to birds and dissipate wave energ . hus, residential communities and infrastructure on the shoreline, as well as the a ecos stem, ma be significantl impacted b the cumulative effect of additional engineered structures along the a shoreline to address sea level rise.

oth the construction and maintenance cost of protection structures increases over time, particularl as sea level rises and the damaging effect of storms increases. Since 1990, the construction cost of a waterside levee rose to approximatel 1,500 per linear foot, a 320 percent increase, and seawalls are even more expensive at approximatel 5,300 per linear foot (eberger et al. 200). aintenance costs range from 1-15 percent of the construction cost per ear over the life of the pro ect, which does not include the cost of damages to public safet , infrastructure, or the ecos stem (eberger et al. 200).

Figure 1.22 Typical Section: Wetlands and Levees

Source: BCDC



he acific Institute reports that statewide the cost of protecting against a 55-inch rise in sea level using static structures would be 14 billion. his cost estimate assumes that, throughout the a , levees are sufficient to provide shoreline protection. owever, the existing shoreline protection is a mix of levees, riprap and bul heads or seawalls. valuating the full cost of protection measures on the a shoreline re uires a full assessment of existing structures, both in terms of the level of flood protection and the resistance to erosion under sea level rise pro ections. In man cases, the wave energ will be sufficient that local governments ma desire the additional protection of a seawall, which is far more expensive. Furthermore, a levees are constructed, in man cases, using loosel compacted a mud that are often insufficient to support the additional weight of material re uired for retrofitting (S 2005, WA 2005). his deficienc is offset, to a degree, because the cost estimate is based on areas potentiall exposed to sea level rise and flooding irrespective of whether current protection exists a more ris - averse approach. Considering that there are multiple t pes of shoreline protection other than levees, and, that where existing levees cannot be raised, the ma re uire replacement with an alternative method of protection, the acific Institute s cost estimate for the a is probabl low.

roviding structural shoreline protection ma actuall increase vulnerabilit b encouraging development in flood-prone areas directl behind the structure and giving those who live behind the structure a false sense of securit (eberger et al. 200 , Smits et al. 2006, nited ations 2004). In areas of the etherlands, as progressivel larger protection structures were built, development behind the structures intensified and populations in those areas increased. he protection structures completel eliminated water circulation in several

estuaries, which were ultimatel abandoned as functioning ecos stems (Smits et al. 2006). arge areas of the ississippi elta are being considered for restoration, in part, to restore previous wave attenuation benefits and help avoid repetition of the devastating impacts caused b urricane atrina, a tragic example of rel ing too heavil on shoreline protection structures (a et al. 200). oss of this ecos stem benefit is ust one of the reasons for ambitious tidal wetland restoration efforts in the a - elta estuar (Save the a 200). While sedimentation and tidal wetlands alone ma not completel protect against flooding and erosion (onge an 200), earl adaptation of existing development, prevention of new development in flood prone areas, and the flood protection benefit of tidal wetlands can help reduce the cost of adaptation.

he *San Francisco Bay Plan* (a lan) re uires a design review process for engineering pro ects, such as ma or shoreline protection wor s on fill. he a lan also includes policies to guide the Commission decisions regarding compensator mitigation for unavoidable adverse impacts resulting from pro ects in the a . Approving structural shoreline protection on a pro ect-b -pro ect basis ma create additional, cumulative adverse impacts to a habitat. Anal sis of these cumulative impacts and potential planning approaches that will minimi e them are needed. oth the S S and the SAC are currentl investigating regional and local effects of shoreline inundation and flooding, respectivel , in the South a . Additional anal sis can provide local governments and landowners with ade uate information for designing erosion control and shoreline protection (nowles 200 , SAC 200).

Summary and Conclusions

he planet is getting warmer and there is broad scientific consensus that human release of s is driving this change. reenhouse gases that naturall reside in the earth s atmosphere, absorb heat emitted from the earth s surface and radiate heat bac to the surface a natural process called the greenhouse effect. he planet is now warming at an accelerated rate due largel to the rapid release greenhouse gases into the atmosphere since industriali ation. emperatures in California are pro ected to rise between 1. °F and 5.4°F (1°C and 3°C) b mid centur and between 3.6°F and 9°F (2°C and 5°C) b the end of the centur . As air temperatures warm, the oceans warm, glaciers and ice sheets melt, causing sea level to rise.

A range of sea level rise pro ections has been estimated, but the ma not ade uatel reflect future contributions from ice-sheet melt. he estimates for this anal sis are based on higher emissions scenarios. Choosing a higher scenario is a more ris -averse approach to protecting public safet . wo sea level rise scenarios were selected for anal sis: a 16-inch (40 cm) sea level rise b mid-centur and a 55-inch (140 cm) rise in sea level b the end of the centur . hese scenarios are generall consistent with other state S estimates.

xtreme storm events will cause most shoreline damage from flooding. Changes in climate ma increase storm activit , which, in combination with higher sea level, will result in more fre uent and extensive flooding. he data used for this anal sis reflects storm activit , but does not include wave activit . With the 16-inch pro ection, 1 0,000 acres (2 1 s uare miles) of shoreline are potentiall exposed to more flooding or permanent inundation b mid-centur and 213,000 acres (332 s uare miles) are at ris from a 55-inch sea level rise at the end of the centur .

Structural shoreline protection can hold floodwaters bac from the shoreline. Incorporating both engineering and ecos stem elements can be used to in some cases to mitigate some of the impacts of structural shoreline protection (owe and Williams 200).

Cumulative impacts of structural shoreline protection can have far reaching adverse impacts to the a ecos stem. ecause structural shoreline protection re uires long-term maintenance and can have unintended adverse impacts, it should be seen as onl one of several adaptation options for a shoreline area (C C 19 a, C C 19 b, Smits et al. 2006).

CHAPTER 2
Shoreline Development

ibrant cities towns communities international airports critical businesses research facilities freeways railroads farms parks trails and important habitat areas stretch along the shoreline of San Francisco Bay. These shoreline land uses are essential to the region s economy provide needed housing and jobs for the region s residents provide habitat for many ecological communities and allow the public to enjoy the Bay. n short continued productive use of the shoreline is the cornerstone of the region s prosperity and fosters a strong bond between the region s residents and the Bay.

The nine-county San Francisco Bay Area is home to approximately seven million people making it the nation s fifth most populous urban center. All nine counties San Francisco San Mateo Santa Clara Alameda Contra Costa Solano Napa Sonoma and Marin front on the Bay. There are 101 cities within the region and 46 cities situated along the shoreline making the San Francisco Bay one of the world s most urbanized estuaries. The Bay Area s three largest cities are San ose (pop. 945 942) San Francisco (pop. 805 235) and Oakland (pop. 390 724) (U.S. Census Bureau 2010).

The San Francisco Bay Area is one of the most economically productive regions in the nation (Bay Area Council Economic nstitute 2008). The highly skilled workforce is employed in a variety of fields including health care technology information services finance education life sciences manufacturing and retail. The natural harbor and its proximity to Pacific trading partners allow the region to export more products than most states (Bay Area Council Economic nstitute 2008). The Bay Area is also home to some of the world s leading universities and research institutions making it a key global center for innovation.

f no adaptation measures are taken an estimated 270 000 people in the Bay Area will be at risk of flooding from a 55-inch rise in sea level a 98 percent increase over the region s current vulnerability to flooding (Heberger et al. 2009). Shoreline development at risk (buildings and their contents) is estimated at 62 billion nearly double the estimated cost of sea level rise flood risk along California s Pacific Coast (Heberger et al. 2009). Where lives and property are not directly vulnerable the secondary and cumulative impacts of sea level rise will affect public health economic security and quality of life.

Shoreline planners and managers already face challenging issues such as managing competing land uses ensuring that shoreline areas are available for water-dependent uses upgrading aged infrastructure reducing traffic congestion protecting habitat and water quality maintaining flood protection and providing public shoreline access. n this chapter shoreline vulnerability is assessed to understand planning and management challenges that may be exacerbated with climate change and identify new challenges that may arise.

Residential Land Use

Land use patterns vary significantly within the region. San Francisco County is the most urbanized with 82 percent of its land developed while rural Napa County a highly productive agricultural area has less than four percent of its land developed. Approximately 16 percent about 700 000 acres (1 093 square miles) of the region s 4.4 million acres (6 875 square miles) are developed. Over half of this urbanized area is residential and approximately 40 percent contains employment centers major infrastructure and schools (ABAG 2008). n addition to urban areas the region has extensive productive agricultural lands and abundant open space and parks. Within the area potentially exposed to a 55-inch rise in sea level approximately 51 percent is residential 32 percent is commercial and 14 percent is industrial.

Much of the shoreline is former Bay that was filled to create land for housing. Construction of levees along the Bay margin and channeling of creeks and rivers opened up large tracts of land for residential development most of which is in the current 100-year floodplain. n accordance with the National Flood nsurance Program standards local governments established elevation requirements for levees homes and local roads in floodplains to lessen potential flood risks. However these standards are based on past flooding events rather than future sea level rise and storm events. Residential development located on subsided land and near the mouth of Bay tributaries especially at the head of tide where high tide meets tributary outflow are particularly vulnerable to flooding. One such community is the town of Alviso in northern San ose which is subject to both sources of vulnerability it has significantly subsided below sea level sits in close proximity to Alviso Slough and has suffered periodically from devastating floods. Storm-related flooding also affects some communities in other low-lying and riparian areas such as Corte Madera and Petaluma.

Difficult choices at the local and regional level are required to determine how to protect housing from future flooding. Approximately 66 000 residential acres (103 square miles) are potentially exposed to a 16-inch sea level rise. Most of this acreage is developed with low-density housing (less than 5 residents per acre). However 560 acres (0.8 square miles) have over

30 residents per acre and over 5 600 acres (8 square miles) have between 5 and 30 residents per acre. Over 82 000 residential acres (128 square miles) are vulnerable to a 55-inch sea level rise. While most of this area is used for low-density housing over 1 000 acres (1.5 square miles) contain over 30 residents per acre and over 9 800 acres (15 square miles) contain between 5 and 30 residents per acre (Table 2.1).

Through the PC the Commission is a partner in an incentive-based program to focus development near transit and thereby reduce driving and GHG emissions. This program among other important goals should consider alternatives to siting residences in areas that are vulnerable to flooding (Box 2.1). n consultation with local governments the FOCUS program has identified Priority Development Areas for infill development in the Bay Area. These Priority Development Areas along with other sites are anticipated to be key components of the Bay Area s Sustainable Communities Strategy that will be adopted and periodically updated pursuant to SB 375. One of the Commission s objectives in adopting climate change policies is to facilitate implementation of the Sustainable Communities Strategy. Some shoreline areas that are vulnerable to flooding are already improved with public infrastructure and private development that has regionally significant economic cultural or social value and can accommodate infill development. n such cases the regional goal of concentrating housing and job density near transit conflicts with the goal of minimizing flood risk by avoiding development in low-lying areas vulnerable to flooding. Reconciling these different worthy goals and taking appropriate action requires weighing competing policy considerations and would be best accomplished through a collaborative process involving diverse stakeholders similar to that being undertaken to develop the Sustainable Communities Strategy.

Table 2.1 Residential Acreage Potentially Exposed to More Flooding or Permanent Inundation due to Sea Level Rise

Residential Land Use	Approximate Acreage Exposed to Flooding or Inundation	
	16-inch sea level rise	55-inch sea level rise
Low-density	59 900	72 100
Medium-density	5 600	9 800
Higher-density	560	1 000
Total	66 000	82 000

Source: U.S. Census Bureau 2000.

Box 2.1 The FOCUS Program

FOCUS is a partnership among ABAG BAA MD BCDC and MTC that encourages future development and growth in areas near existing or planned transit and within existing communities. t is a strategy to work with local and regional entities in the nine-county San Francisco Bay Area by identifying priority development areas (PDAs) that qualify local governments for financial incentives. Priority conservation areas (PCAs) are identified to preserve regionally significant resources such as agriculture natural or scenic resources and recreational areas.

PDAs are locally identified infill development opportunities located within existing communities. They are generally areas of at least 100 acres (0.1 square miles) where there is local commitment to creating more housing in a pedestrian friendly environment that is served by one of the regional transit agencies. The approximately 150 PDAs comprise approximately 106 000 acres (165 square miles) of urban and suburban land. While this constitutes a small percentage of the region s total land area the proposed areas could accommodate over half of the region s projected housing growth to the year 2035 at relatively modest densities (ABAG website 2009). mportantly the increased density around transit can be an effective strategy to reduce greenhouse gas emissions.

Forty PDAs comprising over 60 000 acres (93 square miles) have a portion of area that is vulnerable to sea level rise. Approximately 2 000 acres (3 square miles) or three percent of the 60 000 acres are vulnerable to a 16-inch sea level rise. Ten percent or 6 000 acres (9.3 square miles) are vulnerable to a 55-inch sea level rise. t is important to realize that this analysis was conducted with data that identifies the entire extent of the PDA s. t does not necessarily imply that actual development would occur within vulnerable areas. Future efforts should focus on determining the likelihood of secondary impacts upon the identified PDA s such as impacts to surrounding transportation infrastructure. Appropriate adaptation strategies should be developed for any vulnerable site (Figures 2.1- 2.2).

Residents with Increased Vulnerability. One definition of a resilient community is a community that takes intentional action to enhance the personal and collective capacity of its citizens and institutions to respond to and influence the course of social and economic change (CCE 2000). A critical characteristic that enables communities to respond to and influence social and economic change is their current economic security because it adds to their overall feeling of safety and security (Coburn 2008). Other attributes of resilient communities such as active participation in democracy willingness to draw on resources within the community or confidence (Coburn 2008) may be compromised by a lack of economic security. For example a low-income community may have a willingness to draw on resources within the community but several of the essential resources on which to draw are missing: money being the obvious resource or time spent working and commuting that might otherwise be available as a resource.

A number of low-income communities on the Bay shoreline are potentially exposed to sea level rise. A disproportionate number of low-income residents are potentially exposed to a 55-inch rise in sea level in five Bay Area counties: Contra Costa Solano Sonoma Marin and Napa (Heberger et al. 2009)[1].

[1] This information comes from a statewide study of coastal and Bay shoreline impacts. Marin and Sonoma Counties may or may not have greater proportions of low-income residents on the coast or Bay shoreline. Furthermore because the study applies statewide a lower percentage was used in the calculation of low-income that may exclude some Bay Area residents (see 5 below).

A low-income community is an area where 30 percent or more of the households earn less than 200 percent of the national poverty threshold.[2] Low-income communities are less likely to have sufficient resources to rebuild housing after a flood or to relocate. The canal district in San Rafael (Figure 2.3) is an example of a predominantly low-income community that is highly vulnerable to flooding.

Low-income communities are likely to be less resilient to the indirect cumulative impacts of climate change and adaptation efforts. For example a 16-inch sea level rise will only reach the margins of low-income neighborhoods in Redwood City East Menlo Park and East Palo Alto (Figure 2.4). However critical transportation infrastructure that traverse these areas Highway 101 and the entrances to the Dumbarton Bridge and Caltrain railroad will likely be significantly affected by sea level rise. Retrofitting this essential transportation infrastructure could have direct impacts on these neighborhoods. For instance construction activity on transportation infrastructure can change or disrupt access to public transportation local shopping jobs or medical centers. Easy access to such facilities is something that an automobile owner or an individual with more flexibility in their work schedule takes for granted. On a regional level the impacts from disruption of services would be offset by the benefits from retrofitting important highways and rail corridors. Low-income households may have fewer resources or alternatives available to withstand interim impacts.

A recent report by the California Climate Change Center estimates that 150 000 Asian black and Latino residents live in areas at risk of a 100-year flood event along the Bay with a 1.4-meter rise in sea levels (Heberger et al. 2009) and confirms that along the San Francisco Bay communities of color are disproportionately impacted by sea-level rise (Heberger et al. 2009). Bay Area counties with populations that disproportionately include people of color vulnerable to sea level rise compared to the county as a whole are Contra Costa Marin Solano Napa Sonoma Alameda and San Mateo (Heberger et al. 2009). The report concludes that the greater proportion of people of color in areas affected by a 1.4-meter sea-level rise highlights the need for these counties to take concerted efforts to understand and mitigate potential environmental injustice (Heberger et al. 2009).

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[2] These thresholds are maintained by the U.S. Census Bureau and are scaled based on size and age of a household. Two hundred percent of the national poverty threshold is the standard equation used by other Bay Area agencies to represent low-income based on the standard of living requirements in the Bay Area.

n such communities it is especially important to take proactive measures to prevent harm and reduce vulnerabilities such as reinforcing residential buildings obtaining insurance storing emergencies supplies and having access to transportation evacuation services and emergency medical care. This may be particularly difficult in areas with high concentrations of rental housing and low English-speaking populations. n areas potentially exposed to sea level rise along the Bay there are currently 47 000 rental households and 9 700 linguistically isolated households (meaning no one over the age of 14 speaks fluent English (Heberger et al. 2009). People of color in California also live disproportionately near (within 3 kilometers) hazardous waste facilities (Heberger et al. 2009). t is estimated that 130 EPA-regulated sites that contain hazardous wastes are currently potentially exposed to a 100-year flood event in San Francisco Bay the number of facilities at risk increases to 330 with a 1.4-meter rise in sea levels (Heberger et al. 2009). Additional studies are needed to determine where vulnerable populations are located in proximity to these and other sites with hazardous or toxic substances. The California Climate Change Center notes what we choose to protect and how we pay for it may have a disproportionate impact on low-income neighborhoods and communities of color (Heberger et al. 2009).

Some residents are more vulnerable to sea level rise because it would be physically difficult to evacuate in the case of an emergency flood situation or more difficult to relocate if special facilities are required. People with disabilities the elderly or those who are already ill may experience these difficulties. Children will also have greater difficulty evacuating requiring the assistance of their parents. Single parents may face particular difficulty helping children evacuate or relocating to a new home. Additionally these populations are more vulnerable to a drop in economic status which could subject them to the additional vulnerabilities faced by low-income residents. Additional research is necessary to develop more information on the potential impacts to particularly vulnerable populations and to develop quantitative data on their vulnerability to future flooding. This should be a high regional priority.

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

No data

Priority Development Area

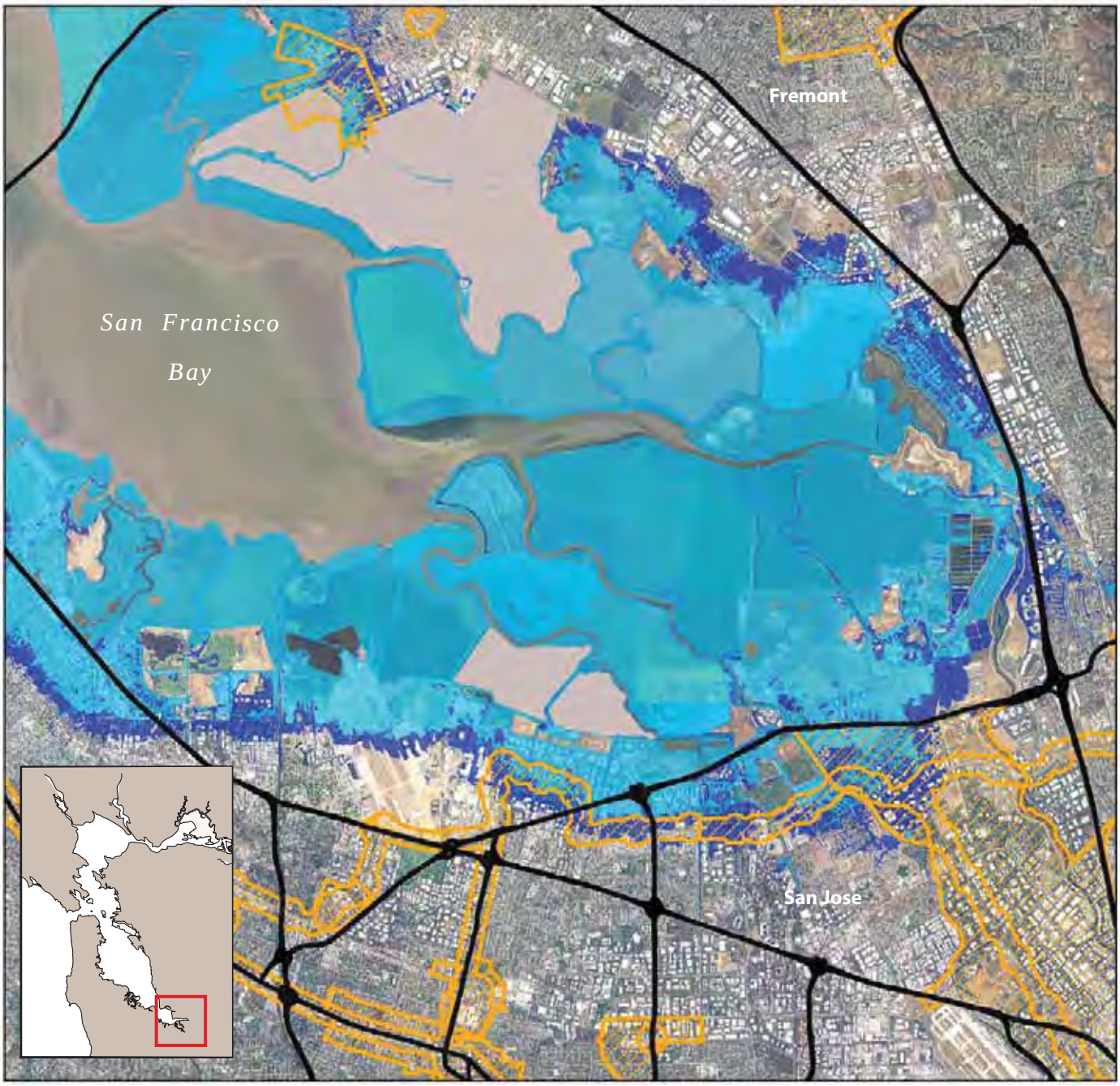
Major Roads and Highways

South Bay
Priority Development Areas
Potentially Exposed to Sea Level Rise

0 1 2 3 MILES

NORTH

DISCLAIMER: The inundation data used in these maps do not account for shoreline protection or wave activity. These maps are for informational purposes only. Users agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with the use of the maps. The maps and data shall not be used to assess actual coastal hazards,insurance requirements, or property values or be used in lieu of Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).



Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; ABAG, 2008.

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

No data

Priority Development Area

Major Roads and Highways

Central Bay North
Priority Development Areas
Potentially Exposed to Sea Level Rise

0 1 2 3 MILES

NORTH

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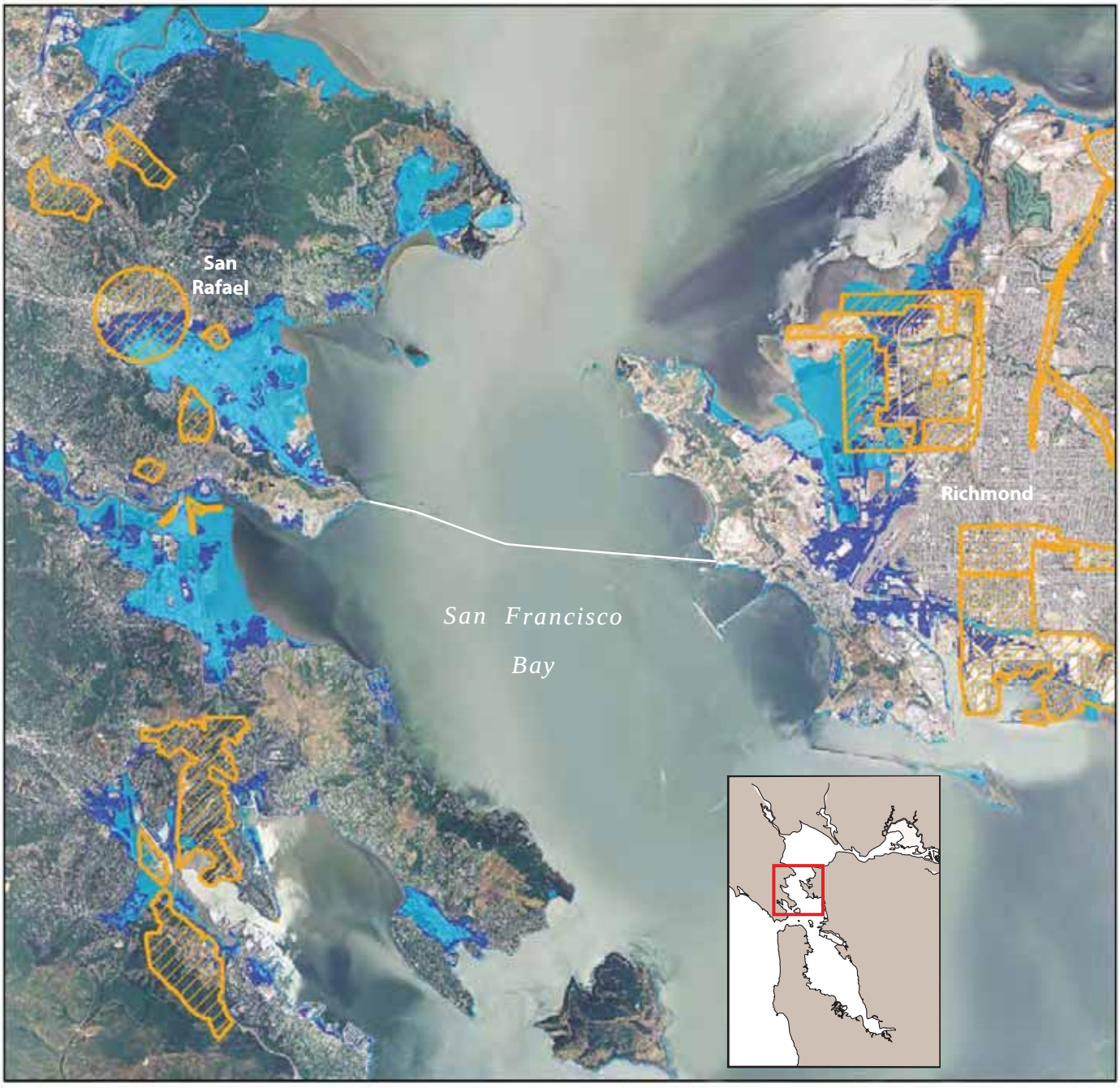

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; ABAG ,2008.

Figure 2.3

30% or more of the households below Federal Poverty Level

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Major roads and highways

Central Bay North Low Income Residential Areas Potentially Exposed To Sea Level Rise

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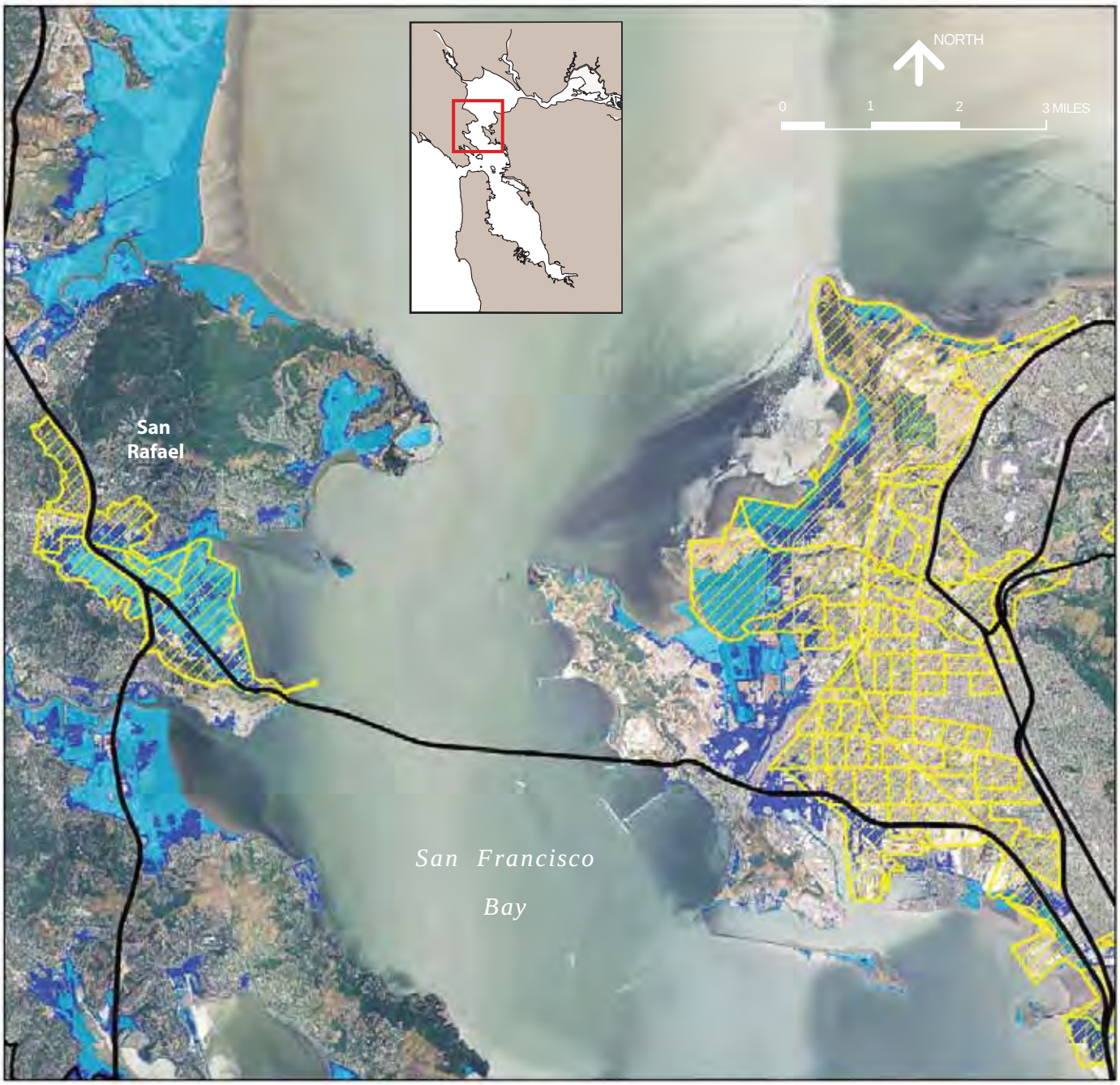

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; Census Bureau, 2000.

Figure 2.4

30% or more of the households below Federal Poverty Level

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Major roads and highways

Central Bay South Low Income Residential Areas Potentially Exposed To Sea Level Rise

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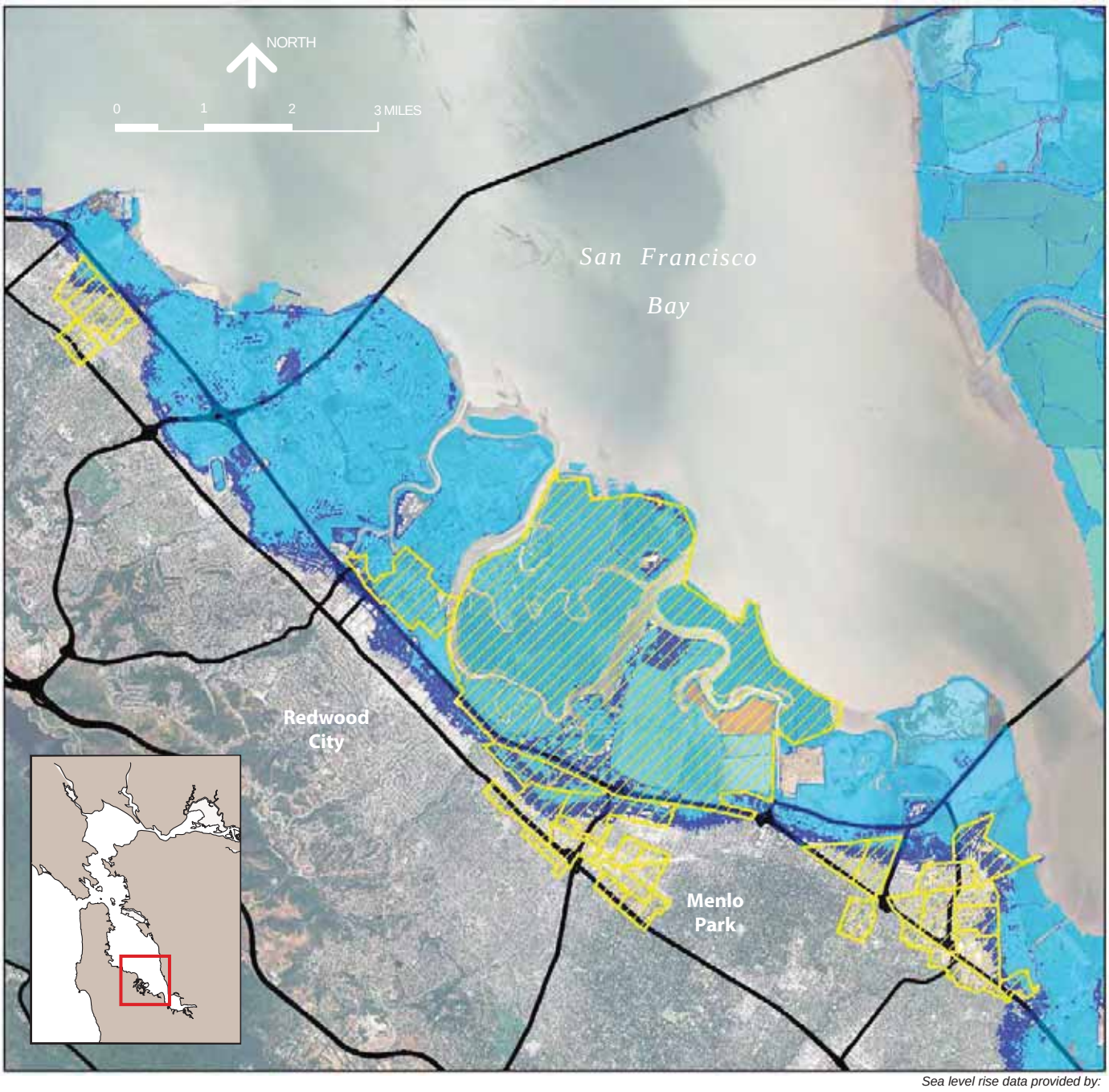

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; Census Bureau, 2000.

Schools and Emergency Services. mportant civic institutions such as schools fire stations and hospitals are at increased risk of flooding under both sea level rise scenarios. Thirty-five schools are located in the current 100-year flood plain where the risk of flooding increases substantially by mid-century. That number increases to 81 with 55-inches of sea level rise (Heberger et al. 2009). Eleven fire stations nine police stations and 42 healthcare facilities are potentially exposed to flooding or permanent inundation with 55-inches of sea level rise (Heberger et al. 2009). The extent to which this could compromise emergency response in an extreme event requires additional attention in coordination with the Federal Emergency Management Agency cities and counties.

Commercial and Industrial Land Use

n 1969 when the Legislature adopted the Bay Plan into law it recognized that some regionally significant land uses require a shoreline location. Without protecting shoreline areas for these land uses there would be future pressure to fill the Bay to accommodate them. Therefore the Bay Plan designates areas of the shoreline that are suitable for water-oriented priority uses: airports ports water-related industry wildlife refuges and waterfront parks and beaches. Currently there are 86 designated areas comprising over 167 000 acres (260 square miles) throughout the nine-county region. These priority use areas help make the Bay Area one of the most economically prosperous ecologically rich and healthy urban centers in the world and they all will experience some increase in potential exposure to flooding.

Airports. Two international airports in the region San Francisco nternational (SFO) and Oakland nternational (OA) are located on the Bay shoreline. These two airports provide important linkages with international and domestic trading partners and serve as major hubs of the national and global air passenger system and air cargo network.

SFO is the principal international air passenger gateway within the region. n 2010 SFO was the ninth busiest airport in the country at over 39 million passengers up from 36 million passengers in 2007 (Airports Council nternational-North America 2010). n 2010 SFO also handled 427 000 metric tons of cargo down from 563 000 metric tons in 2007 (AC -NA 2010). n 2010 OA handled approximately 9.9 million passengers down from 14.8 million passengers in 2007 (AC -NA 2010). Additionally OA handled roughly 511 000 metric tons of cargo in 2010 down from 648 000 metric tons in 2007 (AC -NA 2010). Air cargo is the fastest growing segment of the goods movement economy and is forecast to triple in the next twenty to thirty years (MTC 2004).

Both airports have limited land available for expansion of passenger and cargo facilities and runways. Funding for such improvements is limited due to federal budget constraints and the deteriorating financial health of national airlines. The two airports cover approximately 4 700 acres (7.3 square miles) along the shoreline of the Bay. Without any shoreline protection over 3 400 acres (five square miles) or 72 percent of these designated lands would be potentially exposed to a 16-inch sea level rise while approximately 4 400 acres (six square miles) or 93 percent of these designated lands would be potentially exposed to a 55-inch sea level rise (Figure 2.5).

At OA the perimeter dike serves as the flood protection system for the airport s South Field including the main air carrier runway and passenger terminal facilities. The dike was constructed using dredged bay mud sand and gravel during the 1950s to 1970s. Two active fuel lines are buried under the dike crest. As part of its Airport Perimeter Dike mprovement Project the Port of Oakland plans to construct improvements to the dike portions of which currently do not meet FEMA 100-year flood protection standards (Port of Oakland 2011). The Port estimates that the dike system protecting OA can currently support approximately 36 inches of sea level rise at mean higher high water. Proposed dike improvements include where necessary raising the height of the dike stabilizing inboard slopes protecting against seepage and strengthening portions of the dike that are vulnerable to seismically-induced liquefaction.

SFO was built on landfill and has addressed runway subsidence through a regular program of repaving and overlay. A partial seawall protects the runways and reduces their exposure to flooding. n order to address the gaps remaining in the existing shoreline protection system SFO has been coordinating with FEMA to certify its seawalls and update flood maps. SFO is investigating the issue of storm surge to determine whether additional seawall or levee heights are needed and whether existing drainage is sufficient. As sea level rises raising levees or other adaptation measures will be necessary to protect runways from flooding. Detailed vulnerability assessments for the airports will need to consider existing shoreline protection extreme tides storm surge wind-driven wave run up and other factors.

Congestion within the highway networks that serve each airport makes airport access difficult for passengers and cargo distributors. SFO is linked to the highway transportation network via the U.S. 101 and also has direct Bay Area Rapid Transit (BART) passenger service. Segments of the U.S. 101 and the BART tracks near the airport are potentially exposed to a 16-inch sea level rise. OA is linked to the region via the -880 corridor which is vulnerable to flooding near Port of Oakland and the Bay Bridge approach (Figure 2.6).

The Regional Airport Planning Committee a collaborative effort between BCDC the Metropolitan Transportation Commission and the Association of Bay Area Governments was formed to address regional airport planning issues. During its recent update to the Regional Airport Systems Plan Analysis the committee analyzed methods to reduce GHG emissions from airports and address the affects of future sea level rise.

Ports. There are five major ports in the Bay Area located at Oakland Richmond San Francisco Redwood City and Benicia. Like the region s airports the ports rely on the transportation network to move cargo and employees to and from the ports. The ports handle a variety of cargo types including container cargo dry bulk break bulk neo bulk and liquid bulk. Maritime cargo handled by these five ports was 19 114 199 metric tons in 2010 a 58 percent increase since 1994 (BCDC 2011). The Port of Oakland (Port) the nation s fifth busiest container port handles the largest volume of cargo within the region and currently exports more cargo than it imports. n 2010 the Port handled over 2.3 million twenty-foot equivalent units (TEUs a standardized size of the containers in which goods are shipped) (Port of Oakland 2011). The port generates over 28 800 direct indirect and induced jobs in the Bay Area and an estimated 444 000 jobs in California are in some way related to the Port s activity (Martin Associates 2011). The Port was estimated to generate 3.7 billion annually for the regional economy in 2008 (MTC 2008). However containerized trade declined sharply in 2008 and 2009 due to the recession (The Tioga Group 2009).

Commercial residential port and other industrial uses compete for highly desirable shoreline property.[3] Port activities are normally inconsistent with commercial and residential uses and raise concerns over public health and noise. Constituencies are created that may oppose port improvements or expansion due to this perception. However ports serve an important economic function and require shoreline locations. n addition to occupying waterfront sites ports require maintenance activities that can impact the Bay: maintaining deep-water channels and berths through dredging for the movement of large vessels is not compatible with growth of estuarine ecological communities.

[3] Most of the property on which the Port of Oakland s marine terminals and other facilities are located is subject to the terms of State of California tideland trust grants which generally limit land uses to harbor and airport uses and other uses of statewide interest such as fishing public recreation and enjoyment of the waterfront.

San Francisco Bay
Conservation and Development Commission

Figure 2.5

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Port and Water-Related Industry

Airport

Waterfront Park, Beach

Major Roads and Highways

BART

Railroad

Central Bay West Shore Transportation Network and Shoreline Priority Use Areas Potentially Exposed to Sea Level Rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; BCDC, 2009; MTC, 2009.

San Francisco Bay
Conservation and Development Commission

Figure 2.6

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Port and Water-Related Industry

Airport

Waterfront Park, Beach

Major Roads and Highways

BART

Railroad

Central Bay Transportation Network and Shoreline Priority Use Areas Potentially Exposed to Sea Level Rise

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Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; BCDC, 2009; MTC, 2009.

Shoreline flooding and damage to Bay Area ports as a result of sea level rise would likely have a ripple effect through much of the west coast economy. All of the region s ports are vulnerable in varying degrees to projected sea level rise. Collectively 2 700 acres (four square miles) of land is designated for port use. Approximately 100 acres (0.16 square miles) or four percent of land within the port areas are potentially exposed to a 16-inch sea level rise while approximately 500 acres (0.78 square miles) or 20 percent of land within the port areas are potentially exposed to a 55-inch sea level rise. Additionally segments of the ground transportation network that make vital connections to the Port of Oakland are at greater risk of flooding (Figure 2.6). Several vulnerabilities exist in the Central Corridor the major trade route in the region which originates at the Port of Oakland runs roughly parallel with -80 and heads toward Sacramento and beyond.

Water-Related Industry. Water-related industries are those that require shoreline locations to receive and process raw materials and distribute finished products via deep water shipping lanes rail corridors or highways. For example water-related industrial operations include chemical and petroleum refining and storage metal refining and fabrication food processing mineral resource processing and dredge material handling facilities.

The costs of doing business in the Bay Area rank among the highest in the nation. These high costs combined with other changes to the region s economy have driven many manufacturing jobs out of the region resulting in a job loss of 11 percent since 1995 (Bay Area Economic Forum 2004). Additional factors that have compromised the competitive advantage of Bay Area industries include globalization technology-driven improvements in productivity a shift away from a manufacturing-based economy towards a service-based economy as well as demographic shifts (Bay Area Economic Forum 2004). Like ports and airports water-related industries occupy desirable shoreline property that is subject to encroachment of mixed-use and residential land use into adjacent areas. Several communities have expressed interest in redeveloping water-related industrial sites with non-industrial development continuing a trend that has been underway in the region for decades.

Collectively designated water-related industrial lands cover approximately 12 350 acres (19 square miles). Approximately 2 000 acres (3 square miles) or 16 percent of these designated areas are potentially exposed to a 16-inch sea level rise while approximately 3 500 acres (5 square miles) or 28 percent of these designated areas are potentially exposed to a 55-inch sea level rise. Future flooding could disrupt the operations of water-related industries and thus the provision of important resources to the region. For example many of the petroleum refineries provide fuel for the region s airports goods movement and commuters.

Table 2.2. Summary of Land Use Acreages Potentially Exposed to Flooding or Permanent Inundation due to Sea Level Rise

Land Use	Existing Area (acres)	Acreage Exposed to Sea Level Rise	
		16 inches	55 inches
Airports	4 700	3 400	4 400
Ports	2 700	100	500
Water-related ndustry	12 350	2 000	3 500
Total	19 750	5 500	8 400

Indirect Effects of Sea Level Rise

n addition to the direct effects of sea level rise such as increased flooding sea level rise can be expected to have indirect impacts on groundwater. Sea level rise is expected to lead to salinity intrusion into groundwater along the shoreline potentially impacting shoreline wells and shifting the coastal vegetation to more salt-tolerant species. Sea level rise will also raise the water table along the shoreline increasing the risk of flooding by limiting the amount of precipitation that can infiltrate the ground. A higher water table will also increase the risk of soil liquefaction during an earthquake (Holzer 2006).

Public Health Impacts of Climate Change

Sea level rise is just one of many potential impacts of climate change on the San Francisco Bay region. Climate change is likely to impact public health in the region by changing conditions such as air quality heat events water quality and the distribution of vectors and infectious diseases. The populations most vulnerable to impacts include those who are already ill people with disabilities children the elderly and the poor (Luers et al. 2006). The state currently experiences the worst air quality in the nation and over 90 percent of the population lives in areas that exceed either the ozone or particulate matter air quality standards. Ozone and particulate matter combined contribute to over 8 800 deaths and 71 billion in health related costs per year (Luers et al. 2006). Higher temperatures will exacerbate air pollution by increasing the frequency duration and intensity of conditions that lead to air pollution formation. Other factors such as wildfires contribute to unhealthy air quality conditions. n the summer of 2008 regional air quality was directly impacted by wildfires which are expected to increase in frequency under climate change conditions.

Heat events are also likely to be more intense last longer and occur earlier in the year relative to historical events (1961-1990) (Dreschler et al. 2005). Higher temperatures can lead to increased risk of heat-related illnesses (heat exhaustion dehydration heat stroke and respiratory distress) or mortality particularly among the most vulnerable populations such as the elderly young children and people with chronic illnesses.

Water quality impacts on the Bay can affect Bay Area residents. Marine processes that affect the Bay ecosystem (Chapter 3) are impacted by temperature increases and sea level rise which can kill phytoplankton alter fresh and salt water mixing and upwelling and disrupt primary productivity. mpacts upon these processes could lead to algal blooms and hypoxia which could impact water quality.

Other public health impacts could include the potential for expansion of the range of infectious diseases and vectors as a result of changing environmental conditions. ector borne disease may become a public health concern as the life cycles of organisms such as mosquitoes ticks fleas and rodents change as a result of climate change. Waterborne disease occurrences linked to storm runoff from heavy rainfall flooding and sewage overflow could become a health concern (Dreschler et al. 2005). However predicting the impacts of vector borne diseases is challenging due to the multiple interactions between climate host and vector organism vector control programs and public response to control programs.

Other Shoreline Land Uses, Infrastructure and Institutions

Beyond the land uses that have been discussed above there are other regionally important non-recreational shoreline land uses infrastructure and institutions that may be vulnerable to future coastal flooding. These include water and sewage treatment plants flood control channels landfills contaminated sites pipelines power transmission lines schools fire stations and hospitals.

Wastewater Treatment Facilities. Most of the Bay Area s water and sewage treatment facilities treat wastewater and sewage that is discharged in the Bay. There are 22 wastewater treatment plants on the shoreline that are vulnerable to a 55-inch rise in sea level (Heberger et al. 2009) many of which lack the capacity to handle current storm flows resulting in frequent sewage spills. Without modifying these facilities more frequent storms associated with sea level rise will increase the number of spills in the Bay. Many treatment plants rely on gravity to discharge treated water into the Bay. As Bay water levels rise this mechanism could fail and significantly impact facility operations. Flooding of treatment facilities can disrupt operations or damage pumps and related machinery. Should Bay waters exceed the elevation of plant intake structures saltwater intrusion into treatment facilities will alter biotic conditions necessary for

the breakdown of waste material. Sea level rise will likely require significant investments to retrofit or relocate some sewage treatment plants. Although the Commission s law requires that new fill such as intake structures must minimize impacts to water quality the San Francisco Bay Regional Water uality Control Board has primary authority over water quality in the Bay.

Flood Control Channels. n addition to the rivers and creeks that feed the bay there are a number of flood control channels that drain upland areas. Sea level rise and potential changes in the precipitation patterns may alter the flow dynamics of these channels. With higher Bay water levels and more extreme storm events Bay water will intrude further into flood control channels making it more difficult for fresh water to drain rapidly from upland areas. This will increase flood risks in locations further upstream. More precise identification of upland areas near creeks and flood channels where this type of flooding may occur is needed for addressing future flood risks. Exploring alternative methods of flood control may be necessary.

Contaminated Lands. Prior to BCDC s creation many municipalities filled the Bay for disposal of garbage and waste materials. These landfills contain contaminants and toxins. Some are still in operation while others have reached capacity have been closed and converted to other shoreline land uses such as waterfront parks. Higher sea levels and extreme storm events will cause flooding and erosion or raise ground water levels that may impact the integrity of shoreline landfills and release contaminated leachate adversely impacting ecosystems and public health.

n addition there are a number of shoreline areas that contain contaminated land as a result of past industrial commercial or military uses that were more common along the shoreline over the past century. For example many of the retired shoreline military sites contain contaminated lands that have yet to be fully remediated. Many sites have been remediated with their wastes encapsulated onsite under the assumption that they would remain upland and dry. f these sites become flooded subject to groundwater intrusion or eroded they could release contaminants. While extensive and ongoing efforts have been made to remediate contaminated sites around the Bay it will be imperative to address this issue before contaminated sites begin to be impacted by sea level rise.

Pipelines and Transmission Lines. Numerous pipelines and power transmission lines cross under the Bay cut across wetlands and parallel the shoreline distributing water petroleum and energy. Transmission towers sit on footings within the Bay which must be constructed at

elevations so that towers are either above high tide or can withstand increased exposure to corrosive salt water. The footings must also be engineered keep towers standing through extreme storm events.

Pipelines carry petroleum products across important wetlands including the Suisun Marsh one of the largest habitats on the Pacific Flyway which is at great risk of flooding under both the 16-inch and 55-inch scenarios. n 2004 a 14-inch-in-diameter pipeline ruptured and discharged 123 774 gallons of diesel fuel oil into the marsh damaging approximately 224 acres (0.3 square miles) and injuring a variety of birds small mammals fish reptiles and aquatic and terrestrial invertebrates (inder Morgan 2008). The California Department of Fish and Game s Office of Oil Spill Prevention and Response (OSPR) was instrumental in containing the spill. To prevent future pipeline spills that could be caused by rising sea level OSPR and regulatory agencies must ensure that pipelines traversing the Bay wetlands and vulnerable uplands are retrofitted to withstand higher water levels or relocated.

The Regional Transportation Network

The Bay Area relies heavily upon its transportation network. Central to the quality of life enjoyed by residents and the region s overall economic prosperity is an interconnected network of railroads major roads and highways BART ferries and bicycle lanes. These transportation elements allow for the movement of goods within the region and with domestic and international trading partners while providing mobility to residents by getting them from their houses to their jobs families friends and to recreational areas. Residents travel within the region by a variety of modes. n 2000 83 percent of all trips within the region were made by auto 10 percent by walking 5 percent by transit and 2 percent by bicycle (MTC staff 2009).

Transportation-dependent industries such as ports and airports employ almost half of the workers in the region. Goods-producing businesses spent approximately 8.6 billion on transportation in 2000 (MTC 2004). The major roads and highways and rail network serve to link the regional ports and airports with inland markets including the important Central alley agricultural economy. Projections for goods movement within the Central Corridor indicate that by 2016 goods movement along the corridor is projected to grow to approximately 90 million tons and will be valued at 101 billion (TC F/MTC 2008).

The transportation network also provides mobility to residents and includes the Bay Area Rapid Transit (BART) system the regional rail and ferry network sidewalks trails and a regional bike network. The BART system spans 104 miles contains 43 stations and carries an average of 357 000 riders every week (BART 2008). Passenger rail service is provided by a number of operators including Amtrak Altamont Commuter Express (ACE) and Caltrain. Ferry service is provided by the Golden Gate Highway Transportation District Blue and Gold Fleet

allejo Baylink and Harbor Bay Maritime. As of 2001 annual ferry ridership exceeded over 4 000 000 passengers and has been steadily increasing in the last decade (WTA 2003). Bicycling within the region has also been increasing and a network of bike lanes is being linked to the public transportation network. Certain Bay Area cities have higher percentages of bike ridership including Berkeley (4.9 percent) and Palo Alto (5.8 percent) when compared with the rest of the nation (0.1 percent) (U.S Census Bureau 2000 and MTC 2001).

Major Roadways and Highways. Although the Bay is an essential part of life in the Bay Area it is sometimes viewed an impediment to the mobility of goods (BCDC 2005) requiring bridges to cross its water and long stretches of highway to traverse the shoreline. Trucks move most goods within the region making major roads and highways a critical component of the goods movement network. This network supports local businesses that require delivery of supplies for production and finished products to consumers. Goods producing industries contribute 213 billion to the regional economy and account for 37 percent of the region s industrial output (MTC 2004). Many of the major nodes of the goods movement network such as ports and airports are situated on the shoreline and are connected to producers and consumers via the road network. Four primary road corridors -880 -580 -80 and U.S. 101 handle 80 percent of the goods movement within the region. These roadways serve to link the major economic centers of the region including San Francisco Oakland San ose and Silicon alley thus providing mobility to the region s work force while also providing access to region s open space and myriad recreational opportunities.

The regional road and highway network is highly congested and many critical components of the network need repair. The congestion on Bay Area freeways as measured by the daily vehicle hours of delay has increased significantly from approximately 25 000 hours in 1981 to just over 160 000 (Caltrans District 4 H COMP 2008). Many of the major roads and highways such as -80 in Berkeley and U.S. 101 in the South Bay are situated between highly urbanized communities and / or critical infrastructure and the Bay which constrains options for the expansion of the existing network. n other parts of the region such as Highway 37 in the North Bay the major roads and highways traverse the Bay and sensitive wetland communities. Avoiding adverse impacts on Bay resources creates additional challenges and constraints for road expansion and maintenance projects to address the current maintenance needs and relieve congestion.

San Francisco Bay
Conservation and Development Commission

Figure 2.7

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Port and Water-Related Industry

Airport

Waterfront Park, Beach

Major Roads and Highways

BART

Railroad

Grizzly Bay Transportation Network and Shoreline Priority Use Areas Potentially Exposed to Sea Level Rise

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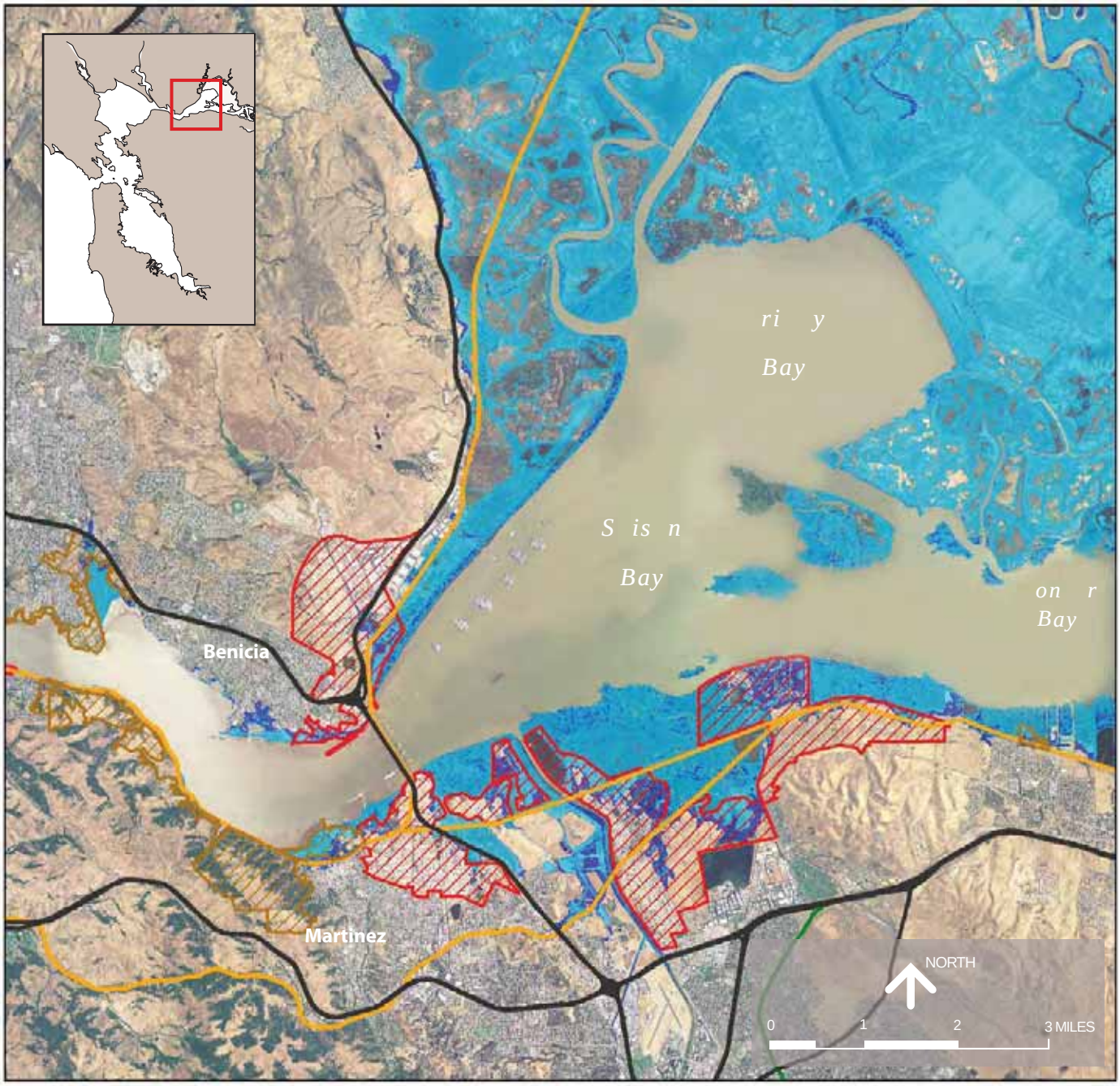


Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; BCDC, 2009; MTC, 2009.

Figure 2.8 Typical Section: Highway Adjacent to the Bay

Source: BCDC

Because of their proximity to the Bay many of the major roads and highways within the region may be significantly impacted by sea level rise and extreme flooding events. Approximately 99 miles of the major roads and highways within the region are potentially exposed to a 16-inch rise in Bay water levels and approximately 186 miles of major roads and highways are potentially exposed to a 55-inch rise. nterstate 880 along the eastern shoreline of the South Bay U.S. 101 in Santa Clara San Mateo and Marin Counties Highway 37 in the North Bay -680 and Highway 12 in Solano County include significant portions of roadway that are potentially exposed to flooding (Figure 2.5-2.7).

Many roads and highways will be subject to secondary impacts from sea level rise. For example much of 1-80 along the Berkeley and Albany shoreline is not directly subject to flooding due to the existing elevation of the roadway (Figure 2.8). However erosion from increased storm activity can undermine existing protective and / or highway structures which can substantially increase the cost of maintaining the highway. Other secondary impacts may occur where traffic from one impacted road is diverted onto another road. ncreased construction activity that is necessary to make transportation infrastructure more resilient to sea level rise can cause more congestion and impact residential communities adjacent to roadways. Congestion causes delays in the movement of goods throughout the region and adds time to residents already lengthy commutes. Finally the supporting structures of many of the region s bridges may be susceptible to unanticipated prolonged contact with corrosive salt water.

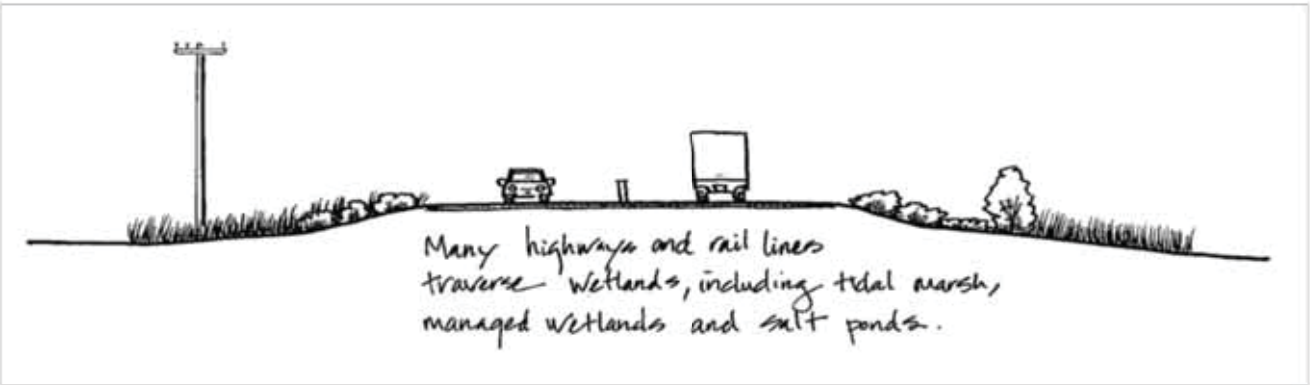
Rail Network. The regional rail network has more than 600 miles of track moves vast quantities of freight and passengers and links the region with the Central alley and inland areas (BCDC 2005). Leading products moved by the rail system include steel waste scrap petroleum products crushed stone and automobiles. (MTC 2004). Freight service is provided by two Class rail carriers Union Pacific (UP) which links the region with Roseville and the

Central alley and Burlington Northern Santa Fe (BNSF) which links the region to Stockton and beyond. Many water-related industries including oil refineries and auto terminals located along the shoreline of the East Bay rely heavily upon rail service. There are a number of locations along the rail network that link multiple transportation sectors. For example intermodal areas are located near the Ports of Richmond and Oakland. These ports rely heavily on rail to transport inbound cargo containers to inland processing and manufacturing locations. Likewise the rail network serves to bring cargo from inland locations for export to trading partners.

Passenger service links the major jobs centers in San Francisco Oakland and San ose with other Bay Area cities and towns and with inland cities in the Central alley such as Sacramento and Stockton. The primary passenger rail service providers include Bay Area Rapid Transit (BART) San Francisco MUN Caltrain Amtrak s Capitol Corridor and Altamont Commuter Express (ACE). BART is an especially critical component of the region s passenger rail network providing commuter service for residents in Alameda Contra Costa San Francisco and San Mateo counties.

Figure 2.9 Typical Section: Highway or Rail Line Through Wetlands

Source: BCDC



Except for BART and MUN Bay Area railroads use the same tracks for both passenger and freight service which creates significant congestion. At-grade rail crossings slow traffic on rail and surface roads. Furthermore freight demand is expected to grow upwards of 350 percent over the next 50 years (MTC 2007) and many of the rail lines are in highly urbanized areas where options for major modifications or expansion are limited. Other stretches of rail are bordered by sensitive Bay habitats and ecological communities which further constrain options for rail expansion (Figure 2.9).

Approximately 70 miles of railroad are potentially exposed to flooding or permanent inundation with a sea level rise of 16-inches while 105 miles are potentially exposed to a 55-inch sea level rise. The rail segments that are particularly vulnerable to flooding include the Central Corridor where it passes through the Suisun Marsh (Figures 2.7) the tracks along the northern Contra Costa shoreline near Martinez the Caltrain corridor on the Peninsula the ACE and Capitol Corridor in the South Bay. Because these rail segments are shared by multiple users and already experience congestion flooding could paralyze rail service regionwide. The economic impacts of a system-wide rail failure would be staggering. Furthermore protection of this infrastructure from sea level rise will also be costly and may require funds to be redirected from projects that address current pressures on the system.

Waterfront Parks and Beaches

Waterfront parks and beaches promote enjoyment of the Bay the region s most important open space and enhance the quality of life for Bay Area residents. Recreation on the shoreline and in the Bay foster a life-long bond between residents and the Bay improves their health and provides a respite from the stress of living in a crowded high-paced urban environment (BCDC 2006). Recreational opportunities can be found at beaches parks marinas shoreline trails and water trails boat launches and fishing piers. People use waterfront parks beaches and public access to hike bicycle kayak swim fish or just watch the sunset.

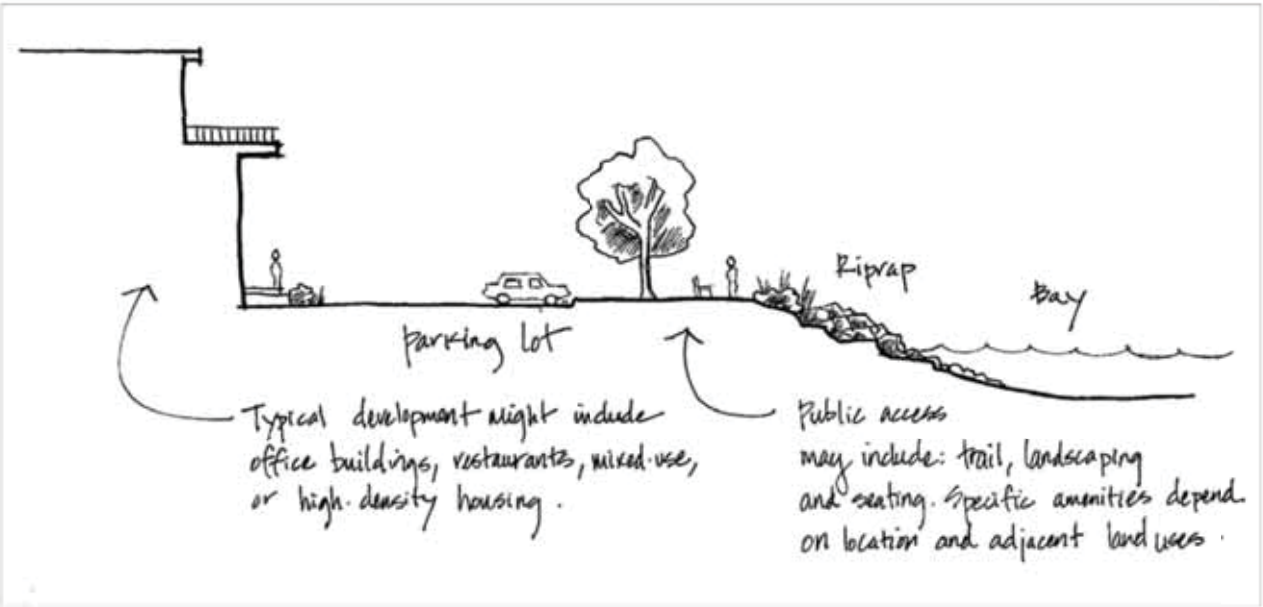
The region has an average of approximately 95 acres (0.1 square miles) of open space per 1 000 residents much of which is located in hills surrounding the Bay (BCDC 2006). Available open space and recreational lands may not be able to keep pace with the region s growing population. n the 1990 s population grew at two percent while the addition to the open space only grew at 1.1 to 1.6 percent per year (Bay Area Open Space Council 1999). Creating shoreline recreational opportunities that reflect the diversity in race culture age and income levels is another important challenge. Some communities particularly on heavily urbanized parts of the shoreline lack sufficient open space and recreational lands. Many of the waterfront parks and beaches are the most accessible recreation areas to the highly urbanized and diverse communities along the shoreline. Prospects for expanding shoreline and Bay recreational opportunities are further limited by their proximity to sensitive habitat the cost of purchasing shoreline property and the long-term maintenance and operations expenses. n many cases remediation of contaminants may also increase the costs of converting some sites to waterfront parks.

Approximately 23 000 acres (35 square miles) are designated in the *San Francisco Bay Plan* as waterfront parks and beaches. Approximately 3 250 acres (5 square miles) or 14 percent of the region s waterfront park and beach areas are located in areas potentially exposed to flooding or

permanent inundation with a 16-inch sea level rise. A 55- inch sea level rise would potentially impact approximately 4 300 acres (6 square miles) or 18 percent of the region s waterfront parks and beaches. As sea level rises it will become more costly to maintain existing waterfront park and beach areas as well as to provide new recreational opportunities to meet the demands of a growing population. Furthermore use of shoreline areas may increase as temperature increases result in more high-heat days. Finally providing recreational opportunities along the shoreline that do not adversely impact sensitive ecological communities will likely contribute to the challenges of providing and maintaining shoreline recreational opportunities in the future especially if sea level rise reduces the viability of Bay habitats.

Figure 2.10 Typical Section: Public Access

Source: BCDC



Public Access Required by BCDC

Another defining feature of the region s shoreline is the abundant and diverse public access opportunities that ring the Bay. Public access includes physical access to and along the shoreline as well as visual public access to the Bay from other public spaces. Shoreline public access includes waterfront parks promenades piers trails plazas overlooks and connections linking public streets to the Bay. BCDC has required shoreline public access as part of shoreline development since 1969. Every proposed shoreline development must provide maximum feasible public access consistent with a proposed project. As a result of BCDC permit requirements there are 700 sites that provide over 300 miles of public access to and along the

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Public access required by BCDC

Central Bay North Public Access Required by BCDC Potentially Exposed To Sea Level Rise

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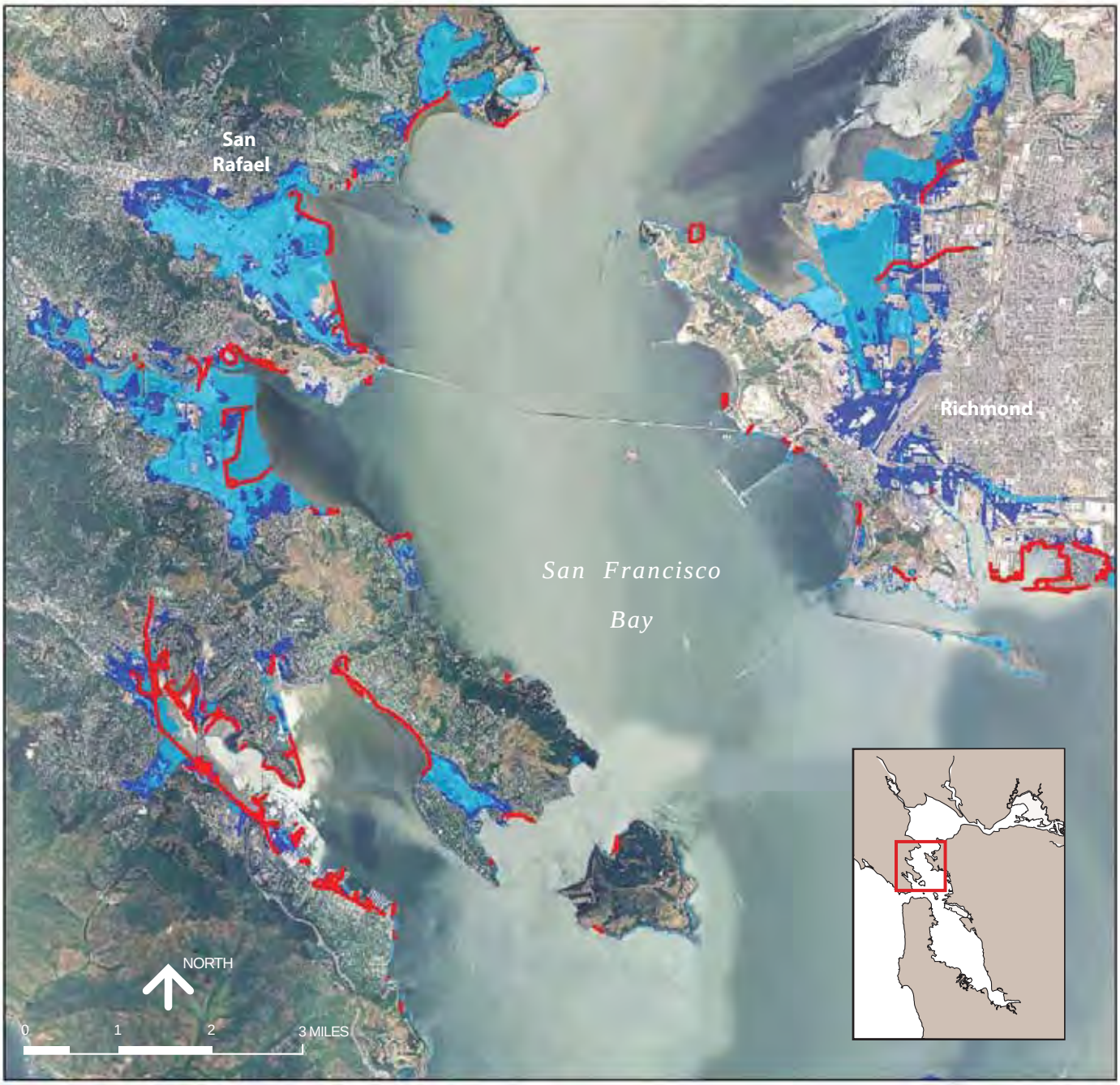

Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; BCDC, 2009.

Figure 2.12

Area potentially exposed to an approximate 16-inch sea level rise

Area potentially exposed to an approximate 55-inch sea level rise

Public access required by BCDC

Central Bay West Shore Public Access Required by BCDC Potentially Exposed To Sea Level Rise

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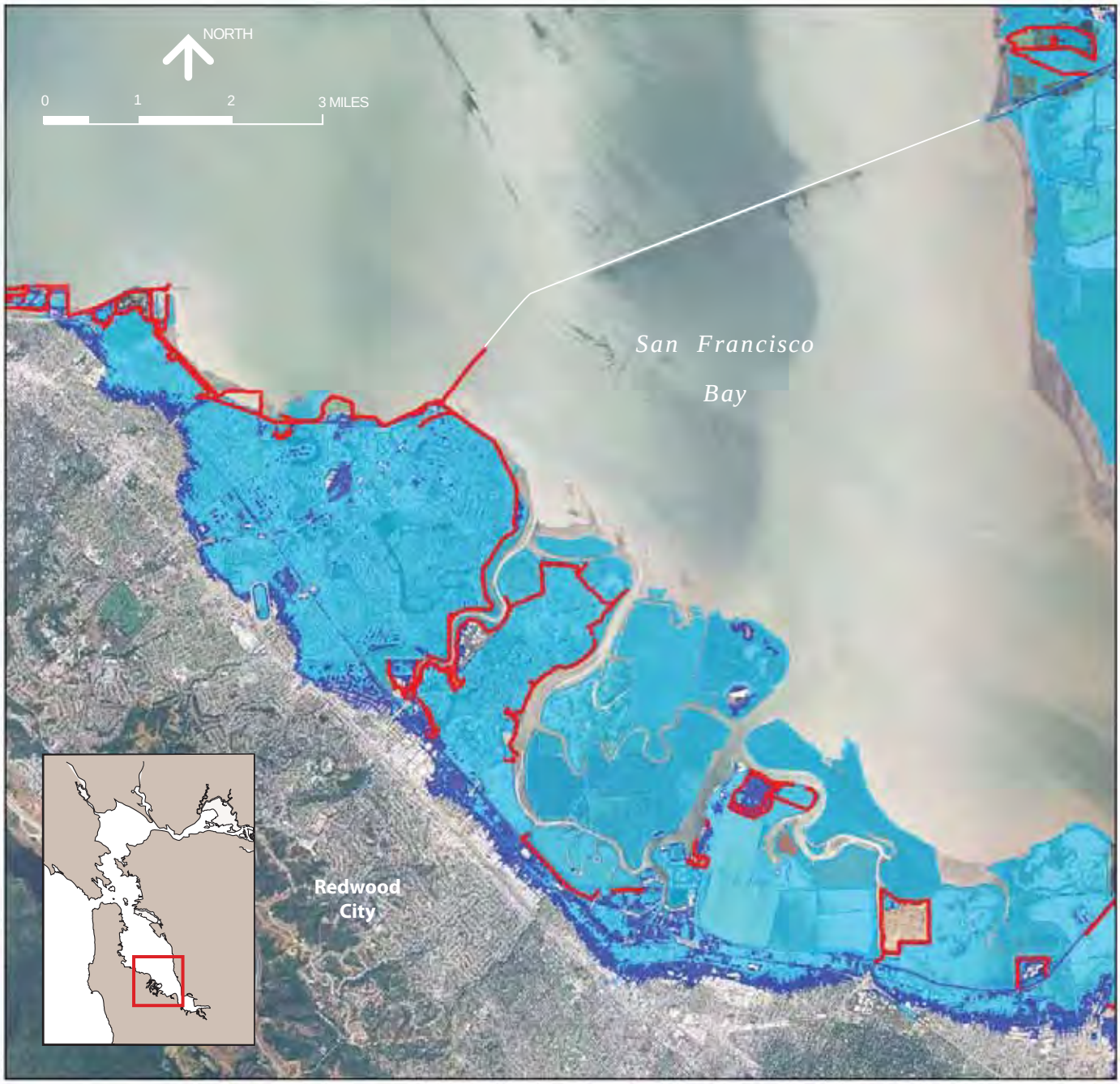


Sea level rise data provided by:

SOURCE: Knowles, N. 2008. Siegel, S.W. and P. A. M. Bachand, 2002; BCDC, 2009.

approximately 1 000 miles of Bay shoreline. Public access generates regional benefits that are similar to waterfront parks and beaches. However public access areas are usually smaller and associated with some type of development (Figure 2.10).

Many of the public access areas required by BCDC are also components of the San Francisco Bay Trail which is a project to provide a recreational trail around the entire Bay. Some of the public access required by BCDC is part of a network of trailheads providing on-water access for non-motorized small boats and sail craft the San Francisco Bay Area Water Trail.

The vast majority of public access is located within the Commission s 100-foot shoreline band jurisdiction (100 feet from the Bay) and therefore potentially exposed to flooding from sea level rise and storm activity. Over 400 public access sites or approximately 57 percent are located in areas that are potentially exposed to a 16-inch increase in sea level rise. Over 616 locations approximately 87 percent are located in areas exposed to a 55-inch increase in sea level rise (Figures 2.11 and 2.12). Public access located on elevated structures such as fishing piers bridges and wharves is not included in these estimates. The impacts to elevated public access features will largely depend on factors such as their design and construction as well as the resilience of the adjacent shoreline.

The increased likelihood of flooding will require difficult choices regarding the location design and maintenance of existing and future public access. n urban areas locating public access further inland may not be feasible. n open space areas wildlife communities require adequate space and buffers to respond to sea level rise which will further constrain public access siting and design options. Where structural shoreline protection is required raising existing or constructing new structures may block physical and visual access to the Bay especially where land has subsided. Access stairs or ramps to the top of shoreline protection structures may be necessary to provide access to the Bay. However stairs or ramps may not satisfy the requirement to provide barrier-free public access to all and new shoreline protection structures that also support public access will have to be designed with the needs of people with disabilities in mind. The widespread impacts to the region s existing public access will limit opportunities to provide a sense of visual continuity and connectedness for public access.

Summary and Conclusions

Residents businesses and entire industries that currently thrive on the shoreline are subject to flooding by the middle of the century and probably earlier. By mid-century shoreline development located in the current 100-year flood plain will be subject to flooding from not just a 100-year flood but from a high tide. A summary of these vulnerabilities is provided in Table 2.3. Approximately half of that development is residential totaling 66 000 acres (103 square

miles). Over 82 000 acres (128 square miles) of residential development is potentially exposed to flooding by the end of the century. Where residents are not directly vulnerable to flooding access to important services such as commercial centers health care and schools would likely be impeded by flooding of the service centers or the transportation infrastructure that links

Table 2.3 Summary of Shoreline Vulnerabilities

Shoreline Uses	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Residential	Significant residential acreage and disproportion-ate amount of low-income residents.	Widespread flooding of approximately 270,000 residents and 82,000 residential acres (128 square miles).	High- Lost investments and/or relocating residents has major financial and social repercussions. Low-income residents are especially sensitive.	Medium- for those with the resources. Low- for low-income residents.	High
Airports	Subsided runways at SFO. Difficulty moving goods on land from SFO & OAK.	Flooding of 72-93% of acreage for airport operations. Secondary impacts to ground movement of cargo and passengers from flooding of transportation network.	High- Airports are critical to the regional economy. They are especially sensitive to primary and secondary impacts of flooding.	High- Shoreline protection for runways and upgrading important ground transportation is costly, but would likely be a high regional priority.	Medium-High
Ports	Difficulty moving goods via highways and rail.	Moderate flooding of ports (4-20% of total acreage). Most flooding impacts regional goods movement.	Medium-High- Ports are central to the regional economy. Rail lines and highways essential to goods movement are sensitive to flooding.	Medium- Goods movement is central to port activities. Ports are unlikely to be burdened with the cost of transportation infrastructure.	Medium-High
Water-related Industry	High business costs and job loss. Competing shoreline uses.	Localized flooding, that is especially troubling for individual sites (16-28 percent of total acreage)	Medium- The industry is already losing jobs, but flooding is localized rather than widespread.	Medium- Flood damage or new shoreline protection would be concentrated in a few areas.	Medium

Continuation of Table 2.3 Summary of Shoreline Vulnerabilities

Shoreline Uses Continued	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Major Roads and Highways	Congested and in need of repairs.	Widespread flooding (99-186 miles), including key highways and interchanges.	High- Many highways are adjacent to the Bay and cross the Bay. Flooding projected on some key passenger and truck routes.	Medium- Current congestion and maintenance issues make costly adaptations difficult.	High
Rail	Congested with multiple users sharing single tracks.	Widespread flooding (70-105 miles of track), including key segments.	High- Rail lines carry passengers and freight, are located on low-lying lands, and wetlands. Freight demand projected to grow	Low- Current location of tracks limits options for expansion or modifications..	High
Waterfront Parks and Beaches	Bay Area population is growing faster than recreational opportunities. Expensive shoreline property limits potential conversion to waterfront parks.	Moderate flooding relative to other shoreline uses (14-18 percent of waterfront parks). Beaches receive widespread flooding.	Medium- Waterfront parks provide a unique experience that requires a shoreline location, but will experience moderate flooding.	Low There are few available locations for waterfront parks.	Medium-High
Public Access	Public access is required on a project-by-project basis, making regional coordination challenging.	Widespread flooding of most public access (57-87 percent of public access sites).	High- Public access is not currently designed or sited to address flooding.	Low- Public access is unique to the shoreline. As the shoreline moves, public access must be designed to move with it, but upland movement may be blocked by development.	High

them. Rising sea levels can impact the delivery of petroleum products electricity and drinking water to Bay Area residents and businesses. The range of impacts can be more difficult for low-income residents because they generally have less financial flexibility and fewer resources to pursue alternative housing and transportation.

Water quality will suffer if wastewater treatment facilities landfills or contaminated sites are flooded from sea level rise and storm activity. Compromised water quality and higher temperatures can result in algal blooms and a higher potential for the spread of water-born vectors.

Large commercial and industrial areas are vulnerable to flooding especially in San Francisco Silicon alley and Oakland. Approximately 72 percent of the San Francisco and Oakland airports is potentially exposed to a 16-inch sea level rise and 93 percent is potentially exposed to 55 inches of sea level rise which can disrupt the transport of as much as 30 million passengers and approximately one million metric tons of cargo. Flooding of highway segments in the regional transportation network can disrupt the movement of goods from ports which handled approximately 25 millions metric tons of cargo in 2007-2008. Other water-related industries would be similarly affected. Flooding of the rail system would be particularly serious since multiple users share a single line in most locations around the Bay.

The Bay is a magnificent body of water that helps sustain the economy of the western United States provides great opportunities for recreation nourishes fish and wildlife affords scenic enjoyment and in countless other ways helps to enrich our lives (Bay Plan 2008). t is central to many activities in the region whether traveling by car or rail along the shoreline landing at an airport strolling along the shoreline or watching the fog stream in on a summer s day. Waterfront parks and public access provide opportunities to enjoy the Bay and remind us of its place in the region. There are 23 000 acres (35 square miles) of waterfront parks of which 14 percent is vulnerable under the lower scenario and 18 percent is vulnerable under the higher scenario. Fifty-seven percent of the public access required by BCDC is vulnerable under the low scenario and 87 percent is vulnerable under the high scenario. The decline of waterfront recreational opportunities will impact the quality of life in the Bay Area and could affect the region s deep connection to the Bay.

To address the widespread flooding from storm activity and sea level rise shoreline protection projects will be needed. Shoreline protection can be structural natural or a combination of both. Choosing the appropriate form of shoreline protection one that both protects public safety and minimizes ecosystem impacts is critically important. n the long-term the region needs to engage in an open and vigorous public dialogue to make the difficult decisions about what to protect and where and what kind of new development is appropriate in vulnerable areas and areas where further development should be avoided.

CHAPTER 3
The San Francisco Bay Ecosystem

San Francisco Bay the largest estuary along the Pacific shore of North and South America is constrained in its ability to adapt to climate change by the intensity of human uses in and around the Bay. The close proximity of urban and industrial development to the Bay dramatically reduces the adaptive capacity of the ecosystem and limits the potential for restoring additional habitats that could otherwise compensate for altered temperature salinity and sediment systems. The Bay provides many benefits to the surrounding human community while supporting numerous plants animals and migratory birds who feed on fish and shellfish (BCDC 2002). Maintaining these ecosystem benefits must be a key element of the region s climate change adaptation strategy.

Tidal wetlands provide critical flood protection and improve water quality by reducing and preventing shoreline erosion and filtering pollutants from surrounding areas. Tidal wetlands also store carbon in their soils (Mitch and Gosselink 2000 Trulio et al. 2007) which may help to mitigate climate change by sequestering GHGs. Tidal salt marshes in the South Bay sequester between 54-385 grams of carbon per square meter per year (Patrick and DeLaune 1990) an amount equivalent to at least 6 000 gallons of gasoline emissions (EPA 2005). Greco sland one of the oldest tidal salt marshes in the Bay sequesters 150-250 grams of carbon per square meter per year and has been doing so for at least 100 years (Callaway and Drexler unpublished cited in Trulio et al. 2007).

n many locations humans have altered degraded or eliminated these ecosystem benefits. Roads levees dredging and urban development have fragmented and destroyed much of the once contiguous shoreline habitats of the Bay. Sand mining shell mining and dredging activities have altered subtidal habitats. There are now 40 000 acres (62 square miles) of tidal marsh a reduction of 80 percent since the late 1800s. Similarly tidal flats have been reduced up to 60 percent to 29 000 acres (45 square miles) from bay fill and erosion. Only seven out of an estimated 23 miles of former sandy beaches remain (Goals 1999).

The existing Bay ecosystem is largely a managed environment. Elements of the Bay ecosystem continue to withstand pressures from climate change and human alteration exhibiting remarkable resiliency. The adaptive capacity of the Bay ecosystem to withstand the rapid climate changes predicted for the next century depends both on the magnitude of impacts resulting from climate change and the management actions taken in response to those impacts. Further habitat loss resulting from climate change and future construction of levees and other

flood protection infrastructure along the shoreline would threaten the survival of critically endangered species and natural communities. The challenge is to preserve the appropriate amount and diversity of habitats to maintain healthy species populations while at the same time finding sustainable flood protection solutions for shoreline development and industry. Retaining the benefits that the Bay ecosystem provides will require a new management approach that recognizes the dynamic nature of the ecosystem. While past management strategies for the Bay ecosystem focused on conserving a static ecosystem or restoring a previous ecological state new strategies must be based on anticipating future conditions such as accelerating sea level rise and implementing adaptive management as the ecosystem evolves over time.

Sea Level Rise in the Bay Ecosystem

Under current sea level conditions the ebb and flow of the tides inundates the intertidal mudflats (tidal flats) and low to middle tidal marshes at the edge of the Bay on a regular basis while storms and other extreme weather events cause occasional flooding of high marsh and upland areas. Low-lying areas behind levees also are flooded occasionally when levees are overtopped or fail due to storms earthquakes or burrowing animals. The lower of the two sea level rise scenarios (16 inches) is sufficient to impact 90 to 95 percent of the existing tidal marshes and tidal flats by changing the frequency and duration of inundation. Of these tidal marsh areas almost 20 percent exist lower in the tidal zone which makes them vulnerable to permanent submersion and erosion (PWA and Faber 2004 Pacific nstitute 2009). A 16-inch rise in sea level would also permanently flood approximately 70 to 75 percent of the subsided wetlands in Suisun Marsh if their fragile levees were to fail. The few remaining beaches (about 45 acres or 0.07 square miles) on the margin of the Central Bay are all vulnerable to sea level rise. ncreased frequency and duration of inundation in some areas and permanent flooding of other areas induced by sea level rise would initiate a number of complex physical ecological and biological responses in estuarine ecosystems which when combined with other impacts of climate change would increase the vulnerability of the Bay ecosystem. While wetlands can adapt to sea level rise given sufficient sediment and room to migrate armoring of the shoreline and other human impacts may hamper or prevent this and result in more loss of tidal marsh habitats.

Constraints to Wetland Adaptation. The shape of the Bay-Delta estuary formed over the past 3 000 years in response to gradual sea level rise and the circulation of sediment by tides waves and inflowing rivers (Byrne et al. 2001 Wells and Gorman 1994 Atwater 1979). The Bay-Delta estuary now supports a mosaic of habitats extending from the subtidal water column where fish live to the tidal flats and tidal marshes. Tidal wetlands not only protect the shoreline from the flooding and erosive effects of storms but also provide a setting for the surrounding communities to connect with the Bay ecosystem. Accelerated rates of sea level rise may outpace sedimentation in tidal flats and tidal marshes which would lead to erosion and drowning of these habitats in the Bay-Delta estuary.

Tidal flats in the Bay are already eroding as a result of insufficient volumes of sediment from tributary watersheds. The area of tidal flats in the North Bay decreased by 68 000 acres (106 square miles) over the period from 1951-1983 and 4 500 acres (7 square miles) in the South Bay between 1858 and 2005 (affe et al. 2007 affe and Foxgrover 2006). The decline in sediment flowing into the Bay is the result of dam construction flood control water diversions and other management actions in the tributary watersheds.

Early studies estimate as much as 80 to 90 percent of the sediment reaching the Bay came from the Sacramento and San oaquin rivers (rone 1979 Porterfield 1980). During the Gold Rush era hydraulic mining in the Sacramento and San oaquin watersheds resulted in approximately 590 million cubic yards of sediment being deposited in the Bay and a 60 percent increase in the area of tidal flats over the period from 1856 to 1887 (affe et al. 2007). Much of this mining sediment contains mercury which was used to extract gold and is now widespread in Bay sediment. Under some conditions such as increased acidity the inorganic mercury in this sediment can be converted to methylmercury a highly toxic form.

n 1884 the California Supreme Court (Sawyer Decision) outlawed the discharge of mine tailings to rivers. This decision dramatically reduced the volume of sediment that was coming from the Sacramento and San oaquin watersheds by the early 1900s (Porterfield 1980) despite the ongoing logging urbanization and agricultural development activities that typically cause soil erosion. A primary cause for the continued sediment decline during the 20th century was the construction of dams for water supply that prevented sediment from reaching the Bay (rone 1979 Ogden Beeman and Associates and rone and Associates 1992).

From the 1940s to the 1970s the damming of rivers trapped sediment in both the Sacramento and San oaquin watersheds and local tributaries of the Bay (e.g. Napa River Sonoma River and Alameda Creek). Damming also reduced flood flows limiting the capacity of rivers to transport sediment from the Delta to the Bay (Porterfield 1980 Mc ee et al. 2006

Wright and Schoellhammer 2004). Now research demonstrates that sediment from local tributaries to the Bay may constitute as much as 43 percent of the annual sediment delivered to the North Bay (Mc ee et al. 2006) and the loss of tidal flats is an indication that the Bay watersheds are contributing less sediment.

Subsidence of diked areas further complicates the restoration of tidal wetlands which would aid the Bay s ability to adapt to sea level rise. Sites planned for tidal marsh restoration are in many cases subsided two to six feet below mean sea level (e.g. South San Francisco Bay Suisun Marsh) (PWA and Faber 2004 Watson 2004 Poland reland 1969 Orr et al. 2003) which is substantially lower than the elevation at which marsh plants usually grow. A fundamental component of tidal marsh restoration is the recruitment of native plants which thrive under specific flooding conditions that are controlled by their elevation with respect to the tides. The target elevation can be achieved by placing dredged material on site or by promoting natural sediment deposition through re-suspension and transport of muddy sediment from tidal flats. Once an adequate elevation is reached marsh plants tend to colonize the site and initiate organic matter accumulation which aids the tidal marsh in keeping up with sea level rise (PWA and Faber 2004 Orr et al. 2003). Regional partnerships such as the Long-Term Management Strategy (LTMS) for dredged material from the San Francisco Bay Area (LTMS Plan 2001) are already working to address the decline in sediment supply by maximizing the beneficial use of dredged material for wetland restoration.

However higher rates of sea level rise may jeopardize efforts to restore tidal wetlands and maintain the current form of the Bay-Delta estuary. Erosion of subtidal areas may also expose mercury-laden sediment and impact circulation patterns in the Central Bay possibly contributing to scour of bottom sediment a primary physical control on habitats in subtidal regions of the Bay (NOAA 2007). The erosion of tidal flats and tidal marshes would result in additional loss of recreational flood protection and water quality benefits.

n order for estuarine migration to occur gently sloping areas of transitional habitat containing a combination of wetland and upland features are needed. These wetland-upland transition zones are high in species diversity and also provide refuge for endangered species like the salt marsh harvest mouse and the California clapper rail during high tides. These areas could potentially evolve into tidal marsh habitat as sea level rises. However wetland-upland transition zones have been almost entirely eliminated due to development of the Bay shoreline in close proximity to the upland edge of tidal habitats. n many areas the wetland-upland transition zone consists of only a few feet of vegetation along the steeply sloping side of a levee.

Salinity Change in Tidal and Subtidal Habitats. Higher salinity due to climate change will stress plant communities and species of concern in the Bay and some may not thrive or persist in the face of this impact (Callaway et al. 2007 Spalding and Hester 2007). Climate change has the potential to impact estuarine salinity in three main ways: (1) changes in total precipitation (2) changes in seasonal patterns of precipitation and runoff i.e. a shift from snow to rain and earlier snowmelt and (3) sea level rise.

These salinity shifts may be moderated or exacerbated by management of reservoirs and water diversions (Callaway et al. 2007). Water managers rely on freshwater conditions in the Delta to preserve drinking water supplies for the growing populations of the Bay Area and Southern California as well as the agricultural lands and brackish habitats of Suisun Marsh. These goals are accomplished by releasing water from reservoirs during spring summer and autumn when there is less rainfall and higher temperatures.

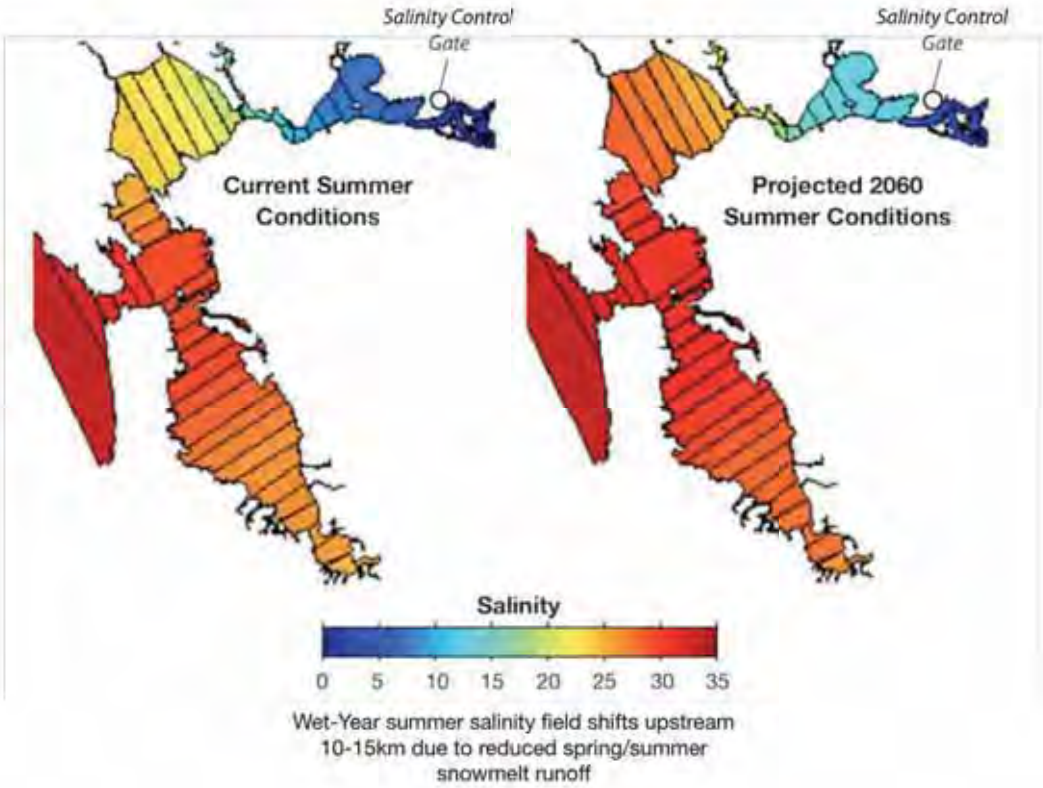
California s water reservoirs are designed with the assumption that a large portion of the state s water will be stored in the snowpack. Warmer temperatures associated with climate change are projected to result in more precipitation falling as rain instead of snow in the winter causing a 50 percent loss of the Sierra snowpack by 2090. Warmer temperatures will also melt the snowpack earlier in the year (Figure 3.1) (nowles and Cayan 2002). Earlier snowmelt would require water managers to release excess water from reservoirs causing more water to flow into the Suisun Marsh and the Bay following winter storms and reducing flows at other times of the year (Barnett et al. 2008). For example spring flows (April- une) are expected to decline from 36 percent of total annual flow in 2030 to 20 percent of total annual flow in 2090 (nowles and Cayan 2002).

The shift in freshwater flows from spring to winter is projected to increase salinity in the South Bay San Pablo Bay and especially Suisun Marsh (nowles and Cayan 2002). nfrequent flushing from the tides in high marsh areas especially during summer months make these areas particularly vulnerable to salinity shifts (Callaway et al. 2007). High marsh areas are particularly important because they contain many of the rare and endangered species that are found in California tidal marshes (Baye et al. 2000).

Salinity increases due to climate change may dramatically impact the brackish and freshwater marshes found in Suisun Marsh and near the confluence with Bay tributaries. Since brackish and freshwater tidal marshes tend to be more productive and provide habitat for a greater diversity of plants than salt marshes elimination of these valuable wetlands or their conversion to salt marshes could reduce the habitat available to rare and endangered species (Callaway et al. 2007 Newcombe and Mason 1972 Baye et al. 2000 Lyons et al. 2005).

Figure 3.1 Salinity Change in San Francisco Bay

SOURCE: Dr. Noah Knowles, USGS

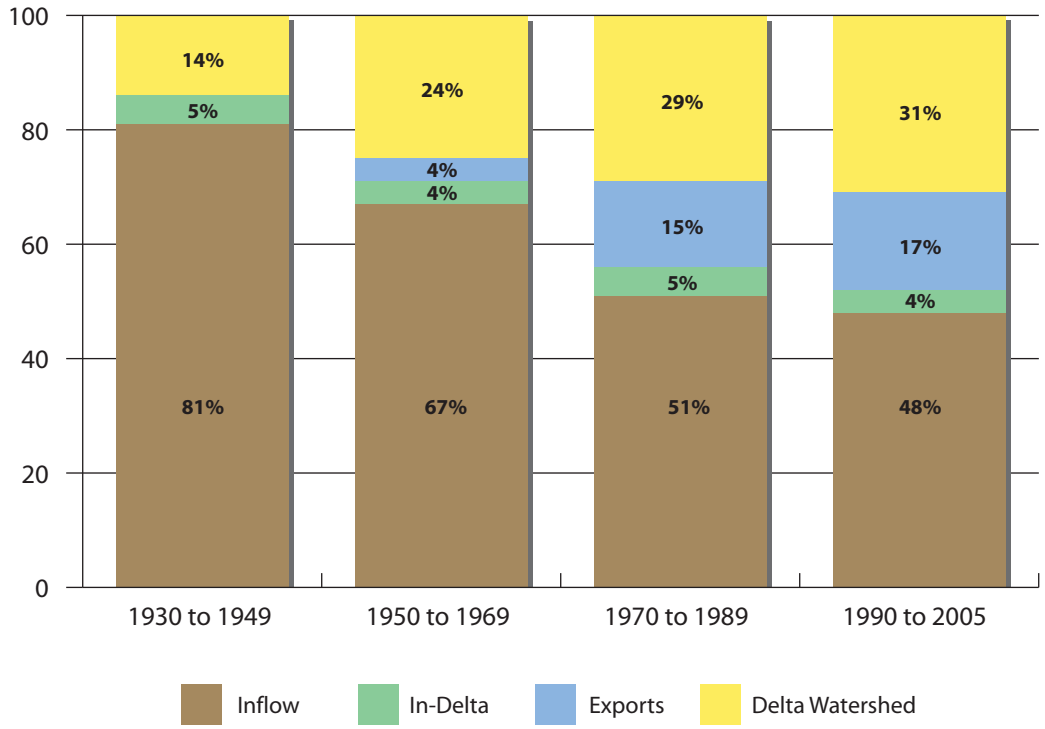


Efforts to use water control structures such as salinity gates to artificially reduce salinity in Suisun Marsh in dry years are likely to become increasingly difficult in the face of climate change. The Suisun Marsh Salinity Control Gates (Figure 3.2) restrict the flow of higher salinity water from incoming tides and retain low-saline Sacramento River water from the previous outgoing tide. An eastward shift of the salinity gradient caused by sea level rise will likely reduce opportunities for importing freshwater into the Suisun Marsh.

These impacts from climate change heighten an already complex debate over water management. Exports from the Sacramento-San oaquin Delta (Delta) by the state and federal water projects water use in the Delta watershed and in-Delta water use have reduced the total volume of water entering the Bay. Flows from the Delta account for about 90 percent of freshwater flows to the Bay while ten percent of flows come from the watersheds surrounding the Bay (San Francisco Estuary Project Aquatic Habitat nstitute 1991). A comparison of annual averages from the years 1930-1949 and the years 1990-2005 shows that inflow from the Delta to the Bay has been reduced from 81 percent to 48 percent of total flows (Figure 3.2) (Delta ision 2008).

Figure 3.2 Changes to Freshwater Inflow to the Estuary

SOURCE: Delta Vision 2008



To address the impacts of water diversions the United States Environmental Protection Agency (EPA) and United States Fish and Wildlife Service (FWS) established a water quality standard for salinity referred to as 2 to ensure adequate minimum freshwater inflow to the Bay to benefit the reproductive success and survival of the early life stages of many estuarine species[1] (immerer 2002). The 2 measurement corresponds to the upstream location of the mixing zone of fresh and salt water and moves eastward or westward both seasonally and from year-to-year depending on the volume and timing of freshwater inflow. The standards require 2 to be maintained at particular locations within the Delta and Suisun Bay between February and une depending on the amount of precipitation.

The anticipated impacts from climate change and the increasing demand for drinking water and agriculture will limit the ability of water managers to maintain the 2 standard. nability to maintain 2 may contribute to the extinction of fish species some of which are a vital economic resource. Fish such as the threatened Delta smelt and endangered salmon rely on higher flows in winter and spring which may be difficult to maintain with less water available in reservoirs (immerer 2002).

Other Water Quality Impacts

ncreases in air temperature salinity and changes in precipitation and runoff patterns will impact both the Pacific Ocean and the tributaries flowing into the Bay threatening water quality and human health. Warmer air temperatures may prevent cool waters in the Pacific Ocean rich in oxygen and nutrients from circulating to the surface and to various parts of the California coast including the Bay (Roemmich McGowan 1995 Harley et al. 2006). When combined with numerous new and existing pollutants and altered tidal circulation these effects may produce algal blooms resulting in reduced water oxygen levels.

The increased carbon dioxide concentrations in the atmosphere that are causing global warming are also causing the world s oceans to become more acidic. This is because carbon dioxide dissolves into ocean water and increases acidity. Levels of acidity in the ocean may exceed any found in the 200-300 million year fossil record (Caldeira Wickett 2003 Feely et al. 2004 Harley et al. 2006). This impact may endanger most of the world s coral reefs.

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[1] X2 is defined as the distance upstream from the Golden Gate Bridge to the point where daily average salinity at one meter from the bottom is two parts per thousand (assby et al. 1995).

High carbon dioxide levels will increase the acidity of Bay waters as well. Although the effects on the Bay are unknown high levels of acidity may prevent organisms from forming shells and skeletons of calcium carbonate because of a chemical reaction that dissolves calcium carbonate into its constituent ions when acidity is high (Doney et al. 2009). n the Bay it could particularly impact organisms at the base of the food web that form carbonate shells such as bivalves crustaceans and copepods.

Invasive and Migrant Species

The geographic ranges occupied by certain species will shift in response to changing environmental conditions due to climate change. While the impacts of climate change may harm or benefit a particular species the shifting of conditions under which native species evolved will aid invasive species (i.e. non-native species that spread quickly and crowd out native species) or native species that are either better adapted to the changed conditions or more tolerant of a wide range of conditions. For example warmer conditions will make the Bay more hospitable to migrant species from the south and species adapted to a wide range of temperatures will fare better those that require colder conditions to survive.

 nvasive species and expanding populations of some natives can threaten other native species through competition for resources predation parasitism interbreeding with native populations transmitting diseases or causing physical or chemical changes to the invaded habitat (California Natural Resources Agency 2009). Climate change may increase the potential for invasive species to become established and spread in the Bay resulting in a loss of native biodiversity and native species that are vital to our economy (e.g. salmon).

The spread of invasive species would further impact one of the most highly invaded estuaries in the world (Cohen and Carlton 1998). n many cases invasive species are introduced through boat hulls ballast water and intentional introductions for commercial and recreational use. The Asian clam (*or la a r nsis*) was introduced into the northern Bay in the 1980s and through an explosive increase in population replaced the resident clams and began filtering enough algae from the water column to significantly reduce the food available to other species (Carlton et al. 1990).

Two non-native crab species the green crab and Chinese mitten crab contribute to erosion and loss of marsh habitat through burrowing in tidal channels. n addition smooth cordgrass (*S ar ina al rni lora*) can outcompete native cordgrass altering vegetative structure and habitat

for endangered species such as the California clapper rail. The spread of smooth cordgrass to tidal flats may inhibit the exchange of sediment from tidal flats to tidal marshes preventing marsh migration and impacting migratory bird populations.

n addition species that are native to certain parts of the state may migrate to new regions and some resident natives could experience increased population growth that could potentially alter community structure and species interactions (California Natural Resources Agency 2009). Recent population bursts among native corvids (crows and ravens) and California gulls are examples of native species population increases that intensify competition for resources and predation on native species.

n the long run maintaining native biodiversity will require accommodating the movement and migration of multiple native species (California Natural Resources Agency 2009) as well as migrating species. For example preserving the species native to brackish marshes may require creation of habitat corridors that connect these habitats to freshwater marshes which will become brackish over time as salinity moves further inland due to sea level rise.

Threat of Extinction

The Bay ecosystem supports a diverse range of threatened and endangered species. Climate change impacts such as warmer water temperatures and reductions in the amount of tidal marsh are likely to make it harder to recover threatened and endangered species and may cause more species to become threatened and endangered.

The plummeting populations of several species of Delta and North Bay fishes during the early 2000s is referred to as the pelagic (open water) organism decline (POD). The abundance indices for 2002-2004 include record lows for the Delta smelt and young striped bass and near-record lows for threatened longfin smelt and threadfin shad. The POD has been attributed to a combination of factors: toxins such as pesticides and herbicides invasive species such as the such as the overbite clam which consumes plankton and other food needed by small fish and the huge pumps used for state and federal water project operations which entrain small fish and impact salinity and circulation patterns in the estuary.

The Delta smelt is listed as threatened by the U.S. Fish and Wildlife Service and as endangered by the California Department of Fish and Game. Warmer estuarine waters resulting from climate change will further increase the risk of extinction for this and other fish species dependent upon cold water. Water temperatures beyond 25 degrees Celsius are lethal to Delta smelt a threshold that is already reached in the estuary during summer heat waves.

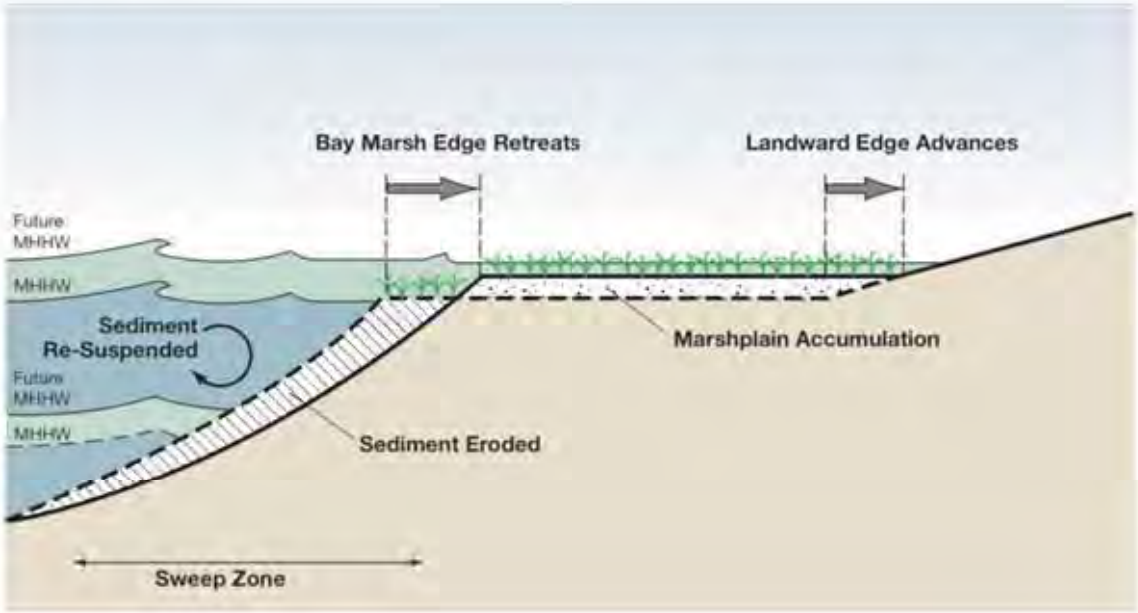
The endangered California clapper rail and salt marsh harvest mouse seek refuge in high tidal marshes and upland transition zones during extreme high water events. Sea level rise and declining sediment supply threaten high marsh and upland transition zones that act as refugia for the clapper rail and mouse posing a significant challenge to providing adequate habitat to enable the recovery of these species.

Tidal marshes and tidal flats are important habitat for a number of bird species migrating along the Pacific Flyway. For many birds who rely on tidal marshes and flats the loss of breeding habitat results in smaller populations. As tidal habitats are lost or degraded some birds may move to other less suitable habitats but reproduction in degraded habitats tends to be lower and mortality tends to be higher. The birds that breed in these poorer quality habitats may eventually become threatened or endangered (Pulliam and Danielson 1991).

Although resource managers are shifting their emphasis from single-species management to an ecosystem-based management approach preventing extinction remains an important goal and is required by the state and federal endangered species acts. n addition monitoring the abundance of threatened and endangered species particularly those that provide early warning of climate change is critical to ensuring the health of the Bay ecosystem.

Figure 3.3 Estuary Migration

SOURCE: Lowe and Williams, 2008



Shoreline Protection Impacts

Static structures have been constructed on tidal marshes and tidal flats a practice that restricts migration of the Bay ecosystem landward during sea-level rise. Shorelines move upward and landward with sea level rise forming tidal marshes and tidal flats further inland. As sea level rises high-energy waves erode mud from tidal flats and deposit that sediment onto adjacent tidal marshes (Figure 3.3). Plants establish on tidal marshes trapping additional sediment and accumulating organic material. f sedimentation and organic accumulation in tidal marshes is sufficient tidal wetlands persist on the Bay shoreline in the same relative position rising at the same rate as sea level (PWA and Faber 2004 Watson 2004). f sedimentation is slower than sea level rise tidal marshes and tidal flats begin to erode and the area in front of shoreline protection structures converts to open water (PWA and Faber 2004 Lowe and Williams 2008).

Because tidal marshes and tidal flats decrease wave heights or attenuate waves the loss of tidal marsh seaward of protection structures further exacerbates potential flooding and erosion during storms by allowing larger waves to reach the structures. Studies in the United ingdom (M ller 2001 2002 2006) estimate that salt marshes in front of levees reduce wave heights by as much as 40 percent reducing required levee height and lowering the total cost of the levee by 30 percent (Turner and Dagley 1993). Seawalls in particular create a hard smooth surface that reflects wave energy back onto the shoreline eroding and undermining the base of the structure and leading to failure (BCDC 1988a). Riprap revetments dissipate this energy somewhat but are also vulnerable to erosion at the base of the structure and at each end (BCDC 1988a). Sea level rise requires that engineers retrofit existing structures to protect against larger waves usually by raising the height of the structure and by strengthening the seaward base (Lowe and Williams 2008 Smits et al. 2006 Heberger et al. 2008).

Ecological Consequences of a Tidal Barrage. n 2007 BCDC reported on the potential impacts on San Francisco Bay from a tidal barrage across the Golden Gate (barrage is the technical term for a barrier or dam across a waterway). t is foreseeable that such a structure could be proposed as an alternative to the extensive shoreline protection structures that may be built in response to sea level rise. After the North Sea flood in 1953 the Dutch sacrificed entire estuaries to build similar structures. The results of BCDC s study indicate that constructing a barrage at the mouth of San Francisco Bay would likely be physically and economically impractical as well as ecologically damaging. The ecological consequences of the barrage would likely be very high. t would affect sedimentation wetlands fresh and salt water mixing animal migration and endangered species. More than likely it would change the landscape of the Bay Area affecting the North Bay and South Bay most heavily.

Damming the Bay would result in less salt water entering the Bay and more fresh water being trapped within. Overall the Bay would become more brackish and less saline. Exchange of nutrients and plankton between the ocean and Bay would also be greatly reduced. There would be reduced ability to assimilate wastewater discharges resulting in reduced water quality and the need for expensive modifications to wastewater treatment facilities.

A barrage would likely greatly decrease sediment exchange between the Bay and the ocean. The reduced sediment load has the potential to increase coastal erosion. Currently scientists and planners are examining whether the existing wetlands will be able to keep pace with sea level rise. As sea level rises in the ocean a barrage would decrease tidal range in the Bay eliminating many intertidal areas by converting them to subtidal areas further decreasing Bay tidal flats and wetlands.

Fish and marine mammals are likely to be the most affected as migratory pathways would be greatly reduced and species using the Bay as a nursery ground such as Dungeness crab and many species of flat fish would be blocked. Changing the salinity regime would also eliminate species that require higher salinities from the Bay. Birds that are dependent on marine fish for food and shorebirds that depend on the mud flats would likely have to relocate. Science has shown that the Bay is one of the most important stops of the Pacific flyway altering this habitat would have global effects on birds that stop here on their yearly migration.

The Bay is home to numerous threatened and endangered species such as Chinook salmon steelhead and green sturgeon. Sturgeon have been known to go through lock systems but only on an accidental basis. Placing fish gates and ladders in the barrage would alleviate some of the issues but creating obstacles for already stressed and endangered species only pushes them further towards extinction. Reducing fish populations would also affect endangered least terns and brown pelicans reducing their chances for survival.

While creating a barrier to sea level rise may seem to solve flooding issues due to storm surges and rising ocean waters it may exacerbate flooding inside the Bay during heavy winter storms. Reducing the ability of fresh water to be released into the ocean would cause severe flooding if excess water has no place to go. Should long-term sea level rise exceed 6.56 feet (2 meters) then tidal flows would no longer be possible and outflow from tributaries would require pumping through the barrage.

Watershed Land Use

Watershed management must account for the need for sediment to feed Bay marshes and mudflats while not hampering pollution control or increasing sediment impacts to creeks that require clean gravels for spawning salmon and steelhead trout.

nflowing waters and sediments from local tributary watersheds of the San Francisco Bay are increasingly recognized as important components of a healthy Bay ecosystem (Collins and Grossinger 2004). Tributaries of the Bay contribute freshwater and sediment that help sustain the tidal marshes and tidal flats where rivers meet the Bay (Collins and Grossinger 2004 Grossinger et al. 2007). Approximately ten percent of the tidal flats in the Bay and Delta are in the tidally influenced portions of major tributaries of the Bay.

However natural flows of water and sediment from watersheds to the Bay have been altered by development. Urbanization in Bay area watersheds has led to increases in paved impermeable surfaces construction of storm drains and culverting and channelization of creeks. As a result during storms rain that is unable to soak into the ground flows over paved surfaces washing accumulated pollutants into storm drains creeks and eventually the Bay. Faster more concentrated storm flows enter creeks increasing channel erosion and bank undercutting which degrades fish habitat and undermines bridges buildings and trails located along creeks. n some areas flooding has become more severe.

Over ten years of research for the Regional Monitoring Project (RMP) has shown that sediment is the main transport mechanism for pollutants entering the Bay (Schoellhammer 2007 Flagel and Davis 2007). Total Maximum Daily Loads (TMDLs) limiting suspended sediment in creeks under the federal Clean Water Act have established a regulatory mechanism for reducing pollutant loads into the Bay and protecting salmon and steelhead spawning habitat. Localities have begun implementing best management practices such as floodplain setbacks and easements infiltration basins and creek and riparian habitat restoration in order to accommodate flood flows and limit sediment and pollutant loads to creeks and the Bay.

However given the decrease in sediment supply and loss of tidal flats fine sediment supply from watersheds could be critical for maintaining equilibrium in tidal marshes particularly in light of sea level rise. The challenge for future watershed management strategies will be to enable sufficient amounts of clean sediment to pass through watersheds to the Bay while avoiding adverse impacts to fish and water quality (Box 3.1).

Restoration and Adaptive Management

Managing the health of the Bay requires a regional process to establish goals for the protection and restoration of wetlands or Baylands ensuring the cumulative success of individual efforts. The Baylands Ecosystem Habitat Goals report (Goals) released in 1999 represents a consensus among area scientists and resource managers. t serves as a guide for sustaining diverse and healthy communities of fish and wildlife resources in the San Francisco Bay Estuary by providing recommendations for the necessary kinds amounts and distribution of baylands and related habitats. The Goals provide a flexible vision for restoration that translates into tangible actions.

n the decade since its release over 75 projects have been initiated to restore baylands along the fringes of San Pablo Bay South Bay Suisun Marsh and throughout the Sacramento-San oaquin Delta. These projects range in size from just a few acres to some 15 000 acres (23 square miles) of salt ponds in the South Bay. Roughly 67 000 acres (104 square miles) have been restored to natural areas or are planned for restoration (Wetland Tracker 2008). These projects represent a tremendous public investment in preserving the baylands for future generations however the impacts of climate change may jeopardize that investment if the Goals are not updated to account for climate change.

Box 3.1 Shoreline Management and Watershed Management Planning

Shoreline Management. Shoreline management plans generally address erosion and flooding hazards in coastal areas. They are widely used in the United ingdom and the European Union to plan for the effects of sea level rise. Shoreline management planning involves dividing the shoreline into a series of natural units or drift cells within the shoreline planning area and developing a management plan for each cell. The shoreline management plans further divide the cells by land use and develop strategies for the following 50-100 years such as: holding the line managed realignment (similar to managed retreat) or no intervention. n the U the Department of Environment Flood and Rural Affairs developed guidelines with which strategies must be consistent. mplementing the strategies is left to the local authorities. Shoreline management plans are designed to be regularly updated to effectively adapt to changing circumstance and new scientific information as the climate conditions change (DEFRA 2007).

The advantages of shoreline management plans are similar to watershed management plans where they avoid a piecemeal approach by setting clear guidelines for a specific planning area that is determined based on ecosystem processes such as littoral drift cells or a watershed. This is especially effective for managing shoreline erosion because the each individual hard shoreline structure that is approved can cause erosion on adjacent properties and eliminate potential marsh migration areas.

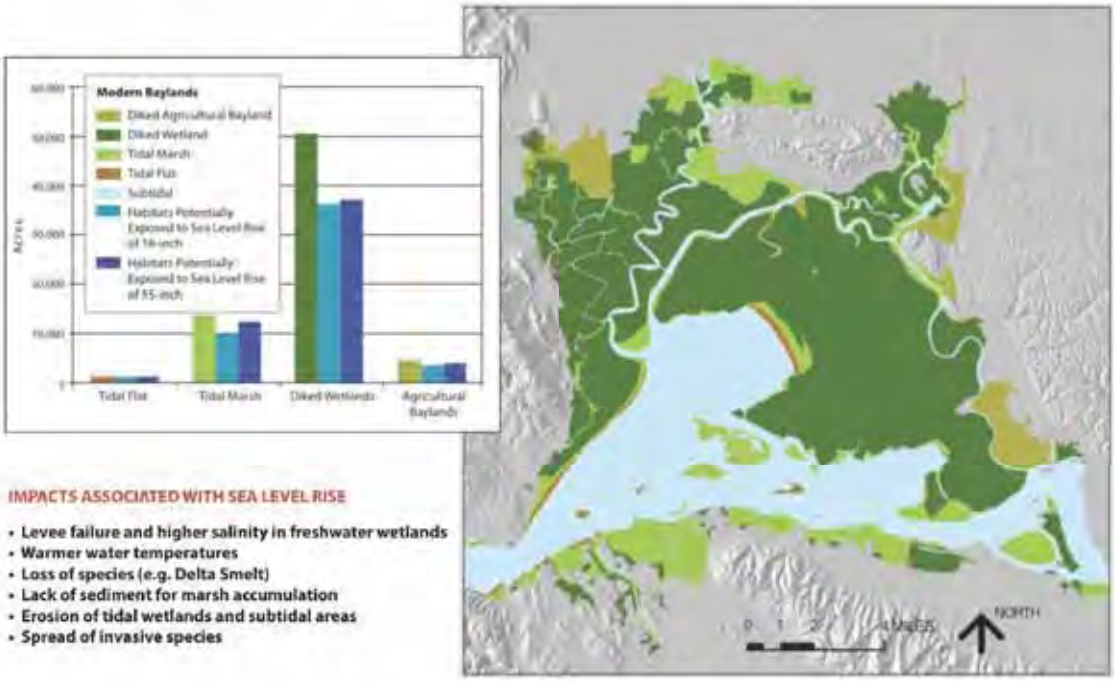
Watershed Management. ntegrated watershed management is a planning concept developed to reconcile competing uses that degrade watersheds. t aims to meet multiple objectives across large spatial scales by coordinating the actions of numerous communities and sectors (MEAM 2008). Some primary goals of integrated watershed management are to provide adequate freshwater flow for ecosystem and human needs maintain healthy riparian habitat and water quality and mitigate past and future watershed impacts.

There are many examples of watershed (or catchment) management frameworks and programs around the world. Locally-based programs such as the California Coastal Commission s Critical Coastal Area program (http://www.coastal.ca.gov/nps/cca-nps.html) aim to track and minimize contaminants and development pressures throughout an entire watershed e.g. Sonoma Creek upstream of San Francisco Bay. Other examples such as the Bay Area ntegrated Water Management Plan (RWMP) aim to develop regional cooperation between many resource agencies and local stakeholders in many cases resulting in a watershed management plan. Watershed management plans reflect a set of common goals that meet the needs of the watershed community including humans and ecosystems.

Climate change impacts may require updating the Goals as regional targets for types amounts and distribution of habitats to ensure that we maintain and expand the invaluable resources that the Baylands provide. Within the next 10 to 50 years the Baylands will face more flooding of potentially greater magnitude that could erode or degrade water quality and existing wildlife habitat in irreparable ways. While restoring historic habitat conditions may not be feasible restoring ecosystem function is essential for enable habitats to adapt to the new stressors and challenges resulting from climate change. The best available science must be used to strategically select restoration sites that are likely to continue to provide ecological services as they evolve in response to sea level rise and other climate change impacts.

Figure 3.4 Suisun Marsh Habitats Potentially Exposed to Sea Level Rise

SOURCE: Baylands (EcoAtlas 2009), Hillshade (USGS NED)



IMPACTS ASSOCIATED WITH SEA LEVEL RISE

- **Levee failure and higher salinity in freshwater wetlands**
- **Warmer water temperatures**
- **Loss of species (e.g. Delta Smelt)**
- **Lack of sediment for marsh accumulation**
- **Erosion of tidal wetlands and subtidal areas**
- **Spread of invasive species**

Suisun Marsh (Figure 3.4). The Suisun Marsh Charter Group formed in 2001 to develop a new restoration and management plan for the Marsh. The first phase of the Suisun Marsh Plan will involve converting between 2 000 and 9 000 acres (3 and 14 square miles) of managed wetlands to tidal marsh and enhancing between 39 000 and 46 000 acres (60 and 72 square miles) of managed wetlands to benefit a variety of species.

Tidal restoration objectives include restoring tidal marshes contiguous with upland transitions expanding the distribution and amount of sloughs and shallow subtidal habitat restoring natural processes increasing productivity and nutrient export to adjacent Bay waters and enhancing populations of listed and sensitive native species (Wilcox 2006). Constraints to tidal restoration include subsidence limited sediment supply protecting infrastructure effects on salinity protection of neighboring properties and reduction of managed marsh. Since most of the managed wetlands in the Marsh are at or below sea level and sediment supply is limited breaching levees would create shallow water habitat rather than tidal wetlands in many areas (Figure 3.4).

Tidal restoration opportunities will be constrained by their salinity effects on other parts of the Delta particularly those areas where water is withdrawn for export by the state and federal water projects. Levee failure in diked wetlands would increase salinity variability by returning them to tidal action if the levees were not repaired. f a major earthquake or flood were to cause catastrophic levee failure and the flooding of several Delta islands the tidal prism would increase dramatically resulting in increased salinity in the Bay and Suisun Marsh as well as changes in erosional and depositional patterns in the estuary (Healey 2008). The Suisun Marsh Plan will have to consider the potential salinity impacts of sea level rise climate-induced changes in the hydrological regime of the Bay-Delta Watershed and proposed changes in storage and conveyance by the state and federal water projects.

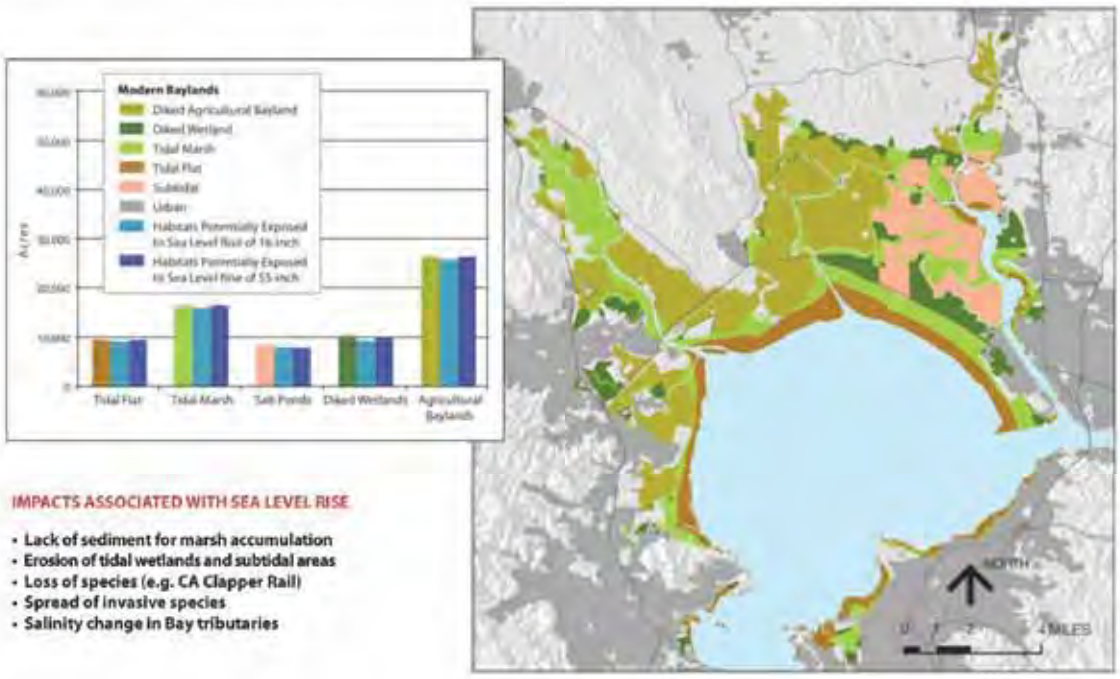
Sea level rise will make managed wetlands increasingly difficult to maintain. Higher water levels will put more pressure on fragile levees increasing the risk of failure. Sea level rise will also reduce managers ability to use gravity to periodically drain the wetlands in order to flush out salts and manage vegetation by discing and planting.

North Bay (Figure 3.5). Most of the North Bay supports a mix of diked agricultural baylands managed wetlands and tidal marsh. The Petaluma and Napa Rivers and Sonoma and Tolay Creeks also flow into the North Bay supporting large areas of brackish marsh. Currently approximately 14 000 acres (22 square miles) of Baylands are restored or are in the process of being restored to tidal habitat in the North Bay. An additional 10 000 acres (15 square miles) are

planned for tidal habitat restoration despite recent erosion of the tidal flats in the North Bay. Tidal flats in the North Bay are replenished increasingly by sediment from local tributaries such as the Napa River and Sonoma Creek. These local tributary watersheds are sufficiently large to supply adequate amounts of sediment. However current watershed management practices such as damming are reducing sediment throughput to the Bay leading to erosion of the tidal flats and marshes.

Figure 3.5 North Bay Marsh Habitats Potentially Exposed to Sea Level Rise

SOURCE: Baylands (EcoAtlas 2009), Hillshade (USGS NED)



IMPACTS ASSOCIATED WITH SEA LEVEL RISE

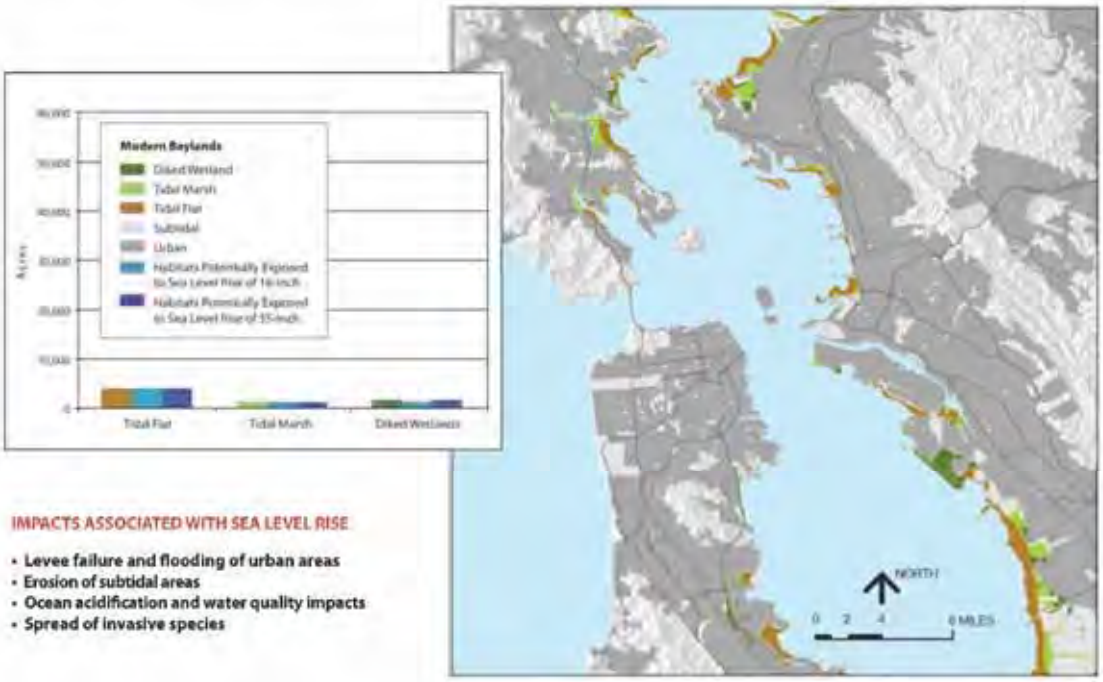
- Lack of sediment for marsh accumulation
- Erosion of tidal wetlands and subtidal areas
- Loss of species (e.g. CA Clapper Rail)
- Spread of invasive species
- Salinity change in Bay tributaries

Central Bay (Figure 3.6). Subtidal areas are the dominant habitat in the Central Bay which includes the Golden Gate San Francisco and Oakland shorelines. t is the deepest part of the Bay and thus is the central shipping corridor. Most of the shoreline is developed with riprap revetments or bulkheads. However the largest eelgrass beds in the Bay are located here. Eelgrass beds provide shelter and food to small fish and Pacific herring lay their eggs on eelgrass (State Coastal Conservancy 2010).

The Subtidal Habitat Goals Project led by BCDC the California Coastal Conservancy the California Ocean Protection Council the National Oceanic and Atmospheric Administration (NOAA) and the San Francisco Estuary Partnership is a collaborative effort to advance the understanding of submerged habitats such as eelgrass beds in San Francisco Bay. The project provides the basic information needed for planning conservation restoration research and management activities related to subtidal habitat in the San Francisco estuary. The project report contains an appendix on climate and other long-term changes likely to affect the future of subtidal habitats (State Coastal Conservancy 2010).

Figure 3.6 Central Bay Habitats Potentially Exposed to Sea Level Rise

SOURCE: Baylands (EcoAtlas 2009), Hillshade (USGS NED)



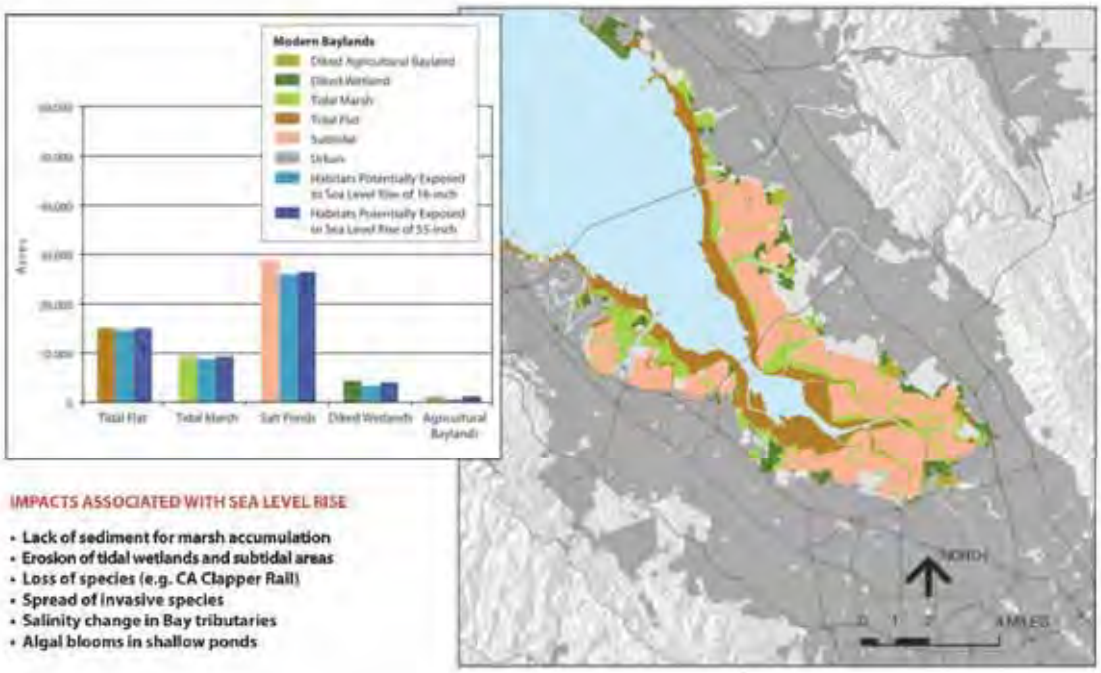
IMPACTS ASSOCIATED WITH SEA LEVEL RISE

- Levee failure and flooding of urban areas
- Erosion of subtidal areas
- Ocean acidification and water quality impacts
- Spread of invasive species

South Bay (Figure 3.7). The South Bay is the focus of the largest tidal restoration project ever planned for the Pacific Coast the South Bay Salt Ponds (SBSP) restoration project. Preliminary design for the SBSP project involves restoration of 15 000 acres (23 square miles) to a mixture of tidal flat tidal marsh and transitional habitat. The project s goals are to restore and enhance wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The project seeks a balance between restoring wetland habitat and maintaining existing pond habitat with alternative scenarios ranging from 50 percent each of wetlands and ponds to 90 percent wetlands and ten percent ponds. The project participants identified eight key uncertainties that could make meeting the project objectives difficult. These included sediment dynamics bird response to changing habitats non-avian species responses mercury issues invasive and non-native species water quality public access and wildlife and social dynamics. The overarching uncertainty of global climate change is incorporated into each of the specific key uncertainties.

Figure 3.7 South Bay Marsh Habitats Potentially Exposed to Sea Level Rise

SOURCE: Baylands (EcoAtlas 2009), Hillshade (USGS NED)



IMPACTS ASSOCIATED WITH SEA LEVEL RISE

- Lack of sediment for marsh accumulation
- Erosion of tidal wetlands and subtidal areas
- Loss of species (e.g. CA Clapper Rail)
- Spread of invasive species
- Salinity change in Bay tributaries
- Algal blooms in shallow ponds

Table 3.1 Summary of Vulnerabilities in the Bay Ecosystem

Bay Ecosystem Subregions	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Suisun Marsh	Subsided wetlands that rely on salinity gates to restrict the flow of higher salinity water into the Marsh. Older levees constructed on peat.	Potential flooding from levee failure. Change in salinity. Loss of species. Lack of sediment. Erosion and invasive species.	High – Subsidence and older levees make the Marsh very sensitive to flooding. Salinity changes can significantly alter habitats.	Low/Medium – Without levee improvements and rethinking management strategies, the Marsh will suffer. Marsh has space to migrate upland.	High
North Bay	Tidal flats are eroding, reducing sediment supply to marshes. Brackish marsh has high biodiversity, but requires freshwater inflow.	Increased erosion and lack of sediment for restoration. Invasive species and loss of biodiversity. Salinity changes near and in tributaries.	High – Managed wetlands are especially susceptible to erosion. Brackish marsh is relatively unique habitat in the Bay.	Medium – Current rates of erosion and lack of sediment may hamper marsh restoration efforts and upland migration. Plentiful open space is available for upland migration.	Medium High
Central Bay	Intense human activity, including shipping, dredging, mining and industrial uses that threaten eel grass beds and impact water quality.	Erosion of subtidal areas. Acidification and other water quality impacts. Spread of invasive species. Major structural shoreline protection to protect urban shoreline can increase erosion.	Medium – Unique subtidal habitats, like eel grass beds, are difficult to restore and their limited numbers could result in total loss.	Medium Low - Eel grass beds may not be adaptable. A great deal of uncertainty remains regarding the effects of acidification and salinity. Little space for marsh migration.	Medium
South Bay	Major restoration efforts will require sufficient amounts of sediment for success. Levees surrounding salt ponds are older and may require improvements.	Lack of sediment for marsh accumulation and increased erosion. Spread of invasive species. Algal blooms in shallow ponds.	High - Current restoration efforts require adequate sediment to succeed.	Low - Although restoration will improve ecosystem functions, little space is available for marsh migration.	High

nitial investigation of the impacts of sea level rise on the SBSP project suggest that sufficient sediment exists to raise subsided sites to elevations suitable for plant growth. However long term replenishment of the tidal flats a critical source of sediment may be in jeopardy if resource managers do not successfully manage sediment in the South Bay. Potential adaptive management actions to address sediment supply include: incorporating monitored changes in sediment supply and mudflat distribution into project phasing using low-crested levees along the bayfront edge to reduce wave energy protect restored tidal areas and encourage marsh sedimentation reconnecting existing mudflats to salt ponds to allow for natural sedimentation using dredged material to raise pond elevations to a level conducive for growth of vegetation augmenting natural sedimentation and prioritizing restoration in ponds adjacent to intertidal mudflats and/or ponds at higher elevations which will require less dredged material and natural sediment supply to offset migration from sea level rise.

Summary and Conclusions

The Bay is inhabited by numerous plants and animals and provides many benefits to humans. For example tidal wetlands provide critical flood protection improve water quality and sequester carbon. Brackish marshes in the North Bay and Suisun Marsh support the greatest diversity of species and provide an important resting place along the Pacific Flyway. The impacts of climate change will substantially alter the Bay ecosystem by inundating or eroding wetlands and transitional habitats altering species composition changing freshwater inflow and impairing water quality. Changes in salinity from reduced freshwater inflow will affect fish wildlife and other aquatic organisms in intertidal and subtidal habitats. The highly developed Bay shoreline constrains the ability of tidal marshes to migrate landward while the declining sediment supply in the Bay reduces the ability of tidal marshes to grow upward as sea level rises. The vulnerabilities from future climate change are further summarized in Table 3.1.

The Bay will continue to evolve in response to the climatic forces that enabled it to come into being. Historic modification of the ecosystem through filling diking and building on the shoreline and reducing freshwater inflow as well as ongoing stressors such as pollution and invasive species have resulted in the decline of many native species and increased the vulnerability of surrounding communities to damaging floods. Substantial progress has been made in restoring the Bay ecosystem by returning diked areas to tidal action and reducing pollution while efforts to increase freshwater inflow have been less successful. Future efforts to restore the Bay ecosystem can benefit from careful design that accounts for the known processes affecting formation of habitats in the Bay the constraints imposed by existing stressors and the future vulnerabilities.

ey issues that resource managers must address regarding climate change include: identifying opportunities for tidal wetlands and tidal flats to migrate landward managing and maintaining adequate volumes of sediment for marsh sedimentation developing and planning for natural flood protection and maintaining sufficient upland buffer areas around tidal wetlands. Furthermore habitats like beaches should be high priority for restoration and conservation.

Developing effective strategies to protect tidal wetland and tidal flat from sea level rise is challenging because the projections of future sea level rise continually change. This range of variation based on different climate models and emission scenarios creates a great deal of uncertainty for decision-makers therefore wetland protection strategies must be adaptable to changing conditions.

CHAPTER 4
Governance: What BCDC and Local Jurisdictions Can Do

The vulnerabilities of the Bay shoreline and ecosystems to sea level rise and other climate change impacts will create new technical challenges for shoreline planning and require difficult decisions to prioritize protection of shoreline development and Bay resources. This chapter assesses the vulnerabilities in Bay Area governance systems that may hinder the region s ability to meet these challenges. The analysis begins by identifying vulnerabilities in the overall organization of government agencies and their authorities and then focuses on BCDC and local governments because of their central roles in adapting to the impacts of climate change on the Bay and its shoreline.

BCDC is addressing regional adaptation for a variety of reasons. The Commission has authority over San Francisco Bay and shoreline from just outside of the Golden Gate Bridge to the Delta and its laws and policies establish the agency s responsibility for protecting and enhancing the Bay and encouraging the Bay s responsible use. As one of California s federally-designated state coastal management agencies BCDC has access to state and federal resources to support coastal management and the authority to review federal and federally-permitted activities under the federal Coastal one Management Act (C MA). The Commission also has an integral regional role in planning for the Bay through its participation in the oint Policy Committee and its partnerships with other federal state regional and local agencies and organizations.

This chapter also lays out the needs of local jurisdictions to effectively address the challenges climate change will pose to their communities. Understanding these needs is essential because local governments have broad land use authority and thus a clear responsibility to adapt to climate change.

The Governance Landscape

BCDC s regional authority and local governments land use authority give these agencies primary roles in adapting to sea level rise impacts but they are just some of the many government agencies that are relevant to adaptation planning in the Bay Area. Management authority over Bay and shoreline resources is sliced up among numerous other government agencies as well. Provision of services such as flood control and water supply and quality is managed by different local regional state and federal agencies based on authorities granted to

them through various federal state and local laws and policies. These sectoral management activities intersect geographic boundaries of agency jurisdiction and land ownership that define the Bay region s parks wildlife areas residential communities and industrial and commercial areas. Together these divisions create a patchwork of jurisdictions and authorities that challenges the region s ability to respond to broad geographic and cross-sectoral impacts such as those expected with a changing climate. n the Bay Area a number of multi-jurisdictional planning programs have successfully addressed complex environmental issues but too often have failed to follow through. Examples of successful follow-through include the Long Term Management Strategy s Dredged Materials Management Office and permit streamlining the South Bay Salt Pond Restoration Project and hazard mitigation planning.

These challenges are not all unique to adaptation planning. Other regional and sub-regional planning efforts such as the South Bay Salt Ponds Restoration Project an effort led by the State Coastal Conservancy and the Multi- urisdictional Local Hazard Mitigation Plan led by the Association of Bay Area Governments (ABAG) (Box 4.1) have faced similar cross-jurisdictional and sectoral issues. These efforts have relied on inter-agency partnerships and extensive outreach to key stakeholders and the public to effectively integrate and address the diversity of authorities and interests relevant to these projects.

However despite many similarities to past planning efforts adaptation planning involves additional complexities that government agencies have not previously had to address. Whereas past regional planning efforts have been able to assume a (basically) static environment or backdrop for the planning project the entire impetus for and context of adaptation planning is a changing environment. Added to this changing backdrop are complexities that are uncommon to other planning projects: climate change impacts are slow to develop and long lasting but create environmental changes that are relatively rapid compared to historic change expected intensities of impacts are well beyond the range of historic effects uncertainty about expected impacts is very high and there is a dearth of experience in rapidly assessing the efficacy of adaptation actions. These complexities magnify the importance of conducting comprehensive regional planning for adaptation yet exacerbate the challenges associated with this type of planning. These challenges present yet another situation where too many authorities can make it difficult to be flexible in planning for and responding to these complex and relatively rapid changes. Some balance of redundancy and flexibility is required.

Box 4.1 Hazard Mitigation Planning in the Bay Area

Effective adaptation planning is limited by the number of and divisions among management authorities in the Bay Area. These existing governance challenges will be exacerbated by climate change impacts. Agencies have had to address overlapping jurisdictions and authorities in other Bay Area regional planning efforts. Preparation of the Multi- urisdictional Local Hazard Mitigation Plan (Plan) for the Bay Area is one example of this.

Development of the Plan was a joint effort by the cities counties and special districts in the Bay Area to build a more disaster-resistant region and to meet requirements of the federal Disaster Mitigation Act (DMA) of 2000 for all local governments to develop and adopt this type of plan. The Association of Bay Area Governments (ABAG) coordinated this multi-jurisdictional planning effort to identify hazards to communities assess risks and develop a disaster resistance goal and objectives and a comprehensive list of strategies (or actions) to mitigate the identified risks. ABAG conducted numerous workshops with local governments to determine the scope of work identify key hazards and develop mitigation strategies for eight different planning or commitment areas. Once the overall Plan for the Bay Area was completed each city county and special district prepared an annex to the Plan with a more specific assessment of hazards and risks within its jurisdiction and prioritization and application of mitigation strategies. (For the 2005 Plan more than 90 local governments prepared annexes.)

n the Plan ABAG highlights two important characteristics of hazard mitigation that are also true of adaptation planning. First it recognizes that disasters do not respect the boundaries between individual jurisdictions and that hazard mitigation requires coordinated cross-jurisdictional planning. Second it recognizes that hazard mitigation planning is iterative and that the Plan needs periodic updates.

This example of a regionally-coordinated multi-jurisdictional planning effort offers possible lessons for adaptation planning. The DMA has clear financial incentives for local governments to participate in hazard mitigation planning in the form of disaster recovery grants that become available to municipalities that have plans in place. Assessing vulnerabilities to hazards such as floods fire and earthquakes requires extensive geographic data analysis. nstead of each local government conducting a separate data collection and mapping effort ABAG compiled available data and created interactive web-based mapping tools that allowed each jurisdiction to assess its vulnerabilities within the different commitment areas. This ensured consistency of the analysis across the many jurisdictions and minimized the workload for local governments.

This planning effort is an opportunity for improving the region s adaptive capacity to climate change impacts. As the Plan is updated the hazard mitigation strategies can be expanded (as appropriate) to address relevant climate change impacts such as sea level rise. Taking advantage of opportunities to integrate adaptation planning into this existing effort could reduce the amount of additional work that climate change will create for local and regional planners.

n the Bay Area five federal agencies are actively involved in shoreline adaptation: the National Oceanic and Atmospheric Administration (NOAA) the United States Geological Survey (USGS) the Federal Emergency Management Agency (FEMA) the United States Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA). As one example of federal involvement the Corps is partnering with the State Coastal Conservancy and the Santa Clara alley Water District to conduct the South San Francisco Bay Shoreline Study which will identify project alternatives and recommend for federal funding for one or more projects for flood damage reduction ecosystem restoration and related purposes such as public access. Although flooding risks from creeks have been reduced by a number of existing projects in the area the area remains vulnerable to tidal flooding and is expected to become more vulnerable as sea level rises. This project is being closely coordinated with the South Bay Salt Ponds Restoration Project which is discussed in Chapters 3 and 5.

The state has numerous agencies that are actively addressing climate change adaptation. To date BCDC has worked primarily with three of the agencies that have been instrumental in funding and managing important research projects related to sea level rise in San Francisco Bay: the California Energy Commission s Public nterest in Energy Research program the

California Coastal Conservancy and more recently the Ocean Protection Council. BCDC also works with the regional agencies on the oint Policy Committee to carry out the PC s climate change strategies. Several nearby regional agencies are taking an active role in planning for climate change in the Delta and the Suisun Marsh: the Delta Protection Commission the Delta Stewardship Council the Delta Conservancy and the Suisun Marsh Charter Group. The Commission provides a staff member to coordinate with these regional efforts.

The Commission's Jurisdiction and Authority

The Commission was established in 1965 as the nation s first state coastal management agency. Alarmed by the fact that between 1850 and 1960 an average of four square miles of the Bay was filled each year citizens in the Bay Area successfully organized to advocate for new state legislation that would protect the Bay. The McAteer-Petris Act was passed in 1965 to establish BCDC as a temporary state agency. The Commission was charged with preparing a plan for the long-term use of the Bay and regulating development in and around the Bay while the plan was being prepared.

The *San Francisco Bay Plan* (Bay Plan) which was completed in anuary 1969 includes policies to protect the Bay as a resource and policies to guide development of the shoreline ranging from ports and public access to water quality and habitat. The Bay Plan also contains maps of the entire Bay that designate shoreline areas that should be reserved for water-related purposes like ports industry waterfront parks airports and wildlife refuges. The Commission is directed to pursue an active planning program to study Bay issues so that Commission plans and policies are based upon the best available current information.

 n August 1969 the McAteer-Petris Act was amended to make BCDC a permanent agency and to incorporate the policies of the Bay Plan into state law. n 1977 the Suisun Marsh Presrvation Act expanded the Commission s authority to provide special protection of the Suisun Marsh. The Suisun Marsh Protection Plan includes policies that guide the Commission and local jurisdictions in their review of marsh development permits as well as the Commission s review of local protection plans developed by local jurisdictions within the marsh.

BCDC is the federally-designated state coastal management agency for the San Francisco Bay segment of the California coastal zone. This designation empowers the Commission to use the authority of the federal Coastal one Management Act to ensure that federal and federally-permitted or funded activities are consistent with the McAteer-Petris Act and the Suisun Marsh Preservation Act and Protection Plan BCDC regulations and the policies of the Bay Plan.

Because the Commission was created in response to rampant filling of the Bay and a dearth of shoreline public access the primary focus of the Commission s authority is on preventing unnecessary fill in the Bay and improving public access. Although fill is defined very broadly this focus limits the ability of the Commission to address climate change issues.

The Commission's Jurisdiction. The Commission has jurisdiction over San Francisco Bay including the Suisun Marsh certain named waterways salt ponds managed wetlands and a 100-foot shoreline band. Section 66610 of the McAteer-Petris Act describes the area of the Commission s jurisdiction over San Francisco Bay as follows:

> all areas that are subject to tidal action from the south end of the Bay to the mouth of the Golden Gate (Point Bonita-Point Lobos) and to the Sacramento River line (a line between Stake Point and Simmons Point extended northeasterly to the mouth of Marshall Cut) including all sloughs and specifically the marshlands lying between mean high tide and five feet above mean sea level .

The Commission typically refers to the above description as its Bay jurisdiction. Section 66610 also describes the Commission s shoreline band jurisdiction which includes the land between the shoreline of San Francisco Bay as described above and a line 100 feet landward of and parallel with that line. The Commission does not have shoreline band jurisdiction upland and adjacent to certain named waterways salt ponds or managed wetlands.

n the 1970s the Commission worked with other agencies and advocacy groups to develop the Suisun Marsh Protection Plan which was enacted into law with the passage of the Suisun Marsh Preservation Act of 1977. The Act gives the Commission permit authority over an approximately 89 000-acre primary management area. Local jurisdictions retain permit authority over a 22 500-acre secondary management area pursuant to their local protection programs approved by the Commission.

The Commission's Permit Authority. Section 66632 of the McAteer-Petris Act grants the Commission authority to require permits for projects in any water land or structure within the area of the Commission s jurisdiction for the following activities: (1) the placement of fill (2) the extraction of materials and (3) any substantial change in use of any water land or structure. t further requires that projects provide maximum feasible public access.

1. **Fill.** The McAteer-Petris Act broadly defines the term fill to include earth or any other substance or material including pilings or structures placed on pilings and structures floating at some or all times and moored for extended periods . Projects that involve the placement of fill in the Commission s Bay and certain waterway jurisdiction must be

consistent with Section 66605 of the McAteer-Petris Act which requires the Commission to perform a tiered analysis. First the Commission must determine whether the public benefits of the fill exceed the public detriment. Then the Commission can approve fill only for a water-oriented use or minor fill to improve shoreline appearance or public access. Finally the fill can be approved only when: (a) there is no alternative upland location for the fill (b) it is the minimum amount of fill necessary to achieve the purpose of the fill (c) the nature location and extent of the fill minimizes harmful effects to the environment as defined in the California Environmental uality Act (CE A) (d) the fill is constructed with sound safety standards for public health safety and welfare (e) the fill establishes a permanent shoreline and (f) the applicant has valid title to the property.

Where a shoreline area is constructed on Commission-approved Bay fill the Commission retains its Bay jurisdiction over that portion of the shoreline. The Commission may approve fill for shoreline protection minor fill to improve shoreline appearance for a water-oriented use or to establish a permanent shoreline provided that the fill satisfies all other provisions of the law.

2. **Extraction of Materials.** The Commission has the authority to require permits for proposals that involve the extraction of materials (e.g. dredging) in the Bay certain waterways salt ponds and managed wetlands. The Bay Plan policies on dredging in part require dredging activities to be consistent with the Long Term Management Strategy for dredged materials in San Francisco Bay establish the interagency Dredge Materials Management Office encourage the beneficial reuse of dredged materials and provide specific requirements for approving permits for dredging activities.

3. **Substantial Change in Use.** The Commission s regulations define a substantial change in use in salt ponds and managed wetlands as any change in use including abandonment and draining . n other areas within the Commission s jurisdiction a substantial change in use is defined as construction reconstruction alteration or other activity whether or not involving a structure and includes: a change in the category of use of a structure in the intensity of use an adverse affect on public access or future public access or any subdivision of land pursuant to the Subdivision Map Act.

Salt Ponds and Managed Wetlands. The Commission s evaluation of fill projects in salt ponds and managed wetlands is limited to consistency with Section 66605 (c) through (g) of the McAteer-Petris Act. The requirement to weigh the public benefits and detriments of the fill does not apply to salt ponds and managed wetlands in the Commission s jurisdiction. Likewise the

test of whether fill in such areas could be sited on an alternative upland location is not required. Regarding permit requirements in salt ponds the extraction of materials is limited to materials extracted for activities associated with salt production. Furthermore the Commission s salt pond jurisdiction extends to dikes and protective structures that form the ponds.

Managed wetlands located in primary and secondary management areas of the Suisun Marsh are subject to additional policies in the Suisun Marsh Protection Plan and the Suisun Marsh Preservation Act of 1977. Those policies address a range of ecosystem and infrastructures issues such as: water supply and quality natural gas resources utilities transportation and recreation.

The 100-Foot Shoreline Band. Within the Commission s shoreline band jurisdiction the Commission may only deny a permit for a project that: (1) fails to provide maximum feasible public access consistent with the project or (2) conflicts with the use designated in a priority use area (McAteer-Petris Act Section 66632.4). Despite this limitation the Commission is granted authority to require permits for projects in the 100-foot shoreline band for all of the reasons described above. However the Commission can only condition a permit require changes to the project to provide maximum feasible public access and to be consistent with a priority use.

The Commission evaluates every permit application to ensure that project proposals provide the maximum feasible public access consistent with the project. The Bay Plan policies on public access guide the Commission s evaluation of public access proposals. Those policies further provide guidance for public access and wildlife compatibility and the siting and design of public access areas. The policies also require public access to be permanently guaranteed and maintained.

Priority use areas are for shoreline uses that are important to the region and require a shoreline location. They include water-related industries airports wildlife refuges and waterfront parks and beaches. Shoreline areas are designated as priority use areas in order to minimize the need to fill the Bay if land is unavailable for those uses.

Existing Bay Plan Policies Pertaining to Sea Level Rise. n 1989 the Commission updated the Bay Plan to address potential impacts from sea level rise based on the best available information about sea level rise at the time. n 2000 the Commission amended the Bay Plan policies on Tidal Marshes and Tidal Flats. As a result of the 1989 and 2000 policy updates the Bay Plan was amended to include the following policies:

- **Safety of Fills, Policy 4.** To prevent damage from flooding structures on fill or near the shoreline should have adequate flood protection including consideration of future relative sea level rise as determined by competent engineers. As a general rule structures on fill or near the shoreline should be above the wave run-up level or sufficiently set back from the edge of the shoreline so that the structure is not subject to dynamic wave energy. n all cases the bottom floor level of structures should be above the highest estimated tide elevation. Exceptions to the general height rule may be made for developments specifically designed to tolerate periodic flooding.
- **Safety of Fills, Policy 6**. Local governments and special districts with responsibilities for flood protection should assure that their requirements and criteria reflect future relative sea level rise and should assure that new structures and uses attracting people are not approved in flood prone areas or in areas that will become flood prone in the future and that structures and uses that are approvable will be built at stable elevations to assure long-term protection from flood hazards.
- **Tidal Marshes and Tidal Flats, Policy 5**. This policy provides specific requirements for the design and evaluation of tidal marsh restoration projects which includes an analysis of the following: (a) the effects of relative sea level rise (b) the impact of the project on the Bay s sediment budget (c) localized sediment erosion and accretion (d) the role of tidal flows: (e) potential invasive species introduction spread and their control (f) rates of colonization by vegetation (g) the expected use of the site by fish other aquatic organisms and wildlife and (h) site characterization.

Except in the case where a structure is proposed on Bay fill the policies on safety of fills largely provide guidance to permit applicants and local governments on siting and designing projects to minimize impacts from flooding. The Commission s authority in the shoreline band to require changes in the siting and design of a project is limited to addressing impacts to present or future public access or the use of a priority use area for its designated purpose.

The Public Trust Doctrine and Takings. The public trust doctrine establishes a public easement over tidal and submerged lands that provides the public with rights to those lands for certain uses. The extent to which those public rights extend inland as sea level rises will impact how the Commission makes future regulatory decisions. The Commission s legal staff prepared a report to the Commission on the implications of rising sea levels on its public trust responsibilities and the relative role of takings. The information below is summarized from the draft report.

The public trust doctrine dates back to Roman times and was imported to America from English common law. Traditionally the public trust doctrine guaranteed public rights to navigable waters and submerged lands only for certain uses: fishing navigation and commerce. Over time each state developed and expanded its own public trust doctrine and the kinds of uses it protects. Through legislation and court decisions in California and other states the doctrine has expanded to include recreational uses and the preservation of lands in their natural state. Uses inconsistent with the public trust (non trust-related uses) are generally those that do not require waterfront locations like residential and non water-related commercial office uses.

The McAteer-Petris Act confers upon BCDC the authority to require maximum feasible public access ensure that public benefits of projects clearly exceed public detriments and preserve water-oriented uses. These statutory provisions are direct expressions of the public trust doctrine.

A key element of the public trust doctrine is its effect on the regulation of private property. Government must compensate property owners under the Fifth Amendment of the U.S. Constitution if it takes private property for public uses. The takings clause limits the regulation of private property to protect natural resources and prevent environmental harm. However the courts have held that government actions to enforce common law public easements such as the public trust doctrine may be insulated from Fifth Amendment takings claims.

When government takes private property for a public purpose through eminent domain or condemnation such as a highway or public works project the property owner is compensated for the loss of value of the property. A taking by government regulation or so-called regulatory taking may also occur when an agency permit allows a physical occupation without sufficient justification or renders a property valueless. However the courts have been unable to establish a clear formula to determine when a regulatory taking occurs.

n summary within the Commission s Bay certain waterway salt pond and managed wetland jurisdiction the Commission has clear but limited authority to address climate change sea level rise and related impacts for projects that involve the placement of fill in all waters within the Commission s jurisdiction including salt ponds and managed wetlands. This authority includes the ability to condition projects to be adaptable to sea level rise. For shoreline protection projects that involve Bay fill the Commission has the authority to ensure that the fill is placed in a manner that minimizes harmful effects to the environment which includes harmful effects from future flooding and harmful effects to waters within the Commission s jurisdiction.

Within the 100-foot shoreline band the Commission s authority is limited to the provision of public access and the designation of priority use areas. This limitation is significant because it prevents the Commission from ensuring that development on the shoreline is sited and designed to avoid or minimize impacts from future flooding. The Commission can have an important advisory role to make recommendations on the siting and design of shoreline development to protect Bay resources and promote the wise development of the Bay shoreline.

BCDC s laws and policies create two other governance limitations. First the Commission implements its authority on a permit-by-permit basis and this limits the potential to analyze and address the cumulative impacts of individual projects such as shoreline protection. Second the focus of the McAteer-Petris Act and the Bay Plan on preventing the Bay from getting smaller creates an awkward policy framework from which to build a set of comprehensive climate change policies that sufficiently address the challenges of an expanding Bay.

The public trust doctrine is based on the historic value that the public has a right of access to the shorelines of navigable waters. The public trust formed the foundation for the McAteer-Petris Act and it is the background principle that can enable a number of adaptation strategies. n exercising the public trust regulatory agencies must act carefully to avoid taking the rights of private property owners under the Fifth Amendment. There is no clear test to determine the extent to which a public easement can move inland as sea level rises without taking private property. This uncertainty about the migration of the public easement could limit the Commission s ability to adopt and implement policies that ensure long-term provision of shoreline public access.

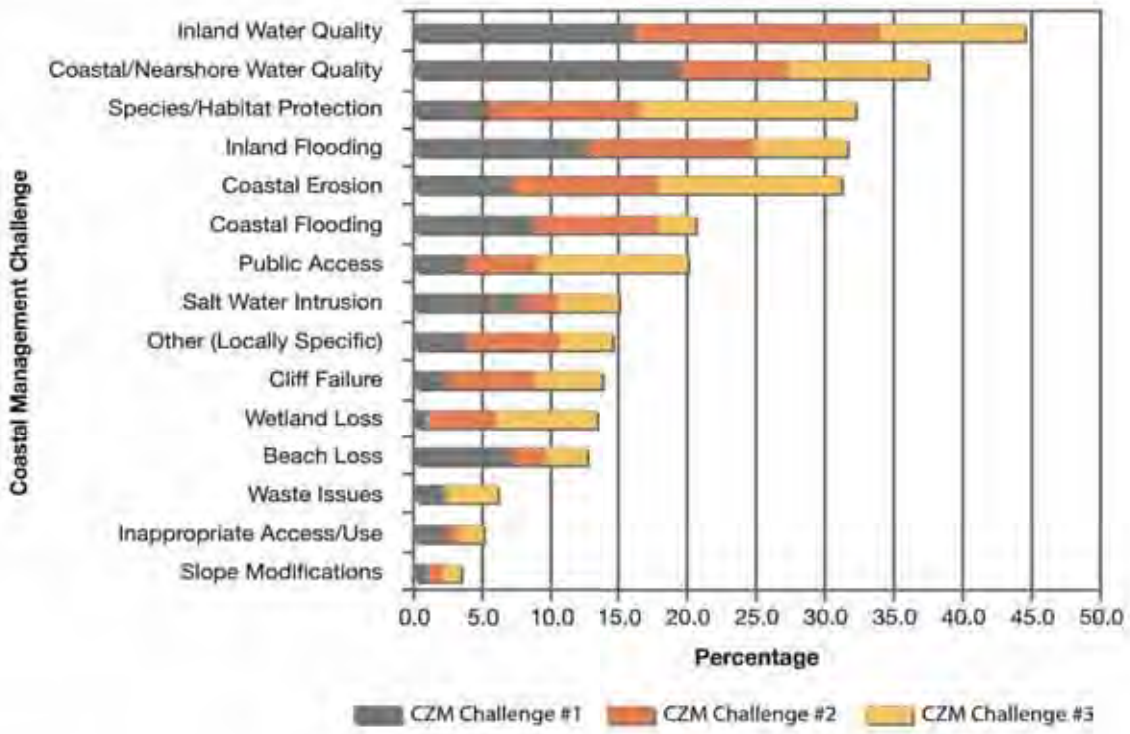
Needs Assessment for Local Jurisdictions

Local jurisdictions shoulder much of the responsibility for land use planning flood management water quality protection and wastewater treatment all of which will be affected by the Bay-related impacts of climate change. Cities and counties are granted police powers by the state which allow them to protect the overall well-being of their communities (lives health and property) by enacting and enforcing ordinances and regulations. The state requires cities and counties to prepare and adopt comprehensive General Plans consistent with state law for physical development within their respective jurisdictions. n order to engage in effective adaptation planning each local jurisdiction needs some level of knowledge about climate change that can be incorporated into ordinances regulations and General Plans.

Statewide Survey. n 2006 the National Center for Atmospheric Research (NCAR) conducted a survey of local coastal managers in California in order to assess their information needs and their capacity to develop adaptation strategies. NCAR surveyed 299 municipal and county governments on the open coast and along the Bay shoreline. One of the key findings of the study was that coastal managers are already dealing with impacts of climate change. Eight of the top fifteen current challenges identified by coastal mangers can directly or indirectly be related to climate variability and / or sea level rise (Moser and Tribia 2007(a)) (Figure 4.1).

Figure 4.1 Top Coastal Zone Management Challenges

Source: Moser and Tribbia 2007a



n the NCAR survey of local coastal managers the topics that were assessed included but were not limited to: level of knowledge of climate change impacts on coastal zones information use and information needs related to coastal decision-making and perceived barriers to adapt to climate change. Major findings from the NCAR study pertain directly to information needs and barriers to taking action:

- **Staffing and Resources.** Staffing is a major barrier to gathering and identifying climate change information. When asked to identify barriers to planning for climate change 74 percent of respondents cited insufficient staff resources to analyze information 60 percent identified lack of staff time to gather information and begin getting informed and 46 percent mentioned lack of technical assistance from state or federal agencies (Moser and Tribia 2007a).
- **Information Accessibility and Relevance.** ulnerability assessments are key to planning for climate change. Assistance in determining what is most at risk is a priority especially locally or regionally specific projections of particular changes in climate . S cientific information even if uncertain needs to be translated into management relevant variables or metrics (Moser and Tribbia 2007b). While flooding scenarios are important a permit analyst deals with rates of shoreline erosion usually on a project-by-project basis. Projections are needed for timeframes that are relative to the life of a proposed project.
- **Information Location and Format.** For scientific information to be easily accessible and useful to local coastal managers it should be processed into formats that are used by planners and permit analysts. (Moser and Tribia 2007b).

Although there are some differences in the issues encountered by coastal managers on the open coast and in the San Francisco estuary qualitative data from a regional summit and a series of interviews conducted by BCDC are generally consistent with the NCAR findings.

n 2006 the Bay Area Air uality Management District (Air District) hosted a regional climate change summit during which local jurisdictions identified areas where they need assistance. Although the discussion focused on greenhouse gas reductions elements of the discussion provide important data regarding Bay Area local jurisdictions. Following the summit the Air District staff identified needs and barriers common to Bay Area governments.

Similar to the findings discussed above participants cited lack of knowledge as a barrier to confronting climate change and identified a specific desire for improving information accessibility through centralized information storage such as a climate information clearinghouse or web portal. Participants also asked for guidelines for implementing climate change programs such as sample ordinances. Participants identified lack of resources and competing internal priorities as major barriers to confronting climate change.

The data from the statewide survey and the Air District s summary of regional needs (BAA MD 2006) provided BCDC with enough data to proceed with targeted structured interviews with individuals from local jurisdictions (counties cities water districts flood control districts water quality agencies and resource agencies). The purpose of the interviews was to assess common needs of local planners and resource managers within the Bay Area. BCDC s objectives in conducting additional interviews were to supplement and refine the existing data. Rather than replicate work that had already been completed BCDC performed a qualitative analysis to integrate the existing data and apply lessons learned on the statewide level to the Bay Area.

Other common themes emerged from the interviews. A consistent comment was a request for a comprehensive regional model or set of projections of climate change impacts. The NCAR finding regarding the need for relevant information in a usable format was further echoed in the interviews. All three of these surveys of climate change planning at the local and regional levels concluded that planners and resource managers need better access to information. They would like to be able to turn to a web clearinghouse or portal for up-to-date information and downloads. Most interview participants want processed data in the form of G S shapefiles or policy guidance documents. Only a few prefer unprocessed data that they can incorporate into in-house models. Regardless a web portal seems to be a preferred distribution method.

The interviews further revealed distinctions between two types of local planners and resource managers: (1) local government land use planning departments and (2) resource-based coastal managers such as staff of flood control districts water districts water treatment facilities and resource agencies. Local government land use planning departments were typically less knowledgeable about the Bay-related impacts of climate change than those in the second group or type. They were more likely than group two participants to identify their primary barrier as lack of financial resources and staff. The agencies they rely on for assistance and information were most often cited as the Federal Emergency Management Agency and the Army Corps of Engineers. Besides the obvious bias of being the interviewer and author it is worth noting that BCDC was cited by almost all participants.

Utilities and others in the second group possessed a greater understanding of Bay-related impacts especially pertaining to their individual purposes (e.g. water delivery water treatment etc.). The most commonly identified barrier was a lack of regional or site-specific information. Group two participants commonly rely on consultants to gather information or produce site-specific analysis.

Other governance vulnerabilities to climate change impacts exist because local governments operate within a policy environment that fails to provide incentives to proactively change their approaches to shoreline development. For example Proposition 13 has forced local governments to rely more on new development for revenues from development fees and sales taxes thus creating a fiscal disincentive to limit new shoreline development. Even where financial and policy incentives do encourage planning to improve disaster preparedness and mitigate the impacts of hazards such as storm flooding local governments are not required to consider future scenarios of climate change impacts in their planning efforts.

Summary and Conclusions

The Bay Area faces a range of vulnerabilities in its systems of governance that are evaluated here and summarized in Table 4.1. Governance vulnerabilities reduce the region s ability to adapt to sea level rise and other climate change impacts on the Bay and shoreline. A look at the region s overall governance system suggests that existing challenges to regional planning caused by the patchwork of federal state regional and local government authorities in the Bay region will be exacerbated by climate change impacts.

Table 4.1 Summary of Vulnerabilities in Bay Area Governance Systems

Governance	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
BCDC	Limited jurisdiction and authority on the shoreline. Limited ability to address cumulative impacts through permit authority.	Inability to effectively address sea level rise and flooding in permits and planning efforts due to focus on preventing fill, and limited authority to deny permits on the shoreline. Uncertainty about changes to public easement due to sea level rise.	High – Bay and (most) shoreline projects designed to address sea level rise and flooding will require BCDC permit.	Low/Medium – Amendment of Bay Plan policies within existing law and policy framework can marginally improve BCDC's capacity to address sea level rise and flooding in some permits.	High

Continuation of Table 4.1 Summary of Vulnerabilities in Bay Area Governance Systems

Governance	Current and Expected Challenges	Projected Climate Change Impacts	Vulnerability Assessment		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Local Governments	Already operating at capacity in terms of staff and funding resources.	Additional demands for staff and funding resources. Lack of information about impacts and guidance on adaptation planning.	High – Local governments will have major responsibilities for adaptation.	Medium – Have authority for conducting community adaptation planning, but lack incentives to change approaches to shoreline development.	High
Governance Landscape	Challenges to regional planning and implementa-tion of regional plans caused by patchwork of government agencies' authorities in the Bay Area.	Need for flexible and adaptive regional adaptation planning and management will be challenged by the patchwork of authority.	Medium – Adaptation requires coordinated regional planning and implementa-tion.	Medium - Region will be able to draw on experience from past regional planning efforts, but complexities of climate change create new, unfamiliar planning challenges.	Medium

BCDC faces governance limitations in its laws and policies. The Commission s jurisdiction on the shoreline is limited to 100 feet from the mean high tide line and within this area BCDC s authority is limited to requiring maximum feasible public access and consistency with priority use areas. This limits the ability of the Commission to address issues like climate change and sea level rise in the shoreline band. The Commission s law is based on principles in the public trust doctrine and the extent to which the public easement established by the public trust can move inland is undetermined. Furthermore because BCDC implements its authority on a permit-by-permit basis the Commission is limited in its ability to address the cumulative impacts of individual shoreline protection projects. The existing framework of BCDC s laws and policies that focus on preventing the Bay from shrinking is an overarching constraint to the Commission s ability to effectively plan for and adapt to climate change impacts.

Local governments and other management agencies especially in cities and counties have broad authority over shoreline land use. However they lack policy incentives resources and regional guidance for addressing climate change impacts in land use planning. To address these gaps local governments need information about the Bay-related impacts of climate change that is region-specific and site-specific. The information should include a regional model that

projects 50-100 years into the future or the expected life of a project. The projections should be developed through a public inclusive process in order to be widely accepted and used throughout the region. The system most commonly used by local governments for analyzing information is G S. However local planners and resource managers can benefit from guidance documents such as sample ordinances.

Lack of staff and adequate financial resources are the primary barriers to planning for coastal impacts of climate change both statewide and in the Bay Area. Any assistance to local governments and public management agencies must address this issue either by providing more staff and financial resources or by providing information that is easily integrated into existing operations planning tools guidance documents and planning processes (e.g. general plan updates).

CHAPTER 5
Adaptation Strategies

California is a leader in working to reduce greenhouse gas emissions. However no matter how successful these efforts are the state needs to plan for the inevitable impacts of climate change caused by past emissions including sea level rise.

Some of California s most highly valued cities and natural areas are in low-lying lands around San Francisco Bay. Critical Bay Area assets may be lost as sea level rises. The most imminent threat facing the region is more frequent and extreme flooding of residential areas which make up 50 percent of the lands potentially affected by sea level rise and storms. Managing the threats to Bay resources and shoreline development from sea level rise will be one of the defining challenges we face in the 21st century.

Communities that fail to plan for these changes will find themselves responding to emergencies with increasing frequency (Pacific Council 2010). Reacting to crises without taking proactive steps to prepare is likely to have devastating societal economic and environmental costs. Therefore the region should develop an adaptation framework upon which to build as science advances innovative technologies and management strategies emerge ecosystems change and lessons are learned from successes and failures.

This chapter discusses issues to consider when planning for climate change adaptation and presents a decision-making framework that can increase adaptive capacity of the Bay ecosystem and the built shoreline environment. This chapter also presents staff recommendations to the Commission for updating the Bay Plan to address climate change and facilitating a regional climate change strategy that includes strengthening agency partnerships and assisting local governments.

Adaptation Planning Considerations

A prudent approach to addressing climate change impacts is to use a robust planning framework and active stakeholder participation to select an appropriate set of responses for a specific site community or subregion of the Bay Area prioritize them and implement them over time incorporating lessons learned into the process. The following issues should be considered when developing adaptation strategies.

Adaptation Planning Strategies. To make the best use of the limited resources available to local governments climate change planning can be mainstreamed into existing planning efforts (Luers and Moser 2006 USEPA 2008 Moser and Tribbia 2007). For example some Bay Area cities have assessed climate change impacts in the process of updating their General Plans and adopted adaptive land use policies to reduce or prepare for these impacts.

Adaptation strategies that address immediate or ongoing concerns while reducing future risks (often called no regrets or low regrets strategies) can readily be integrated into current planning efforts (Luers and Moser 2006). Water conservation is an example of a potential no regrets strategy that mitigates greenhouse gas emissions by reducing the needed for treatment and transport of water and improves resilience to climate change impacts on water supply. Another example is the restoration of tidal marshes to provide open space natural habitat and flood protection.

Other strategies can be used to mainstream adaptation efforts for example incorporating actions to address future climate change into routine efforts such as repair and maintenance projects without incurring substantial additional costs at the time of the upgrade (Luers and Moser 2006). For example to reduce possible flood damage costs expensive home appliances such as furnaces water heaters clothes washers and dryers can be relocated to an upper story at the time of replacement. To the extent that these strategies can be identified they should be implemented immediately.

Box 5.1 Adaptive Management in the South Bay Salt Pond Restoration Project

Adaptive management is a widely recognized approach to addressing uncertainty in resource management. t is often characterized as learning by doing. An adaptive management approach takes account of uncertainty in the design and implementation of resource management policy and maximizes the opportunity to learn from management actions. Monitoring the success of our management actions in both the Bay ecosystem and along the natural and built shoreline is the fundamental process for reducing uncertainty and implementing effective management. The adaptive management process links values science and managers in the decision-making process and throughout project implementation.

The South Bay Salt Pond Restoration Project (Project) is based on an Adaptive Management Plan (Plan). The Plan creates a framework for achieving project objectives through learning from restoration and management actions by monitoring restoration progress and gradually reducing scientific and social uncertainties.

The Project s goal is to restore and enhance over 15 000 acres (23 square miles) of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The Project seeks a balance between restoring wetland habitat and maintaining existing pond habitat with alternative scenarios ranging from 50 percent each of wetlands and ponds to 90 percent wetlands and 10 percent ponds. Project participants identified eight key uncertainties that could make meeting the project objectives difficult. These included sediment dynamics bird response to changing habitats non-avian species responses mercury issues invasive and non-native species water quality public access and wildlife and social dynamics. The overarching uncertainty of global climate change is incorporated de facto into each of the specific key uncertainties.

The Project participants agreed that due to the many uncertainties the mix of habitats that will optimally meet the project objectives including the amount of tidal restoration and its location cannot be predicted at this time. Therefore the project will be implemented and evaluated in phases and will use adaptive management as the process for determining how far the system can move toward full tidal action and associated tidal habitats while still meeting the project objectives (Trulio et al. 2007).

The Project is led by the U.S. Fish and Wildlife Service California Department of Fish and Game Conservancy Santa Clara alley Water District and Alameda County Flood Control and Water Conservation District.

Adaptive Management. Adaptation planning and implementation should be based on the principles of adaptive management so that they take into account uncertainty and maximize the opportunities to learn from management actions. (See Box 5.1.) This requires careful monitoring which takes time financial resources and scientific and technical expertise. Although advances in science have led to better climate change projections there is still a large degree of uncertainty about future rates of sea level rise. There is also uncertainty about climate change impacts and the effectiveness of adaptation measures. Scientific and technical knowledge will continue to develop at a rapid rate requiring planners and resource managers to create flexible management strategies and identify triggers for changing course when necessary.

Ecosystem-Based Management. Shoreline planning will become increasingly challenging as the line between uplands and baylands becomes more dynamic thereby requiring a creative planning approach that integrates natural resource management and land use planning. Ecosystem-based management (EBM) integrates human needs and systems into marine or estuarine environmental management bringing stakeholders into decision-making processes and providing direction through those processes. EBM also recognizes the need for iterative approaches to managing complex systems i.e. adaptive management. EBM can provide a portfolio of approaches and the online tools to support these approaches ranging from tools for stakeholder outreach to mapping tools.

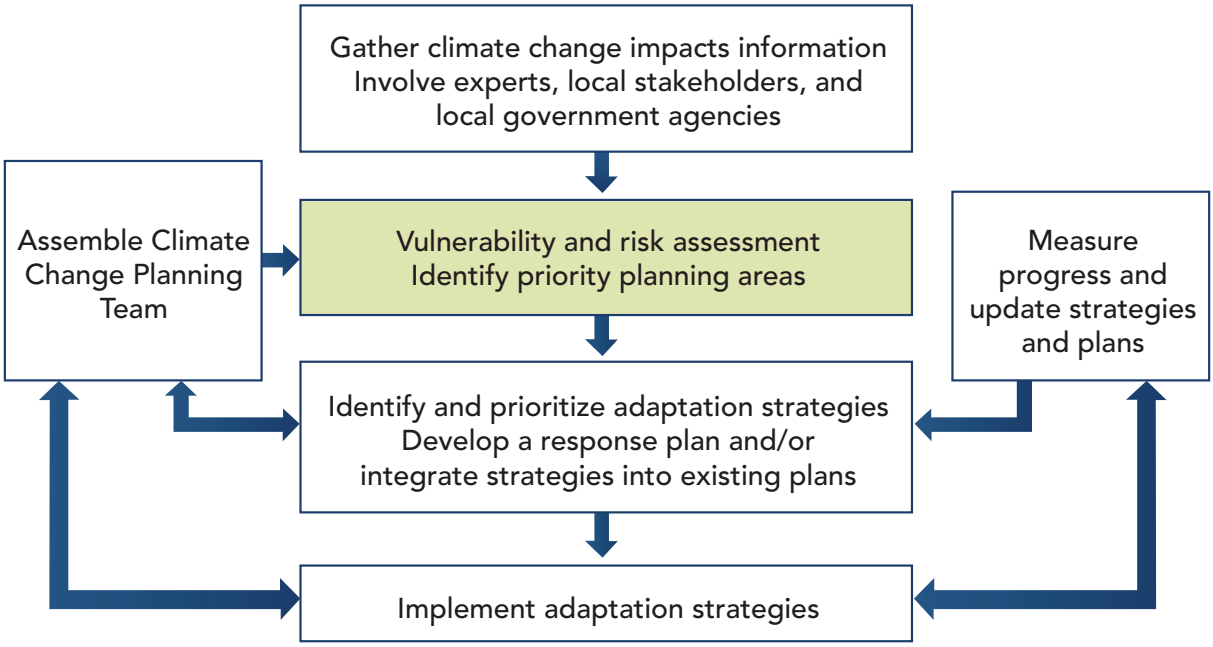
Integrating Mitigation and Adaptation. While mitigation lessens future impacts by taking steps to reduce greenhouse gas emissions and capture greenhouse gases adaptation makes communities infrastructure and the natural environment more resilient to the impacts from emissions. Mitigation has traditionally been at the forefront of the global climate change dialogue as the world attempts to avoid further altering the Earth s atmosphere. Adaptation reduces the vulnerability of natural systems and human communities to existing or predicted climate change impacts.

ntegrating mitigation and adaptation planning can reduce inefficiencies and potential conflicts while providing greater protection. For example conserving and restoring tidal marsh provides flood protection and achieves mitigation by sequestering carbon. n addition increased habitat will be available to climate-stressed species. Another example is the siting of new sustainable communities outside of current and future floodplains. Development of sustainable communities in which housing is located near jobs and public transit reduces greenhouse gas emissions from driving while focusing such development in upland areas is one means of reducing its vulnerability to sea level rise.

Adaptation Planning Framework

Most adaptation planning frameworks include a few key steps: identifying a planning area and scoping of potential climate change impacts conducting vulnerability and risk assessments developing and implementing an adaptation plan and conducting monitoring and adaptive management. (See Figure 5.1.) BCDC developed the framework used in this report based on its review of several examples. The analysis in this report provides the basis for the Commission to identify ways to promote adaptation within BCDC s limited jurisdiction and to recommend that a collaborative process be undertaken in partnership with other regional agencies local governments and stakeholders to develop a regional strategy to deal effectively with sea level rise and other adaptation challenges in the Bay Area. The iterative nature of this framework will allow BCDC to continually incorporate new scientific knowledge and analytical tools as they are developed.

Figure 5.1. Climate Change Adaptation Planning Model



Vulnerability and Risk. A vulnerability assessment helps communities identify the resources the people places buildings infrastructure and natural areas that are most susceptible to climate change impacts. A risk assessment builds on the information developed in a vulnerability assessment by describing the likelihood that specific impacts will occur and the consequences those impacts would have for the community. Together these assessments are important steps in an adaptation planning process that can help communities define key issues related to climate change impacts determine how best to respond and decide when to take action.

n a vulnerability assessment communities examine how people property and resources are susceptible to the types of impacts associated with climate change. They begin by reviewing information about global and regional climate change trends to identify locally relevant impacts such as more frequent flooding and inundation due to sea level rise. Then to better understand these impacts the community can use its knowledge of existing resources and stressors to determine how and when it could be sensitive to change. Last the community can determine its capacity to cope with these impacts now and into the future.

n a risk assessment communities combine information about the economic social legal and ecological consequences of specific impacts with the likelihood that those impacts will occur in order to set priorities. A highly likely impact (such as higher daily tides) that has considerable negative consequences (such as inundation of critical transportation infrastructure or groundwater intrusion into a community s water supply) is a high-risk impact that should be elevated to an adaptation planning priority.

n this report a vulnerability analysis was conducted to understand the effects of climate change on San Francisco Bay and the shoreline. This effort began with identifying three systems that encompass the broad scope of climate change planning considerations: shoreline development the Bay ecosystem and governance. Current challenges facing each system were identified to provide a qualitative assessment of adaptive capacity and identify where challenges will be exacerbated with climate change. Two climate change scenarios were selected to evaluate the impacts on the Bay and shoreline. Where possible quantitative analysis was provided to illuminate the scale of the impact such as the size of an area or population affected. n the discussion on governance current challenges were identified in terms of the limits of the Commission s jurisdiction and authority and the needs of local governments.

Adaptation Strategies for San Francisco Bay and its Shoreline

Effective adaptation to address the climate change impacts identified in the vulnerability analysis will require action by a wide range of organizations and individuals. The ocean and coastal resources chapter of the 2009 California Climate Adaptation Strategy provides some guiding principles for making difficult decisions about maintaining and enhancing natural resources while protecting development and public safety:

- Protect public heath and safety and critical infrastructure.
- Protect restore and enhance ocean and coastal ecosystems on which our economy and wellbeing depend.
- Ensure public access to coastal areas and protect beaches natural shoreline and park and recreational resources.
- Plan and design new development and communities so they will be sustainable over the long term in the face of climate change.
- Facilitate adaptation of existing development and communities to reduce their vulnerability to climate change impacts over time.
- Begin now to adapt to the impacts of climate change.

The Bay Area will need to select adaptation strategies to address key vulnerabilities that occur at various scales and timeframes. n the near term the Commission has limited legal authority to ensure that sea level rise is taken into consideration in the design of projects within BCDC s jurisdiction. n the long run the Commission can help facilitate a collaborative process to develop a regional strategy to deal effectively with sea level rise and integrate climate change mitigation and adaptation planning in the Bay Area. The following sections focus on adaptation strategies that the Commission can undertake and encourage through amendment of the Bay Plan to address the issues identified in the vulnerability assessment and discuss the Commission s role in facilitating the development of a regional strategy.

1. Shoreline Development

The heavily developed Bay shoreline supports multiple competing uses including residential commercial industrial and recreational uses. Shoreline development that is now potentially exposed to a 100-year high water event could be exposed to the average high tide by mid-century. Approximately half of the development potentially at risk is residential. Large commercial and industrial areas will also be at risk of flooding or permanent inundation especially in San Francisco Silicon alley and Oakland. Ports airports water-related industry

wastewater treatment plants waterfront parks and beaches trails and other important facilities are all at risk. n addition many of the major roads highways and railroads within the region may be significantly impacted by sea level rise and extreme flooding events.

Critical public infrastructure and essential development on the Bay shoreline will require protection to prevent flooding and permanent inundation from sea level rise yet protecting all developed areas may prove to be financially infeasible or ecologically destructive. n the long-term the region needs to engage in an open and vigorous public dialogue to make the difficult decisions about where and how existing development should be protected and infill development encouraged where new development should or should not be permitted and where existing development should eventually be removed to allow the Bay to migrate inland.

The Commission has limited authority to address climate change sea level rise and related impacts for projects that involve the placement of fill in the Bay. Within the 100-foot shoreline band the Commission s authority is limited to requiring maximum feasible public access and land use consistency within priority use areas. This limitation prevents the Commission from requiring that development on the shoreline is sited and designed to avoid or minimize impacts from future flooding due to sea level rise. However the Bay Plan can be amended to incorporate the following objectives for achieving resilience to flooding when planning and designing shoreline projects.

Risk Assessments and Adaptive Management Plans. Risk assessments should be conducted for larger shoreline projects and updates of plans addressing shoreline areas vulnerable to flooding. These assessments should use the best available science-based projection for sea level rise at the end of the century and should identify all types of potential flooding degrees of uncertainty consequences of defense failure and risks to existing habitat from proposed flood protection devices. Shoreline plans and larger shoreline projects should be designed to be resilient to a mid-century sea level rise projection and if it is likely the project will remain in place longer than mid-century an adaptive management plan should be prepared to address the long-term impacts. To be cost-effective risk assessments should not be prepared for projects that do not significantly increase overall risks to public safety such as small projects repairs of existing facilities interim uses and public parks.

Evaluating Project Proposals. Large projects proposed in vulnerable areas should be evaluated on a case-by-case basis to determine the project s public benefits resilience to flooding and capacity to adapt to climate change impacts. Projects with regional benefits such as environmental remediation critical public infrastructure infill that concentrates employment or housing near transit service and natural resource restoration or enhancement should be

encouraged if their regional benefits and their advancement of regional goals outweigh the risks from flooding. Projects that do not negatively impact the Bay and do not increase risks to public safety such as repairs small projects interim uses and public parks should also be encouraged.

Safety of Fills. Flood damage to fills and shoreline areas can result from a combination of sea level rise storm surge rainfall high tides and winds blowing onshore. The most effective way to prevent such damage is to locate projects and facilities above the 100-year flood level that takes future sea level rise into account during the expected life of the project. Adequate measures should be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. The Commission may approve fill that is needed to provide flood protection for existing projects and uses as long as the fill is the minimum necessary and serves a water-oriented use.

New projects on the shoreline should either to either be set back from the edge of the shore so that the project will not be subject to dynamic wave energy be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project be specifically designed to tolerate periodic flooding or employ other effective means of addressing the impacts of future sea level rise and storm activity. Rights-of-way for levees or other structures protecting inland areas from tidal flooding should be sufficiently wide on the upland side to allow for future levee widening to support additional levee height so that no fill for levee widening is placed in the Bay.

Shoreline Protection. Critical public infrastructure and essential development on the Bay shoreline will require protection to prevent inundation and flooding from sea level rise. BCDC s existing shoreline protection policies focus on protecting the shoreline from erosion. Due to sea level rise the Commission needs amended policies to enable it to address shoreline flooding as well as erosion. Shoreline protection can be structural natural or a combination of both. Choosing the appropriate form of shoreline protection one that both protects public safety and minimizes ecosystem impacts is critically important.

New shoreline protection projects and the maintenance or reconstruction of existing projects and uses should be allowed if the project is necessary to provide flood or erosion protection for (a) existing development use or infrastructure or (b) proposed development use or infrastructure that is consistent with other Bay Plan policies. The type of the protective structure should be appropriate for the project site the uses to be protected and the erosion and flooding conditions at the site. nowledgeable professionals such as civil engineers experienced in coastal processes should participate in the design.

Addressing the impacts of sea level rise and shoreline flooding may require large-scale flood protection projects including some that extend across jurisdictional or property boundaries. Coordination with adjacent property owners or jurisdictions to create contiguous effective shoreline protection is critical when planning and constructing flood protection projects. Failure to coordinate may result in inadequate shoreline protection (e.g. a protection system with gaps or one that causes accelerated erosion in adjacent areas). Each project should be integrated with current or planned adjacent shoreline protection measures.

Shoreline protection projects should include provisions for nonstructural methods such as marsh vegetation and integrate shoreline protection and Bay ecosystem enhancement using adaptive management whenever feasible. Along shorelines that support marsh vegetation shoreline protection projects should establish transitional upland vegetation as part of the protective structure whenever feasible. Shoreline protection projects should be properly designed and constructed to prevent significant impediments to physical and visual public access. The adverse impacts to natural resources and public access from new shoreline protection should be avoided. Where adverse impacts cannot be avoided habitat mitigation or alternative public access should be provided.

High Water Level Metric. The Bay Plan policies should be amended to use a more appropriate measure of high water levels. Staff considered three alternative measures that could be used as a base high water level metric on to which sea level rise can be added when designing projects to be resilient or adaptable to climate change: (1) highest estimated tide (2) Base Flood Elevation (BFE) provided by the Federal Emergency Management Agency (FEMA) and (3) a case-by-case determination of the appropriate high-water metric based on individual project characteristics.

BCDC s existing Bay Plan policies require all projects within the Commission s jurisdiction to be built above the highest estimated tide and wave run up levels for the life of the project. The highest estimated tide (NG D) with an expected recurrence interval of 100 years is available for sites around the Bay based on a 1984 Army Corps of Engineers analysis of the highest yearly tide level observed at the Presidio for the period from 1855-1983. Since the highest estimated tide is based on an extrapolation of data from one tide gauge (the Presidio) and is based on the historic record this metric has limited utility for producing accurate estimates of future conditions in the entire estuary. n addition site-specific conditions such as wave run up and watershed contributions from runoff are generally underestimated by this metric. The case-by-case approach creates a great deal of uncertainty regarding the appropriate metrics to be used for project evaluations and would create difficulties for permit applicants and their consultants when analyzing project vulnerabilities and developing resilient designs and adaptation plans.

Representatives of the Bay Area Flood Protection Agencies Association (BAFPAA) the Bay Area s regional flood control experts recommended that BFE provided on maps published by FEMA be used because: (1) BFE reflects 100-year flood stillwater elevations plus wave run up (2) FEMA wave run up values are conservative (3) interpolation between nearest published elevations is an acceptable way to estimate elevations for locations that do not have a published BFE (BAFPAA 2010). Therefore the Bay Plan should be revised to recommend using the estimated 100-year flood elevation that takes sea level rise into account (i.e. BFE plus sea level rise) in risk assessments in the design of projects on fill or near the shoreline and in the design of shoreline protection projects.

Public Access. Accelerated flooding from sea level rise and storm activity will severely impact existing shoreline public access resulting in temporary or permanent closures. Periodic and consistent flooding would increase damage to public access areas which can then require additional fill to repair raise maintenance costs and cause greater disturbance and displacement of the site s natural resources. Risks to public health and safety from sea level rise and shoreline flooding may require new shoreline protection to be installed or existing shoreline protection to be modified which may impede physical and visual access to the Bay. Flooding from sea level rise and storm activity increases the difficulty of designing public access areas (e.g. connecting new public access that is set at a higher elevation or located farther inland than existing public access areas). Public access should be sited designed managed and maintained to avoid significant adverse impacts from sea level rise and shoreline flooding. Any public access provided should either be designed to remain viable in the event of future sea level rise or flooding or equivalent access should be provided nearby.

2. Bay Ecosystem

The Bay ecosystem is already stressed by human activities that lower its adaptive capacity such as diversion of freshwater inflow and conversion of tidal wetlands. These activities have resulted in losses in critical estuarine functions loss of habitat extent and compromised water quality. Climate change will further alter the ecosystem by inundating or eroding wetlands and transitional habitats changing sediment dynamics altering species composition raising the acidity of Bay waters changing freshwater inflow or salinity altering the food web and impairing water quality all of which may impair the system s ability to rebound and function. Changes in salinity from reduced freshwater inflow will affect fish wildlife and other aquatic organisms in intertidal and subtidal habitats. Further inundation of tidal wetlands is potentially devastating to the San Francisco Bay ecosystem. Moreover further loss of tidal wetlands will increase the risk of shoreline flooding.

Tidal Marshes and Tidal Flats. The highly developed Bay shoreline constrains the ability of tidal marshes to migrate landward while the declining sediment supply in the Bay reduces the ability of tidal marshes to grow upward as sea level rises. The loss of transitional habitats such as the upland ecotone to erosion or inundation would devastate a diverse number of species including California clapper rail and the salt marsh harvest mouse who use these habitats for refuge during high tides.

ey issues that resource managers must address regarding adaptation planning for tidal marshes and tidal flats include: protecting undeveloped areas with current or potential habitat value identifying opportunities for tidal wetlands and tidal flats to migrate landward by maintaining sufficient upland buffer areas developing and planning for natural flood protection managing and maintaining adequate volumes of sediment for marsh restoration and preservation and updating regional ecosystem targets to take climate change into consideration.

Some undeveloped low-lying areas that are at risk of shoreline flooding contain important habitat or provide opportunities for habitat enhancement. Preservation or restoration of tidal habitat in these areas could help offset the loss of tidal habitat due to sea level rise in other areas.

Buffers are areas established adjacent to a habitat to reduce the adverse impacts of surrounding land use and activities. Buffers around tidal wetlands could minimize loss of habitat from shoreline erosion resulting from accelerated sea level rise and allow tidal habitats to move landward.

Nonstructural shoreline protection methods such as tidal marshes can provide effective flood control. n some instances it may be possible to combine habitat restoration enhancement or protection with structural approaches to provide protection from flooding and control shoreline erosion thereby minimizing the shoreline protection project s impact on natural resources.

Sedimentation is an essential factor in the creation maintenance and growth of tidal marsh and tidal flat habitat. However scientists have observed that the volume of sediment entering the Bay annually is declining. As sea level rises an inadequate sediment supply could adversely affect the sustainability of tidal wetland restoration projects. Human actions such as dredging disposal ecosystem restoration and watershed management can affect the distribution and amount of sediment available to sustain and restore wetlands.

The Baylands Ecosystem Habitat Goals report provides a regional vision of the types amounts and distribution of wetlands and related habitats that are needed to restore and sustain a healthy Bay ecosystem including restoration of 65 000 acres of tidal marsh. These recommendations were based on conditions of tidal inundation salinity and sedimentation in the 1990s. While achieving the regional vision would help promote a healthy resilient Bay ecosystem global climate change and sea level rise are expected to alter ecosystem processes in ways that require new regional targets for types amounts and distribution of habitats.

The Bay Plan can be amended to incorporate the following objectives for achieving environmental sustainability in the face of climate change. Habitat preservation and enhancement should be encouraged in undeveloped areas that are both vulnerable to future flooding and currently sustain significant habitats or species or possess conditions that make the areas especially suitable for ecosystem enhancement. Each ecosystem restoration project should include an appropriate buffer where feasible between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises. Shoreline protection projects should include provisions for establishing marsh and transitional upland vegetation as part of the protective structure wherever feasible. Comprehensive Bay sediment research and monitoring should be supported to understand sediment processes necessary to sustain and restore wetlands. Monitoring methods should be updated periodically based on current scientific information. Regional ecosystem targets should be updated periodically to guide conservation restoration and management efforts that result in a Bay ecosystem resilient to climate change and sea level rise.

3. Governance

Managing the threats to the Bay and shoreline development from sea level rise will create major challenges for the governance system in the Bay Area. Numerous government agencies create a patchwork of authority that requires a strong but flexible network of partnerships. As mentioned above failure to coordinate across property lines and jurisdictional boundaries could result in gaps in the shoreline protection system and accelerated erosion in adjacent areas. An uncoordinated approach to flood protection could also result in cumulative adverse impacts to tidal marshes and other important habitats. Conversely coordinated regional planning will be essential to gaining political support for regional funding for flood protection and ecosystem restoration programs.

Regional Strategy. The Commission was created in 1965 because haphazard filling was shrinking the Bay. Although this issue has been successfully addressed climate change and accompanying sea level rise are causing the Bay to expand at an increasing rate. Sea level rise has put shoreline development and habitats throughout the region at risk and creating the need for a comprehensive regional strategy that addresses this challenge.

Developing a regional strategy to address sea level rise will help the Bay Area avoid the pitfalls of the piecemeal approach and capitalize on the opportunity to continue to lead the nation in climate change adaptation. The goal of this strategy should not be to restore the Bay to historic conditions. nstead the strategy should describe a vision for resilient communities and adaptable natural areas around a dynamic and changing Bay that will have different sea level elevations different salinity levels different species and different chemistry than the Bay has today. The strategy should embrace an adaptive management strategy aimed at putting conditions in place that can respond in a desired way to changes that will come about in the future as a result of climate change. The task sounds daunting but for over 60 years the Bay Area has pioneered regional action regarding difficult decisions and environmental hazards (See Box 5.2.).

This new strategy should draw from the lessons learned during the formulation and implementation of BCDC s existing highly effective San Francisco Bay Plan particularly the plan s goal of balancing conservation and development. The new strategy should integrate ecosystem-based adaptive management principles to ensure that future development shoreline retreat flood protection and wetland enhancement strategies are coordinated to achieve a vibrant healthy Bay co-existing with sustainable communities around the Bay.

The regional strategy should also build on the FOCUS program initiated by the Association of Bay Area Governments and the Metropolitan Transportation Commission to promote a more compact Bay Area land use pattern. n consultation with local governments the FOCUS program has identified Priority Development Areas (PDAs) for infill development in the Bay Area. These PDAs along with other sites are anticipated to be key components of the Bay Area s Sustainable Communities Strategy that will be adopted and periodically updated pursuant to SB 375.

One of the Commission s objectives in adopting climate change policies is to facilitate implementation of the Sustainable Communities Strategy. Some shoreline areas that are already improved with public infrastructure and private development that have regionally significant economic cultural or social value and can accommodate infill development including some PDAs are also vulnerable to shoreline flooding. n such cases the regional goal of concentrating

housing and job density near transit conflicts with the goal of minimizing flood risk by avoiding development in low-lying areas vulnerable to flooding. Reconciling these different worthy goals and taking appropriate action requires weighing competing policy considerations and is best accomplished through a collaborative process involving diverse stakeholders similar to that being undertaken to develop the Sustainable Communities Strategy.

The Commission in collaboration with the oint Policy Committee other regional state and federal agencies local governments and the general public should formulate a regional sea level rise adaptation strategy for protecting critical developed shoreline areas and natural ecosystems enhancing the resilience of Bay and shoreline systems and increasing their adaptive capacity. deally the regional strategy will determine where and how existing development should be protected and infill development encouraged where new development should and should not be permitted and where existing development should eventually be removed to allow the Bay to migrate inland.

To develop a regional strategy the Commission could amend the Bay Plan policies to recommend that:

- The regional strategy incorporate an adaptive management approach

Box 5.2 Regional Problems, Regional Solutions: A History of Regional Action on Public Safety and Environmental Issues in the Bay Area.

The Bay Area Air uality Management Districts website describes how the region came together to address poor air quality (http://www.baaqmd.gov/50th/index.html). When America s fighting forces came home from World War many settled in the last place they saw before going overseas--California s embarkation ports. Here they went to school on the G Bill married bought homes and began the biggest baby boom the world has ever seen. With this population growth came expanding urban areas shrinking agricultural lands and the building of housing developments farther from urban centers. For the first time in many years cars were available affordable and now necessary to reach the new suburbs.

The term smog originally coined to describe the combination of smoke and fog prevalent in London soon became a household word in the Bay Area with open fires from dumps and wrecking yards burning 24 hours a day. nitially measured in levels of eye irritation air pollution was becoming a major problem causing significant damage to Bay Area crops.

n 1946 the California Legislature enacted the first air pollution control law authorizing the formation of county air pollution control districts. Los Angeles County opened the first air pollution control office in early 1947 and Santa Clara County followed soon after. However by 1950 it was evident that pollution overflowed political boundaries and that a single-county district was not the answer for the Bay Area. n 1955 the Bay Area Air Pollution Control Law was adopted establishing the Bay Area Air Pollution Control District as the first regional air pollution control agency in the nation.

Alarmed by the fact that between 1850 and 1960 an average of four square miles of the Bay were filled each year in 1961 citizens in the Bay Area formed the Save San Francisco Bay Association now called Save the Bay. At the urging of this organization state legislation--the McAteer-Petris Act--was passed in 1965 to establish the San Francisco Bay Conservation and Development Commission (BCDC) as a temporary state agency. The Commission was charged with preparing a plan for the long-term use of the Bay and regulating development in and around the Bay while the plan was being prepared.

The San Francisco Bay Plan which was completed in anuary 1969 includes policies on issues critical to the wise use of the Bay ranging from ports and public access to design and transportation. The Bay Plan also contains maps of the entire Bay which designate shoreline areas that should be reserved for water-related purposes like ports industry public recreation airports and wildlife refuges.

- The strategy be consistent with the goals of SB 375 and the principles of the California Climate Adaptation Strategy
- The strategy be updated regularly to reflect changing conditions and scientific information and include maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding
- The maps be prepared under the direction of a qualified engineer and regularly updated in consultation with government agencies with authority over flood protection and
- Particular attention be given to identifying and encouraging the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies.

The Commission could also recommend that the entities that formulate the regional strategy consider the following strategies and goals:

- Advance regional public safety and economic prosperity by protecting: (i) existing development that provides regionally significant benefits (ii) new shoreline development that is consistent with other Bay Plan policies and (iii) infrastructure that is crucial to public health or the region s economy such as airports ports regional transportation wastewater treatment facilities major parks recreational areas and trails
- Enhance the Bay ecosystem by identifying areas where tidal wetlands and tidal flats can migrate landward assuring adequate volumes of sediment for marsh accretion identifying conservation areas that should be considered for acquisition preservation or enhancement developing and planning for flood protection and maintaining sufficient transitional habitat and upland buffer areas around tidal wetlands
- ntegrate the protection of existing and future shoreline development with the enhancement of the Bay ecosystem such as by using feasible shoreline protection measures that incorporate natural Bay habitat for flood control and erosion prevention
- Encourage innovative approaches to sea level rise adaptation
- dentify a framework for integrating the adaptation responses of multiple government agencies
- ntegrate regional mitigation measures designed to reduce greenhouse gas emissions with regional adaptation measures designed to address the unavoidable impacts of climate change
- Address environmental justice and social equity issues

- ntegrate hazard mitigation and emergency preparedness planning with adaptation planning by developing techniques for reducing contamination releases structural damage and toxic mold growth associated with flooding of buildings and establishing emergency assistance centers in neighborhoods at risk from flooding
- Advance regional sustainability encourage infill development and job creation and provide diverse housing served by transit
- Encourage the remediation of shoreline areas with existing environmental degradation and contamination in order to reduce risks to the Bay s water quality in the event of flooding
- Support research that provides information useful for planning and policy development on the impacts of climate change on the Bay particularly those related to shoreline flooding
- dentify actions to prepare and implement the strategy including any needed changes in law and
- dentify mechanisms to provide information tools and financial resources so local governments can integrate regional climate change adaptation planning into local community design processes.

Adaptation Tools for Local Government. Local governments and other management agencies with broad authority over shoreline land use and flood risk mitigation will play important roles in developing and implementing a regional strategy for sea level rise adaptation. Until a regional strategy is developed local governments will have the primary responsibility for addressing sea level rise but they often lack adequate information financial and technical resources and policy guidance. Assistance to local governments and public management agencies can provide staff and financial resources and/or information that can easily be integrated into existing operations planning tools guidance documents and planning processes.

Local governments can use a variety of tools to implement climate change adaptations strategies. Regulatory market-based and spending tools such as those described below have potential to help fund the protection of existing and planned development promote resilient development that can accommodate flooding shift new development away from floodplains address the needs of vulnerable populations and preserve open space and public benefits.

- **Flood Zone Mapping, Codes and Ordinances.** Local governments rely on flood zones mapped by the Federal Emergency Management Agency (FEMA). FEMA currently bases flood risk analysis on past events but can incorporate additional risk associated with sea level rise into its maps if requested to do so by a local government. Within the 100-year floodplain FEMA requires communities to meet its flood protection standards in order to qualify for federal flood insurance. FEMA provides the incentive of lower insurance rates to local governments through the Community Rating System in which local governments receive higher ratings for practicing good floodplain management. For example higher ratings are awarded for implementing building codes that provide flood protection and for requiring that development sites are elevated.

  BCDC s staff is currently working with partners to develop a regional sea level rise visualization tool that would enable local governments and others to see how various projected sea levels would impact their communities. While this type of visualization would not have any regulatory status it could be used to inform long-range planning efforts.

- **Clustered Development.** One type of open space zoning that could be applied to reduce flood risk is clustered development which only allows development in one area of a parcel. Where parcels are adjacent sometimes development is clustered near adjacent property lines to maximize open space within a few parcels. Under this strategy development could be allowed in flood zones but strategically located back from the shoreline to provide space for the shoreline to move.

- **Purchase or Transfer of Development Rights.** A purchase or transfer of development rights program is usually a voluntary program in which landowners sell the development rights of their land to an intermediary usually a nonprofit land trust or a public agency. Such programs have traditionally been used to protect farmland and scenic vistas from development but could be applied to flood zones as well. Once the development rights are sold the right to develop or subdivide that land is permanently relinquished. The landowner retains all other rights and responsibilities associated with the land (Gathering Waters Conservancy). Relinquishing the development rights is similar to having a conservation easement on the property. To establish the value of the development rights the estimated sale price of the property with a conservation easement is subtracted from the current market value of the property with its development rights (Western Governors Association 2001).

n the case of transfer of development rights program a landowner who wishes to develop at higher density in another location can purchase rights from the intermediary organization or agency. This type of program is advantageous to local governments because it does not cost them anything as long as there is a market for increased density. f such a program were applied to reduce development in a flood zone the program could require that the development credits be transferred only to areas within a certain boundary but outside the flood zone.

- **Social Equity Study and Financial Assistance Programs.** As discussed in Chapter 2 additional research is necessary to develop more information on the potential impacts of sea level rise to particularly vulnerable populations including low-income communities persons with limited English proficiency the elderly children and persons with disabilities or chronic illnesses and to develop quantitative data on their vulnerability to future flooding. The region must work collaboratively to develop outreach and assistance programs for those most in need. Measures to include vulnerable populations in regional decision-making should be identified and implemented. Social-equity environmental justice organizations and public agencies are already working on climate change mitigation and other measures to reduce climate change impacts to and increase resilience of vulnerable populations. Addressing risks and impacts associated with sea level rise must be incorporated into these efforts now to allow sufficient time to successfully adapt in the future.

- **Development Conditions.** Local governments can consider imposing special conditions when issuing permits for development of individual parcels or subdivisions that they have determined are vulnerable to sea level rise. The following examples are provided and discussed in greater detail in the Georgetown Climate Center s Sea Level Rise Adaptation Toolkit (Grannis 2011):

    - Restrictions on hard armoring the landowner agrees not to build hard coastal armoring in the future to protect structures from flooding. These types of conditions can plan for and authorize soft-armoring solutions.

    - Removal requirements the landowner agrees to remove structures when the tideline recedes such that his or her structure encroaches on public lands. As the seas rise the boundary between private lands and public beaches (the tideland) will be pushed inland. This type of condition allows landowners to develop property but with the expectation that development will eventually cede to the rising seas.

- Dedications the landowner dedicates an easement to preserve natural buffers floodways or to provide public access.
- mpact fees the developer is required to pay a fee to cover the costs of potential emergency response flood-proofing infrastructure servicing the new development future armoring or mitigating impacts to natural resources from future armoring.
- Flood-proofing requirements developers must design the new development and its supporting infrastructure to be more resilient to flood impacts. For example permits could require that roads be elevated and that sewer lines be flood-proofed.

- **Limitations on Rebuilding in High Risk Areas.** f structures in certain zoned areas are subsequently damaged by flooding jurisdictions could limit reconstruction. The following examples are discussed in greater detail in the Georgetown Climate Center s Sea Level Rise Adaptation Toolkit (Grannis 2011):
    - Allow limited rebuilding landowners are allowed to build smaller more resilient structures to replace older damaged structures or additional setbacks could be required.
    - Totally prohibit rebuilding landowners are prohibited from rebuilding properties destroyed when located in flood- or erosion-prone areas.
    - Allow reconstruction without armoring landowners are allowed to rebuild properties largely as they were but with the condition that they will not build protective armoring. Regulators could then prohibit rebuilding if the structure is subsequently damaged or destroyed.

The Commission currently assists local governments in adaptation planning by providing training workshops producing case studies featuring local examples of adaptation in action maintaining a clearinghouse of climate change resources on the BCDC website and working collaboratively on an adaptation planning pilot project in Alameda County the Adapting to Rising Tides (ART) project. The Commission also works in partnership with several other agencies and organizations that provide adaptation support to local governments such as the National Oceanic and Atmospheric Administration s Coastal Services Center the San Francisco Bay National Estuarine Research Reserve the Association of Bay Area Governments CLE - Local Governments for Sustainability U.S. Environmental Protection Agency s Climate Ready

Estuaries program and FEMA. Additional cooperation can help the region develop a strategy that protects the Bay ecosystem and public access to the shoreline while recognizing the key role of local governments in planning for climate change both within and beyond the Commission s jurisdiction.

Table 5.1. Summary of Adaptation Strategies

Shoreline Development
Conduct risk assessments for shoreline areas and larger shoreline projects.
Design projects to be resilient to a mid-century sea level rise projection and adaptable to longer-term impacts.
Build projects that do not negatively impact the Bay and do not increase risks to public safety or if projects do increase flood risks ensure that regional public benefits outweigh the increased risk of flooding.
Protect new projects from future storm activity and sea level rise by using setbacks elevating structures designing structures that tolerate flooding or other effective measures.
Set aside land on the upland side of levees to allow for future levee widening to support additional levee height so that no fill is placed in the Bay.
Build shoreline protection only if necessary to protect existing or appropriate planned development.
Design and construct shoreline protection to avoid blocking physical and visual public access.
ntegrate shoreline protection projects with current or planned adjacent shoreline protection measures.
nclude provisions for nonstructural shoreline protection methods such as marsh vegetation whenever feasible.
Avoid reduce or mitigate adverse impacts to natural resources and public access from new shoreline protection.
Site design manage and maintain public access to avoid significant adverse impacts from sea level rise and shoreline flooding.
Design any public access to remain viable in the event of future sea level rise or flooding or provide equivalent access to be provided nearby.

Bay Ecosystem
Preserve and enhance habitat in undeveloped areas that are both vulnerable to future flooding and have current or potential value for important species.
nclude a buffer where feasible between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises.
Design shoreline protection projects to include provisions for establishing marsh and transitional upland vegetation as part of the protective structure wherever feasible.
Conduct comprehensive Bay sediment research and monitoring to understand sediment processes necessary to sustain and restore wetlands.
Update regional habitat conservation and restoration targets to achieve a Bay ecosystem resilient to climate change and sea level rise.

Governance
Develop a regional strategy for conservation and development of the Bay and its shoreline that incorporates adaptive management.
Ensure that the strategy is consistent with the climate change mitigation goals of SB 375 and the principles of the California Climate Adaptation Strategy.
Update the strategy regularly to reflect changing conditions and scientific information.
nclude maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding.
Prepare the maps under the direction of a qualified engineer and regularly update them in consultation with government agencies with authority over flood protection.
dentify and encourage the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies.
Address environmental justice and social equity issues.
ntegrate hazard mitigation and emergency preparedness planning with adaptation planning.
Develop a framework for integrating the adaptation responses of multiple government agencies.
Provide information tools and financial resources to help local governments integrate regional climate change adaptation planning into local community design processes.

Summary of Proposed Bay Plan Amendment

Adaptation to climate change should be incorporated into the Bay Plan in the following manner:

1. Create a climate change policy section of the Bay Plan that addresses the following:
   a. ncorporating sea level rise projection ranges in project design and planning and using them in the permitting process
   b. Developing a long-term strategy to address sea level rise and storm activity and other Bay-related impacts of climate change in a way that protects the shoreline and the Bay and allows for appropriate well-planned development that responds to the impacts of climate change and future sea level rise
   c. Working with the oint Policy Committee (PC) and other agencies to integrate mitigation and adaptation strategies at a regional scale to coordinate the adaptation responses of multiple government agencies to analyze and address equity issues and to support research that provides useful climate change information and tools
   d. Providing recommendations and requirements to guide planning and permitting of development in areas vulnerable to sea level rise and
   e. ncluding policies that promote wetland protection creation enhancement and migration.
2. Amend findings and policies on tidal marshes and tidal flats to ensure that buffer zones are incorporated into restoration projects where feasible and sediment issues related to sustaining tidal marshes are addressed.
3. Amend the policies on safety of fills by updating the findings and policies on sea level rise and moving some to the new climate change section of the Bay Plan.
4. Amend the policies on protection of the shoreline to address protection from future flooding.
5. Amend findings and policies on public access to provide public access that is sited designed and managed to avoid significant adverse impacts from sea level rise and ensures long-term maintenance of public access areas through site-specific adaptive management strategies.

Conclusion

Global climate change has been described as one of the most challenging problems ever faced by humans. The quality of the lives of future generations depends on how the current generation deals with this challenge. The course outlined in this report is an initial cautious and modest step in the long journey the people of the Bay Area will need to take to ensure that our region remains viable sustainable and prosperous in the future and that our beloved San Francisco Bay continues to be protected.

APPENDIX A
METHODS FOR DEVELOPING DATA

n order to perform the analysis and mapping performed in this report it was necessary to accurately identify areas vulnerable to projected sea level rise. A team led by Noah nowles USGS built a hydrodyamic model to identify areas at risk of inundation under a variety of sea level rise scenarios. n order to identify areas vulnerable to these inundation scenarios it was necessary to assemble the best available elevation data into a regional grid integrate historic (1996-2007) tidal data and overlay with estimated increases in sea level 40 and 140 cm.

A regional digital elevation data set was assembled that was comprised of a number of data sources including LiDAR (Light Detection and Ranging) in the South Bay and in portions of Solano County and Napa County. Additional photogrammetry and satellite based data was assembled to create the regional data set. The data has a horizontal resolution of 2 m and nearly all areas have a vertical accuracy of between 10 and 30 cm.

n order to integrate the elevation of the water within the estuary a hydrodynamic model of the system was driven by hourly data collected between 1996-2007 at the Golden Gate. This historic data captures the temporal range in tides as well as storm based inputs such as storm surge. The model then propagates the fluctuations throughout the Bay and towards the Delta as far east as Mallard sland. The model was verified using tide gauge data in various locations throughout the Bay. Based on the historic data the mean monthly high water was mapped for the Bay at 200 m resolution which corresponds with present day average monthly high water. Finally the water surface height within the model was modified by 40 cm and 140 cm to integrate Rahmstorf s projections (2007). Further verification was performed by comparing water height fields for present day and projected conditions to land elevations (nowles 2008).

REFERENCES CITED

Association of Bay Area Governments (ABAG). 2008. nformation about Bay Area land use and demographics nternet . Oakland CA. http://bayareavision.org/bayarea

ABAG. 2006. Disasters Affecting the San Francisco Bay Area from 1950 2006. http://quake.abag.ca.gov/mitigation/disaster-history.html. Accessed February 27 2009.

ABAG. 2005. Taming Natural Disasters: Multi- urisdictional Local Government Hazard Mitigation Plan for the San Francisco Bay Area. http://quake.abag.ca.gov/mitigation/plan.html

Airport Commission San Francisco City and County. 2008 Analysis of Airline Traffic nteroffice Memorandum.

Airports Council nternational-North America (AC -NA). 2010. Airport Traffic Reports: 2010 North American Final Rankings. http://aci-na.org/content/airport-traffic-reports

Alley Richard B. et al. 2005. ce-Sheet and Sea Level Changes. Science. October 21 2005. ol. 310: 456-460. www.sciencemag.org

Arnold A. 1996. Suisun Marsh history. Hunting and saving a wetland. Monterey Marina Publishing Company. Marina CA.

Atwater B.F. 1979. Ancient processes at the site of southern San Francisco Bay: movement of the crust and changes in sea level. n: San Francisco Bay: the urbanized estuary T. . Conomos (ed). American Association for the Advancement of Science San Francisco CA.

Atwater B.F. Hedel C.W. and E. . Helley. 1977. Late uaternary depositional history Holocene sealevel changes and vertical crustal movement southern San Francisco Bay California. U.S. Geological Survey Professional Paper 1014.

Barnett T.P. D.W. Pierce H.G. Hidalgo C. Bonfils B.D. Santer T. Das G. Bala A.W. Wood T. Nozawa A.A. Mirin D.R. Cayan and M.D. Dettinger. 2008. Human-induced changes in the hydrology of the Western United States. Science. 319. 22 February 2008.

Baron .S. C.D. Allen E. Fleishman L. Gunderson D. Mc enzie L. Meyerson . Oropeza and N. Stephenson 2008: National Parks. n: Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research ulius S.H. .M. West (eds.) .S. Baron B. Griffith L.A. oyce P. areiva B.D. eller M.A. Palmer C.H. Peterson and .M. Scott (Authors) . U.S. Environmental Protection Agency Washington DC USA pp. 4-1 to 4-68.

Bay Area Council Economic nstitute 2008 nformation about the Bay Area economy nternet San Francisco CA Bay Area Council Economic nstitute. http://www.bayeconfor.org/

Bay Area Economic Forum. 2004. The Future of Bay Area obs The mpact of Offshoring and Other ey Trends.

Bay Area Flood Protection Agencies Association (BAFPAA). 2010. Meeting of BAFPAA members and BCDC Staff. Participants: Ralph ohnston Alameda County Flood Control and Water Conservation District Mitch Avalon Contra Costa County Flood Control and Water Conservation District Tracy Clay Marin County Flood Control and Water Conservation District Cheryl Foster San Mateo County Flood Control District Carol Mahoney one 7 Water Agency oe LaClair BCDC Wendy Goodfriend BCDC Sara Polgar BCDC.

Bay Area Open Space Council. 1999. Regional Needs Briefing Book.

Bay Area Rapid Transit (BART). 2008. nformation about BART ridership nternet . Oakland CA. http://www.bart.gov/about/reports/index.aspx

Baye P.R. P.M. Faber and B. Grewell. 2000. Tidal Marsh Plants of the San Francisco Estuary. n: Baylands Ecosystem Species and Community Profiles: Life Histories and Environmental Requirements of ey Plants Fish and Wildlife. P.R. Olofson editor. Prepared by the San Francisco Bay Area Wetlands Ecosystems Goals Project. San Francisco Bay Regional Water uality Control Board Oakland CA.

Bindoff N.L. et al. 2007. Observations: Oceanic Climate Change and Sea Level. n: Climate Change 2007: The Physical Science Basis. Contribution of Working Group to the Fourth Assessment Report of the ntergovernmental Panel on Climate Change Solomon S. D. in M. Manning . Chen M. Marquis .B. Averyt M. Tignor and H.L. Miller (eds.) . Cambridge University Press. Cambridge U and N C USA.

Bromirski P.D. and R.E. Flick. 2008. Storm surge in the San Francisco Bay/Delta and nearby coastal locations. Shore Beach. 76(3): 29-37.

Bromirski Peter et al. 2002. Storminess ariability along the California Coast: 1858-2000. ournal of Climate. ol. 16: 892-993.

Byrne R. B.L. ngram S. Starratt F. Malamud-Roam .N. Collins and M.E. Conrad. 2001. Carbonisotope diatom and pollen evidence for late Holocene salinity change in a brackish marsh in the San Francisco Estuary. uaternary Research 55: 66-76.

Caldeira . M.E. Wickett. 2005. Ocean model predictions of chemistry changes from carbon dioxide emissions to the atmosphere and ocean. ournal of Geophysical Research. ol. 110.

California Air Resources Board (CARB). 2008. Climate Change Proposed Scoping Plan.

California Department of Transportation. 2008. 2007 H COMP State Highway Congestion Monitoring Program. CalTrans District 4.

California Ocean Protection Council. 2011. Resolution of the California Ocean Protection Council on Sea-Level Rise. http://www.opc.ca.gov/2011/04/resolution-of-the-california-ocean-protection-council-on-sea-level-rise/.

Carlton .T. . Thompson L.E. Schemel F.H. Nichols. 1990. Remarkable invasion of San Francisco Bay (California USA) by the Asian clam *Po a ocor la a r nsis* Marine ecology progress series. . ntroduction and dispersal. Oldendorf. ol. 66 no. 1-2 pp. 81-94.

Cayan D. A. Luers M. Hanemann G. Franco and B. Croes. 2006 (a). Scenarios of Climate Change in California: An Overview. A Report from the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency. CEC-500-2005-186-SF.

Cayan D. M. Tyree M. Dettinger H. Hidalgo T. Das E. Maurer P. Bromirski N. Graham and R. Flick. 2009. Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment. A Paper from the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency Sacramento CA. CEC-500-2009-014-F.

Cayan D.R. P.D. Bromirski . Hayhoe M. Tyree M.D. Dettinger and R.E. Flick. 2008. Climate Change Projections of Sea Level Extremes Along the California Coast. Climatic Change. 87 (Suppl 1): S57-S73. Doi: 10.1007/s10584-007-9376-7.

Cayan D. P. Bromirski . Hayhoe M. Tyree M. Dettinger and R. Flick. 2006 (b). Projecting Future Sea Level. A Report from the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency Sacramento CA. CEC-500-2005-202-SF.

Centre for Community Enterprise (CCE). 2000. The Community Resilience Manual. Canadian Cataloguing in Publication Data SBN 1895828-40-0.

Chao F.F. .H. Wu and .S. Li. 2008. mpact of Artificial Reservoir Water mpoundment on Global Sea Level. Science. 320(5873): 212

Church ohn A. and Neil . White. 2006. A 20th century acceleration in global sea level rise. Geophysical Research Letters. ol. 33. L01602. Doi: 10.1029/2005GLO24286.

Climate Action Team (CAT). 2006. Report to Governor Schwarzenegger and the Legislature. Prepared for the California Environmental Protection Agency. Sacramento CA.

Climate mpacts Group et al. 2007. Preparing for Climate Change: A Guidebook for Local Regional and State Governments. ing County Washington.

Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT). 2010. State of California Sea-Level Rise nterim Guidance Document. http://www.opc.ca.gov/2011/07/sea-level-rise-task-force-interim-guidance-document/

Coburn arrod et al. 2008. Building Resilient Communities: Defining Resilience. New ealand Resilience Trust.

Cohen A.N. .T. Carlton. 1998. Accelerating invasion rate in a highly invaded estuary. Science. ol. 279: 555-558.

Collins .N. 2002. nvasion of San Francisco Bay by smooth cordgrass *S ar ina al rni lora*: A forecast of geomorphic effects on the intertidal zone. California State Coastal Conservancy and U.S. and U.S. Environmental Protection Agency San Francisco CA.

Collins .N. et al. 2004. Syntheses of Scientific nowledge for Maintaining and mproving Functioning of the South Bay Ecosystem and Restoring Tidal Salt Marsh and Associated Habitats over the Next 50 ears at Pond and Pond-Complex Scales. San Francisco Estuary nstitute for the South Bay Salt Pond Restoration Project. Draft Final Report SFE Report No. 308.

Day .W. r. D.F. Boesch E. . Clairain G.P. emp S.B. Laska W. . Mitsch . Orth H. Mashriqui D. . Reed L. Shabman C.A. Simenstad B. . Streever R.B. Twilley C.C. Watson .T. Wells and D.F. Whigham. 2007. Restoration of the Mississippi Delta: Lessons from Hurricanes atrina and Rita. Science. 315: 1679- 1684.

Department of Water Resources State of California (DWR) Department of Fish and Game (DFG). 2008. Risks and options to reduce risks to fishery and water supply uses of the Sacramento/San oaquin Delta. Report pursuant to requirements of Assembly Bill 1200 Laird.

Doney S.C. . . Fabry R.A. Feeley and .A. leypas. 2009. Ocean Acidification: The Other CO2 Problem. Annu. Rev. Mar. Sci. 1 doi: 10.1146/annurev.marine.010908.163834 169-192.

DWR. 2008. Managing An Uncertain Future - Climate Change Adaptation Strategies for California s Water.

DWR. 2005. Suisun Marsh Levee Conceptual Model: State of nowledge ersion 4. Prepared for the Habitat Management Preservation and Restoration Plan for Suisun Marsh. Draft Report Environmental Planning and nformation Branch.

DWR. 1995. Delta Levees. Draft Report Division of Planning Delta Planning Branch.

Dreschler et al. 2005. A Report From the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency.

Feely R.A. C.L. Sabine . Lee W. Berelson . leypas . . Fabry et al. 2004. mpact of anthropogenic CO2 on the $CaCO^3$ system in the oceans. Science. 305: 362 366.

Flegal A. C.H. Conway .A. Davis and M. Connor. 2007. ntroduction Sources transport fate and toxicity of pollutants in the San Francisco Bay estuary. Environmental Research pp. 1-4.

Gathering Waters Conservancy. http://www.gatheringwaters.org

Global Climate Change and the South Bay Salt Pond Restoration Project. December 2007.

Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystems Goals Project. First Reprint. U.S. Environmental Protection Agency San Francisco CA/S.F. Bay Regional Water uality Control Board Oakland CA.

Governor s Delta ision Blue Ribbon Task Force. 2008. Our ision for the California Delta. Sacramento CA.

Grannis . Adaptation Tool it: Sea Level Rise Coastal Land Use: How Governments Can Use Land Use Practices to Adapt to Sea Level Rise (forthcoming Sep. 2011). Georgetown Climate Center. http://www.georgetownclimate.org/adaptation/index.php.

Hanes D.M. P.L. Barnard. 2007. Morphological evolution in the San Francisco Bight. ournal of Coastal Research. S 50. Proceedings of the 9th nternational Coastal Symposium. Gold Coast Australia.

Hansen .E. 2007. Scientific Reticence and Sea Level Rise. Environmental Research Letters. 2 (April- une 2007) 024002. Doi: 10.1088/1748-9326/2/024002.

Hansen .E. et al. 2006. Global Temperature Change. Proceedings of the National Academy of Sciences. September 26 2006. 103. No. 39. 14288-14293.

Harley C.D.G. R.A. Hughes .M. Hultgren B.G. Miner C. .B. Sorte C.S. Thornber L. . Rodriquez L. Tomanek and S.L. Williams. 2006. The impacts of climate change in coastal marine systems. Ecology Letters. ol. 9 pp. 228-241.

Healy M. 2008. CALFED Science Program Workshop on Delta conveyance modeling. CALFED Bay-Delta Program. Memo to Phil senberg Chair Delta ision Blue Ribbon Task Force. April 22 2008.

Healy M. 2008a. Report on Science Program Workshop on linking hydrodynamic and ecological modeling in the Delta. CALFED Bay-Delta Program. Memo to Phil senberg Chair Delta ision Blue Ribbon Task Force. May 27 2008.

Heberger M. H. Cooley P. Herrera P. Gleick and E. Moore. 2009. The mpacts of Sea Level Rise on the California Coast. California Climate Change Center. CEC-500-2009-024-F.

Holzer T. Blair . Noce T. and Bennett M. 2006. Predicted Liquefaction of East Bay Fills During a Repeat of the 1906 San Francisco Earthquake Earthquake Spectra olume 22 No. S2 pp. S261-S277 April 2006.

ntergovernmental Panel on Climate Change (PCC). 2007: Summary for Policymakers. n: Climate Change 2007: The Physical Science Basis. Contribution of Working Group to the Fourth Assessment Report of the ntergovernmental Panel on Climate Change. Solomon S. et al. eds. Cambridge University Press Cambridge U 7-22.

affe B. R.E. Smith A.C. Foxgrover. 2007. Anthropogenic influence on sedimentation and intertidal mudflat change in San Pablo Bay California: 1856- 1983. Estuarine Coastal and Shelf Science. 73 pp. 175-187.

assby A. et al. 1995. sohaline position as a habitat indicator for estuarine populations. Ecological Applications. ol. 5: 272-289.

oint Policy Committee. 2009. Staff Report on Policies for the Bay Area s mplementation of Senate Bill 375 anuary 23 2009.

ones and Stokes Associates H.T. Associates and ohn Blayney Associates. 1979. Protection and restoration of San Francisco Bay fish and wildlife habitat. U.S. Fish and Wildlife Service and CA Department of Fish and Game and U.S. Fish and Wildlife Service Sacramento CA.

ongejan R.B. . . rijling M. .F. Stive S.N. onkman. 2008. A comment on Changing Estuaries Changing iews. Hydrobiologia. ol. 605: 11 15.

immerer W. . 2002. Physical biological and management responses to variable freshwater flow into the San Francisco Estuary. Estuaries. 25(6B): 1275-1290.

inder Morgan/Suisun Marsh Trustee Council. 2008. inder Morgan Suisun Marsh Diesel Fuel Oil Spill: Damage Assessment and Restoration Plan/Environmental Assessment. Prepared by California Department of Fish and Game and the United States Fish and Wildlife Service.

nowles N. 2008. Potential nundation due to Rising Sea Levels in the San Francisco Bay Region. A report from the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency Sacramento CA. CEC-500-2009-023-F.

nowles N. 2002. Natural and management influences on freshwater inflows and salinity in the San Francisco Estuary at monthly to interannual scales. Water Resources Research. 38(12): 1289.

nowles N D.R. Cayan. 2002. Potential effects of global warming on the Sacramento/San oaquin watershed and the San Francisco estuary. Geophysical Research Letters. 29(18): 1891.

rone R.B. 1979. Sedimentation in the San Francisco Bay System. n T. . Conomos ed. San Francisco Bay: the urbanized estuary. Pacific Division American Association for the Advancement of Science San Francisco CA.

Lowe .L. and P. Williams. 2008. How rising seas will affect Bay processes and adaptation planning and strategies for local governments to consider. Presentation at Preparing for Sea Level Rise in the Bay Area - A Local Government Forum.

Luers A.L. D.R. Cayan G. Franco M. Hanemann and B. Croes. 2006. Our Changing Climate: Assessing the Risks to California A Summary Report from the California Climate Change Center sponsored by the California Energy Commission and the California Environmental Protection Agency Sacramento CA. CEC-500-2006-077.

Martin Associates. 2011. Economic mpacts of the Port of Oakland C 2010. Lancaster PA.

Moser Susanne and ohn Tribbia. 2007. More than nformation: What California s Coastal Managers Need to Plan for Climate Change. California Energy Commission Public nterest Energy Research Program. CEC-500-2007-046

Moser Susanne and ohn Tribbia. 2007. ulnerability to Coastal mpacts of Climate Change: Coastal Managers Attitudes nowledge Perceptions and Actions. California Energy Commission Public nterest Energy Research Program. CEC-500-2007-082.

Malamud-Roam Frances et al. 2007. Holocene Climates and Connections between the San Francisco Bay Estuary and its Watershed. San Francisco Estuary and Watershed Science. ol. 5 ssue 1 (Feb. 2007). Article 3. http://repositories.cdlib.org/jmie/sfews/vol5/iss1/art3

Matern S.A. P.B. Moyle L.C. Pierce. 2002. Native and Alien Fishes in a California Estuarine Marsh: Twenty-One years of Changing Assemblages. Transactions. America Fisheries Society. 131: 797-816

Mc ee L. N. Ganju D. Schoellhamer. 2006. Estimates of suspended sediment entering San Francisco Bay from the Sacramento and San oaquin Delta San Francisco Bay California. ournal of Hydrology. 323: 335-352.

Metropolitan Transportation Commission (MTC). 2008. Changing Motion: Transportation 2035 Plan for the San Francisco Bay Area. Oakland CA.

MTC. 2008. Northern California Trade Corridors Strategy. Northern California Coalition Trade Corridor mprovement Fund application to the California Transportation Commission. http://www.mtc.ca.gov/funding/infrastructure/index.htm

MTC. 2007. San Francisco Bay Area Regional Rail Plan Final Report. Oakland CA.

MTC. 2005. Mobility for the next generation. Transportation 2030 Plan for the San Francisco Bay Area. Oakland CA.

MTC. 2004. Regional Goods Movement Study for the San Francisco Bay Area Final Summary Report. Oakland CA.

MTC. 2001. Regional Bicycle Plan for the San Francisco Bay Area. Oakland CA.

Miller R.L. M. Fram R. Fujii and G. Wheeler. 2008. Subsidence reversal in a re-established wetland in the Sacramento-San oaquin Delta California USA. San Francisco Estuary and Watershed Science. ol. 6 ssue 3 (October) Article 1. http://repositories.cdlib.org/jmie/sfews/vol6/iss3/art1

Mitsch W. . and .G. Gosselink. 2000. The value of wetlands: importance of scale and landcape setting. Ecological Economics. 35: 25-33.

M ller . 2006. uantifying saltmarsh vegetation and its effect on wave height dissipation: results from a U East coast saltmarsh. ournal of Estuarine Coastal and Shelf Sciences. 69(3-4): 337-351.

M ller . and T. Spencer. 2002. Wave dissipation over macro-tidal saltmarshes: Effects of marsh edge typology and vegetation change. ournal of Coastal Research. S 36: 506-521.

M ller . T. Spencer .R. French D. . Leggett M. Dixon. 2001. The Sea-Defence alue of Salt Marshes: Field Evidence From North Norfolk.

Mount effrey and Robert Twiss. 2005. Subsidence Sea Level Rise and Seismicity in the Sacramento-San oaquin Delta. San Francisco Estuary and Watershed Science. ol. 3 ssue 1 (March 2005) Article 5. http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art5

National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service. 2007. Report on the Subtidal Habitats and Associated Biological Taxa in San Francisco Bay.

Nobriga M. 2007. Report on the CALFED Science Program Workshop Defining a ariable Delta to Promote Estuarine Fish Habitat . Prepared for Dr. Michael Healey CALFED Lead Scientist.

Oakland nternational Airport. 2011. Airport Perimeter Dike mprovement Environmental Assessment and nitial Study Public Scoping Workshop.

Ogden Beeman Associates nc. 1992. Sediment budget study for San Francisco Bay. Report prepared for the San Francisco District Corps of Engineers. Ogden Beeman Associates nc. Portland Oregon and Ray B. rone Associates nc. Davis California. 25 pp. Appendices.

Oppenheimer Michael. une 26 2006. ce Sheets and Sea Level Rise: Model Failure is the ey ssue. Real Climate: Climate Science from Climate Scientists. http://www.realclimate.org/indes.php/archives/2006/06/ice-sheets-and-sea-level-rise-model-failure-is-the-key-issue/

Overpeck onathan T. et al. March 26 2006. Paleoclimatic Evidence for Future ce-Sheet nstability and Rapid Sea Level Rise. Science. ol. 311. http://www.mindfull.org/water/2006/ice-sheet-instability24m1406.htm

Pacheco . Sung. Suisun Marsh Levee conceptual model. http://www.delta.dfg.ca.gov/suisunmarsh/charter/iep2006.asp on uly 1 2008.

Pacific Council on nternational Policy. 2010. Preparing for the Unavoidable Effects of Climate Change A Strategy for California (Draft).

Patrick W.H. r. and R.D. Delaune. 1990. Subsidence accretion and sea level rise in south San Francisco Bay marshes. Limnology and Oceanography. ol. 35: 1389- 1395.

Pfeffer W.T. .T. Harper and S. O Neel. 2008. inematic Constraints on Glacier Contributions to 21st-Century Sea Level Rise. Science. ol. 321(5894): 1340 1343.

Phillip Williams and Associates Ltd. for the California State Coastal Conservancy US Fish and Wildlife Service California Department of Fish and Game. South Bay Geomorphic Assessment Final E S/R Appendix October 2006.

Philip Williams Associates Ltd. and P.M. Faber. 2004. Design Guidelines for Tidal Wetland Restoration in San Francisco Bay. The Bay nstitute and California State Coastal Conservancy Oakland CA.

Philip Williams Associates H. T. Harvey Associates Brown and Caldwell EDAW. 2005. Flood Management and nfrastructure Existing Conditions Report South Bay Salt Pond Restoration Project. San ose CA. Prepared for: California State Coastal Conservancy U.S. Fish and Wildlife Service California Department of Fish and Game.

Poland .F. and R.L. reland. 1969. Land Subsidence in the Santa Clara alley California as of 1982. U.S. Geological Survey Professional Paper 497-F and Shelf Sciences 69(3-4): 337-351.

Port of Oakland. 2011. Container Statistics: Container History. http://www.portofoakland.com/maritime/facts cargo.asp

Porterfield G. 1980. Sediment transport of streams tributary to San Francisco San Pablo and Suisun Bays California 1909-66. Water resources investigations. United States Geological Survey. Water Resources Division Menlo Park California.

Pulliam H.R. and B. . Danielson. 1991. Sources sinks and habitat selection: a landscape perspective on population dynamics. The American Naturalist. ol. 137: S50-S66.

Rahmstorf S. 2007. A Semi-Empirical Approach to Projecting Future Sea-Level Rise. Science. ol. 315: 368-370.

Roemmich D. McGowan .A. (1995). Climatic warming and the decline of zooplankton in the California current. Science 267 1324 1326.

Rollins GL. 1981. A guide to waterfowl habitat management in Suisun Marsh. California Department of Fish and Game.

San Francisco Bay Conservation and Development Commission (BCDC). 2008. 2007 Bay Area Maritime Cargo Monitoring Report. San Francisco CA.

BCDC. 2007. San Francisco Bay Area Seaport Plan.

BCDC. 2007. Managed wetlands. Draft staff report.

BCDC. 2006. Recreation and San Francisco Bay. Draft Staff Report.

BCDC. 2005. Transportation and the San Francisco Bay.

BCDC. 2002. San Francisco Bay ecology and related habitats. Staff Report.

BCDC. 2001. Long Term Management Strategy Management Plan.

BCDC. 1988a. Protecting Shoreline Property from Tidal Erosion: An Analysis of the Effectiveness and Environmental mpacts of Administratively Authorized Protected Structures.

BCDC. 1988b. Sea Level Rise: Predictions and mplications for San Francisco Bay.

BCDC. 1976 (Amended 2007). Suisun Marsh Protection Plan.

San Francisco Estuary nstitute (SFE). 2007. The Pulse of the Estuary: Monitoring and Managing Water uality in the San Francisco Estuary. SFE Contribution 532. San Francisco Estuary nstitute Oakland CA.

San Francisco Estuary Project (SFEP). August 2004. Suisun Rising ESTUAR Newsletter. Oakland CA.

SFEP. Aquatic Habitat nstitute. 1991. Proceedings of the State of the Estuary Conference. San Francisco Estuary Project. Oakland CA.

Save San Francisco Bay Association. Greening the Bay Financing Wetland Restoration in San Francisco Bay. August 2004.

Schoellhammer D.H. T.E. Mumley .E. Leatherbarrow. 2007. Suspended sediment and sediment-associated contaminants in San Francisco Bay. Environmental Research. ol. 105: 119-131.

Schoellhammer D.H. . Lacy N. Ganju G. Shellenbarger and M. Lionberger. 2005. Sediment management: Creating desired habitat while preserving existing habitat. Technical report of the South Bay Salt Pond Restoration Project.

Shellhammer H.S. 1989. Salt Marsh Harvest Mice Urban Development and Rising Sea Levels. Conservation Biology. ol. 3 No. 1: 59-65.

Smits A. .M. P.H. Nienhuis and H.L.F Saeijs. 2006. Changing Estuaries Changing iews. Hydrobiologia 565: 339 355.

Sommer T. C. Armor R. Baxter R. Breuer L. Brown M. Chotkowski S. Culberson F. Feyrer M. Gingras B. Herbold W. immerer A. Mueller-Solger M. Nobriga and . Souza. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32: 270-277.

Spalding E.A. and Hester M.W. 2007 nteractive Effects of Hydrology and Salinity on Oligohaline Plant Species Productivity: mplications of Relative Sea Level Rise. Estuaries and Coasts. ol. 30 No. 2: 214-225.

State Coastal Conservancy. 2010. San Francisco Bay Subtidal Habitat Goals Report: Conservation Planning for the Submerged Areas of the Bay. California State Coastal Conservancy. Oakland CA. www.sfbaysubtidal.org/report.html.

Suisun Ecological Workgroup. 2001. Suisun Ecological Workgroup Final Report to the State Water Resources Control Board. Department of Water Resources.

Takekawa . . et al. 2006. Environmental Threats to Tidal Marsh ertebrates of the San Francisco Bay Estuary. Studies in Avian Biology. No. 32: 176 197.

The Tioga Group. 2009. SF Bay Area Containerized Cargo Outlook. Prepared for SF Bay Conservation and Development Commission. Philadelphia PA.

Trulio L. . Callaway and S. Crooks. 2007. White paper on carbon sequestration and tidal salt marsh restoration. South Bay Salt Pond Restoration Project.

Turner . and . Dagley. 1993. What price sea walls Enact. Managing land for wildlife pp. 8-9.

United Nations. 2004. Guidelines for Reducing Flood Losses. United Nations. Accessed April 2006. n: Pacific nstitute 2009.

U.S. Census Bureau. 2008. nformation about select Bay Area populations nternet . Updated 7/25/2008. http://quickfacts.census.gov/qfd/states/06000.html

U.S. Environmental Protection Agency (EPA). 2005. Emission Facts: Average carbon dioxide emissions from gasoline and diesel fuel. EPA420-F-05-001. Office of Transportation and Air uality.

U.S. Environmental Protection Agency (EPA). 2005. Emission Facts: Average carbon dioxide emissions from gasoline and diesel fuel. EPA420-F-05-001. Office of Transportation and Air uality.

U.S. Geological Survey (USGS). 2008. CASCADE: Computational Assessments of Scenarios of Change for the Delta Ecosystem. http://sfbay.wr.usgs.gov/cascade

USGS. Nichols Frederic H. Mario M. Pamatmat. 1998. The Ecology of the Soft-Bottom Benthos of San Francisco Bay: A Community Profile. September 1988.

URS. 2005. Urban Levee Flood Management Requirements South Bay Salt Pond Restoration Project. San ose CA. Prepared for: California State Coastal Conservancy U.S. Fish and Wildlife Service California Department of Fish and Game.

ermeer M and S. Rahmstorf. 2009. Global Sea Level Linked to Global Temperature. Proceedings of the National Academy of Sciences. http://www.pnas.org/content/early/2009/12/04/0907765106.full.pdf html

Water Transit Authority (WTA). 2003. A Strategy to mprove Public Transit with an Environmentally Friendly Ferry System. Final mplementation and Operations Plan.

Watkinson Andrew R. and William . Sutherland. 1995. Sources Sinks and Pseudo-Sinks. The ournal of Animal Ecology. ol. 64 No. 1: 126-130.

Watson E. B. 2004. Changing Elevation Accretion and Tidal Marsh Plant Assemblages in a South San Francisco Bay Tidal Marsh. Estuaries. ol. 27: 4 pp. 694- 698.

Wells L.E. and M. Gorman. 1994. Late Holocene environmental variability in the upper San Francisco Estuary as reconstructed from tidal marsh sediments. n: Proceedings of the eleventh annual Pacific Climate (PACL M) Workshop. Technical Report 40 nteragency Ecological Program Sacramento CA.

Western Governor s Association. 2001. http://www.westgov.org

Wetland Tracker. 2008. http://www.wetlandtracker.org

Wilbanks Thomas. 2003. Possible Responses to Global Climate Change: ntegrating Mitigation and Adaptation. Environment p.28 une 2003. Washington.

Wilcox C. 2006. Suisun Marsh tidal wetland restoration and species recovery. nteragency Ecological Program 2006 Annual Workshop. California Department of Fish and Game. http://www.delta.dfg.ca.gov/suisunmarsh/charter/iep2006.asp on uly 1 2008.

Wright S.A. D.H. Schoellhamer. 2004. Trends in the Sediment ield of the Sacramento River California 1957 - 2001. San Francisco Estuary and Watershed Science 2(2).

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Resolution No. 11-08

Adoption of Bay Plan Amendment No. 1-08 Adding New Climate Change Findings and Policies to the Bay Plan; And Revising the Bay Plan Tidal Marsh and Tidal Flats; Safety of Fills; Protection of the Shoreline; and Public Access Findings and Policies

Whereas, Government Code Section 66652 states that the Commission at any time may amend or repeal and adopt a new form of all or any part of the San Francisco Bay Plan but such changes shall be consistent with the findings and declaration of policy contained in the McAteer-Petris Act and

Whereas, the *San Francisco Bay Plan* (Bay Plan) policies pertaining to sea level rise and climate change have not been reviewed and updated comprehensively since their adoption in 1989 and

Whereas, the Commission s strategic plan included the initiation of the review and possible update of the Bay Plan findings and policies concerning climate change and

Whereas, between 1850 and 1960 one-third of San Francisco Bay was diked filled or reclaimed as land. Alarmed by projections that as much as 70 percent of the remaining Bay might be lost by 2020 in 1965 the California Legislature passed the McAteer-Petris Act to create a new temporary state agency the San Francisco Bay Conservation and Development Commission (BCDC). The new law directed BCDC to prepare a plan for the long-term use and protection of San Francisco Bay. The Commission delivered its *San Francisco Bay Plan* to the Legislature on time and under budget in 1968. The plan contained findings and policies the Commission recommended be used to guide future regulatory decisions on activities in and around the Bay. n 1969 the Legislature made BCDC a permanent state agency adopted the Bay Plan by reference into state law and directed the Commission to use the Bay Plan findings policies and maps to guide the Commission s regulatory decisions on permit applications for development and other activities within BCDC s jurisdiction and

Whereas, the Bay Plan includes findings and policies on 26 subject areas ranging from water quality and weather to commercial fishing and airports. All of the policies have equal status and every BCDC permit decision must be consistent with all applicable policies. However the policies are applied on a case-by-case basis to the specific conditions of that site where a project is proposed and the nature of the proposed project. As a result not all of the policies apply in all situations. For example the policies on dredging are not relevant to a proposed development project located entirely on existing land along the shoreline and the policies on ports are not applied to a wetlands restoration project proposed in a salt pond and

Whereas, in addition to serving as mandatory state policies that are enforced by the Commission through its regulatory authority some the Bay Plan policies are declarations of the Commission s intention to undertake future studies or planning and others offer advice to local governments other agencies and organizations in dealing with Bay management issues. However both state law and the Bay Plan stipulate that any such recommendations are advisory only and cannot be enforced by the Commission and

Whereas, the Legislature directed the Commission to keep the Plan up to date so that it reflects the latest scientific research on the Bay and addresses emerging issues that could impact the Bay in the future. To accomplish this the Legislature empowered the Commission to amend the Bay Plan if two thirds (18) of the 27 members of the Commission vote for the amendment after providing an opportunity for public review of the proposed amendment and after holding a public hearing on the amendment. Over the past 42 years the Commission has made numerous amendments to the Bay Plan some of which dealt with simple matters such as changing a boundary of a Plan map designation and some of which have addressed major issues such dredging and dredged material disposal and

Whereas, the initial step in revising the Bay Plan is a policy decision by the Commission whether to consider an amendment dealing with a specified issue. Thereafter the staff prepares a report containing the results of research and policy analysis on the issue preliminary recommended findings and policies and an environmental assessment of the proposed amendment. One such staff report entitled *S a l is Pr ic ions an lica ions or San Francisco Bay* was released in December 1987. Relying on this report in 1989 the Commission amended the findings and policies in the section of the Bay Plan dealing with Safety of Fills making BCDC one of the first public agencies in the country to address the issue of sea level rise when making permit decisions and to provide policy advice to local governments and

Whereas, perhaps the biggest change in the twenty years since the Commission first adopted sea level rise policies is the attention received by the international consensus-based approach to delivering scientific conclusions for policy-makers initiated by the United Nations ntergovernmental Panel on Climate Change (PCC). Because the PCC represents a wide range of scientific opinion its conclusions are generally conservative but widely accepted. However another important change in the last twenty years is that the effects of climate change are already being observed. Conclusions in both the PCC and state-sponsored work are based in part on observed changes in global surface temperature ocean water temperature ocean acidification and land and sea ice melt. Finally what was lacking twenty years ago was conclusive evidence that climate change is caused largely by human actions primarily the release of carbon dioxide into the atmosphere. Today such evidence solidly links the significant human contribution to greenhouse gases beginning with industrialization to increases in global temperature and

Whereas, in 2006 the State of California used PCC scenarios to develop a report on climate change impacts in the state. n that same year the legislature passed the Global Warming Solutions Act requiring reductions in greenhouse gas emissions. The most recent update to the PCC assessment reports was in 2007 and in 2008 the state reported the results of an updated analysis of climate change scenarios. Both reports conclude that the reduction of greenhouse gases now will reduce the degree to which the world must adapt to the effects of climate change. However it is inevitable that over the next century global temperatures will increase 1 to 3 C (1.8 to 5.4 F). To deal with this increase in temperature adapting to climate change and its impacts is both unavoidable and essential and

Whereas, three years ago the Commission decided to again deal with the issue of sea level rise within the larger context of global climate change. To accomplish this in November 2008 the Commission initiated the process of considering Bay Plan Amendment No. 1-08 by authorizing the staff to propose amendments of the findings and policies in four sections of the Bay Plan Tidal Marshes and Tidal Flats Safety of Fills Protection of the Shoreline and Public Access and to develop additional findings and policies in an entirely new section to the Plan entitled Climate Change.

Whereas, in April 2009 the staff released a report entitled *i in i a isin Bay ln ra ili y an a a ion in San Francisco Bay an on S or lin* . n addition to providing extensive background information on the most current scientific research on climate change the report contained maps depicting the low-lying areas around the Bay that could be vulnerable to future flooding from sea level rise and storm surge. Along with the background report the staff provided a preliminary recommendation on proposed Bay Plan amendments to address climate change and

Whereas, the background report indicated that while the rate of global climate change will depend on the volume of future greenhouse gas emissions sea level rise in San Francisco Bay could be as much as 16 inches by mid-century and 55 inches by the end of the century. By mid-century 180 000 acres of Bay shoreline could be vulnerable to flooding and 213 000 acres vulnerable by the end of the century. The area vulnerable to inundation with a 16-inch sea level rise roughly corresponds to today s 100-year floodplain. The economic value of Bay Area shoreline development at risk from a 55-inch rise in sea level is estimated at 62 billion nearly double the estimated value of development vulnerable to sea level rise along California s Pacific Ocean coastline. An estimated 270 000 people in the Bay Area would be at risk of flooding from a 55-inch rise in sea level 98 percent more than are currently at risk from flooding and

Whereas, the Commission held its first public hearing on the preliminary staff recommendation on May 7 2009. To respond to requests for more time for public review and input the Commission held three more public hearings held three public workshops and kept the public comment period open for three months. The staff revised its preliminary recommendation to address the public comments and incorporate suggestions that had been made to improve the amendment language and a revised preliminary recommendation was released on October 1 2009. The Commission held another public hearing on the revised preliminary staff recommendation on November 5 2009 and another public workshop on December 3 2009 and

Whereas, a third staff recommendation and response to comments was released on September 3 2010. The Commission held eight public hearings on this draft during the fall of 2010 and the staff worked with local governments business interests and environmental organizations to further refine the amendment language. n all since April 2009 the Commission has held 35 public hearings workshops and meetings on the amendment language as it has evolved and the Commission will hold another public hearing on September 1 2011 before voting on the amendment on October 6 2011 and

Whereas, five principal policy goals will be achieved by adopting proposed Bay Plan Amendment No. 1-08.

1. Outdated language on sea level rise policy that has been in the Bay Plan since 1989 will be eliminated. This current policy language recommends that new development not be approved in low-lying areas that are in danger of flooding now or in the future unless the development is elevated above possible flood levels. The amended policies allow protection from flooding encourage innovative means of dealing with flood danger and make it clear that local governments will determine how best to deal with development proposals inland of the Commission s jurisdiction.
2. A variety of types of projects that have regional benefits will be encouraged and proposed new development will continue to be evaluated by the Commission on a case-by-case basis to determine if the benefits of a project outweigh the risk from flooding and to ensure steps are taken to deal with the flooding danger.

3. The Bay and other valuable natural resources within BCDC s jurisdiction will continue to have the same level of protection that has worked so well for the past half-century.
4. Because wetlands play vital roles in both reducing greenhouse gases and providing flood protection existing tidal wetlands will continue to be protected and where appropriate expanded. To accomplish this resource protection and habitat enhancement in undeveloped low-lying areas will be encouraged but development will not be absolutely prohibited in these areas.
5. The Commission will commit itself to working with its regional partners local governments businesses labor environmentalists investors insurers and the general public to develop a comprehensive regional strategy that deals with all the impacts of climate change. Such a strategy is essential to the Bay Area s long-term economic prosperity and

Whereas, in addition to concerns that have been expressed about specific language in the proposed findings and policies there has been considerable concern expressed about the maps of shoreline areas that are potentially vulnerable to flooding from sea level rise and storm surge. These maps can be found in both the staff background report and on the Commission s website and

Whereas, at the most basic level the maps depict areas around the Bay that have low elevations. Overlays compare these ground elevations with projected Bay water depths that are 16 inches (0.4 meter) and 55 inches (1.4 meters) higher to illustrate possible sea levels around the middle of the 21st century and the beginning of the 22nd century. The maps do not take into account wind and waves that would increase the extent of inundation and do not show existing levees that might provide protection from flooding because detailed information on wind and wave conditions and levee heights and strengths was not available at a regional scale. Nor do the maps show where new levees or other shoreline protection to prevent flooding could be built or the cost of any such protection. These limitations of the maps are reflected in the following legal disclaimer on each map:

> nundation data does not account for existing shoreline protection or wave activity. These maps are for informational purposes only. Users by their use agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with its use in any form. The maps and data shall not be used to assess actual coastal hazards insurance requirements or property values or be used in lieu of Flood nsurance Rate Maps issued by the Federal Emergency Management Agency (FEMA).

Despite efforts to make it clear that the maps simply show low land elevations in relation to possible future water depths three types of objections to the maps have been raised. The first is that the presence of the maps is inhibiting capital from being invested in what critics call the inundation zone around the Bay. While it may be true that some investors may be more cautious about supporting development around the Bay the maps are not the cause of concern. As noted the maps simply depict areas around the Bay that have low elevations in relation to projected water depths. These elevations will be the same whether or not BCDC s maps exist. Similar maps have been published by the U.S. Geological Survey the California Energy Commission the Pacific nstitute and others and

Whereas, the second objection to the maps is that they depict the area over which BCDC intends to exert regulatory authority even though the maps will not be adopted as part of the Bay Plan and therefore cannot be used by the Commission in making regulatory decisions and

Whereas, the Commission s Bay jurisdiction extends to the Mean High Tide line an elevation that is established by the National Oceanic and Atmospheric Administration. f nothing is done to protect low-lying areas around the Bay over time these areas could become flooded and eventually fall within BCDC s jurisdiction. With this in mind some have conjectured that BCDC intends to extend its jurisdiction over this area now. This simply is not true. BCDC cannot change its jurisdiction without a change of state law and BCDC has not requested such a change. And even if an area becomes flooded by Bay waters BCDC has a legal obligation to notify a landowner of the flooding and the landowner then has a year to repair any levee or other shoreline protection. f these repairs are made BCDC s jurisdiction remains unchanged. f the area has no pre-existing shoreline protection the proposed policies in Bay Plan Amendment No. 1-08 would allow the construction of such protection and

Whereas, the third objection raised about the maps is that the Commission could use its authority under the federal Coastal one Management Act and the California Environmental uality Act to exert jurisdiction over development proposals within the low-lying areas around the Bay that are vulnerable to future flooding and to pre-empt local government control. The Commission never had any such intention. Rather the Commission s intention is to adopt Bay Plan Amendment No. 1-08 pursuant to the provisions of the McAteer-Petris Act and the Suisun Marsh Preservation Act of 1977. The Amendment is not intended to and does not increase or decrease BCDC s jurisdiction or authority under either act. To express this intention and to reassure critics proposed Bay Plan Climate Change Policy 1 was drafted in consultation with the Attorney General s staff and attorneys representing the business community labor and local governments. Proposed Climate Change Policy 1 explicitly states that the climate change findings and policies will apply only within BCDC s current jurisdiction that local governments will retain their authority over development more than 100 feet inland from the Bay shoreline and that the provisions of the Bay Plan do not apply outside the Commission s jurisdiction for purposes of implementing the California Environmental uality Act. Proposed Policy 1 also responds to public comments requesting that the Commission restrict the use of the policies for Coastal one Management Act consistency determinations and

Whereas, on November 18 2010 the Commission considered six possible Optional Strategic Approaches for Dealing with Proposed Bay Plan Amendment No. 1-08 Concerning Climate Change to respond to concerns about the third preliminary staff recommendation:

1. Revise the proposed language in response to comments from the public as part of the process of updating the 21-year-old sea level rise findings and policies in the Bay Plan and adding a new section to the Plan to deal more broadly with climate change and adapting to sea level rise to address concerns that the proposed amendments would vastly increase BCDC s regulatory authority usurp local autonomy institute a moratorium on development in low-lying areas and block all development.
2. Abandon the process of updating the Bay Plan and leave the current sea level rise findings and policies in place.
3. Amend the Bay Plan to delete the current sea level rise findings and policies.
4. Amend the Bay Plan to update the current sea level rise findings and policies in a new section dealing with climate change to clearly specify that the new provisions will be used exclusively to guide the Commission in making regulatory decisions within its permit jurisdiction and are not intended to be advisory for local governments.
5. Amend the Bay Plan to update the current sea level rise findings and policies in a new climate change section that calls only for the preparation of a long-term regional sea level rise adaptation strategy and not include any interim guidance for the Commission or advice for local governments.

6. n combination with any of the options above develop a guidance document that can be used by the Commission local governments and others when dealing with sea level rise. The document would explicitly state that the guidelines are not binding or enforceable.

At its December 2 2010 meeting after receiving public comment on the six options the Commission directed the staff to prepare a revised recommendation that would propose findings and policies that are exclusively for the Commission s use in carrying out BCDC s regulatory responsibilities within its current permit jurisdiction (Option 4). The Commission postponed to 2011 a decision on whether and in what form any guidance or advice will be provided for dealing with sea level rise outside BCDC s regulatory jurisdiction. To date the Commission has not provided any additional direction with respect to preparing stand-alone guidelines for local governments and

Whereas, on December 16 2010 the Commission considered another Staff Report on Policy Alternatives for Bay Plan Amendment No. 1-08 Concerning Climate Change that considered a range of possible alternative approaches for addressing comments and issues raised during the public hearings on the third preliminary recommendation. The staff report discussed (1) the preparation of risk assessments for planning shoreline areas and designing larger projects within the Commission s permit jurisdiction (2) the preparation of a regional adaptation strategy to address sea level rise and (3) limiting development in low-lying areas within the Commission s jurisdiction to a broad list of project types. The Commission considered a range of alternatives for each of these policies and directed staff to utilize the discussion and public input to modify the staff recommendation and

Whereas, over the course of the Commission s consideration of Bay Plan Amendment No. 1-08 various alternatives for dealing with sea level rise were advanced. Environmental organizations recommended that state legislation should be enacted to give BCDC regulatory jurisdiction over all low-lying areas around the Bay affected by sea level rise. The California Climate Adaptation Strategy recommends that state agencies should consider prohibiting projects that would place development in undeveloped areas containing critical habitat or containing opportunities for tidal wetland restoration. Business groups and local governments suggested the Commission should not amend the Bay Plan at all until the economy improves and there is more certainty about the impacts of climate change. The Commission considered these ideas but selected a more moderate course of action one that will provide the Commission with updated policies for regulating development within BCDC s jurisdiction to address the impacts of sea level rise and will commit the Commission to working in partnership with all stakeholders on a comprehensive and long-range climate change resilience strategy for the Bay Area and

Whereas, the San Francisco Bay Conservation and Development Commission: (1) on November 5 2008 approved a Descriptive Notice of the proposed Bay Plan amendment and set the public hearing date for February 5 2009 (2) on November 6 2008 distributed the Adopted Descriptive Notice and notice of the public hearing to all agencies organizations and individuals interested in the proposed amendment (3) rescheduled the public hearing to May 7 2009 with a public notice mailed on anuary 23 2009 (4) mailed the staff background report *i in i a isin Bay* and the first staff preliminary recommendation and environmental assessment on April 7 2009 to all agencies organizations and individuals interested in the proposed amendment (interested parties) (5) held a public hearing on May 7 une 4 and uly 16 2009 pertaining to proposed Bay Plan policy language changes and received comments on the background report preliminary recommendation and environmental assessment sent on April 7 2009 and the hearing was closed on uly 16 2009 (6) on October 1 2009 staff distributed a revised (second) preliminary staff recommendation and response to comments to all agencies organizations and individuals interested in the proposed amendment and (7) the Commission held and closed a public hearing on November 5 2009 and (8) mailed a

third preliminary staff recommendation and response to comments to the Commission and interested parties on September 3 2010 (9) the Commission held six public hearings (October 7 and 21 November 2 4 and 18 and December 2 2011) on this draft and the Commission closed the public hearing on December 2 2011 and closed the written comment period on December 17 2010 (10) on uly 29 2011 the staff mailed a fourth preliminary recommendation revised environmental assessment and response to comments on the third staff preliminary recommendation to the Commission and interested parties (11) on September 1 the Commission held and closed a public hearing on staff s recommendation (12) on September 23 2011 staff mailed a final recommendation including a response to comments on staff s fourth preliminary recommendation which included revisions to the staff background report *i in i a isin Bay* incorporating changes based on comments received during prior public hearings and changes in scientific information during the lengthy amendment process all to the Commission and interested parties and (13) on October 6 2011 the Commission voted on the staff s final recommendation all in accord with the requirements and procedures set out in Government Code Section 66611 and 66652 and the California Code of Regulations Sections 11000 11001 11003 11004 and 11005 and

Whereas, throughout the three-plus year plan amendment process the staff and Commission held numerous meetings and workshops outside of the formal public hearing and public review process with local governments business environmental social equity and flood control groups throughout the region to answer questions and receive comments on the many staff recommendations and to devise alternative policy approaches and

Whereas, on May 15 2009 the staff presented to the oint Policy Committee (PC) its recommended updates to the Bay Plan findings and policies and recommended that the PC support the proposed Bay Plan updates and agree to play a key role in developing a regional strategy to the address the Bay-related impacts of climate change. On uly 17 2009 the staff presented the findings and policies again to the PC and the PC unanimously agreed it should play a key role in developing regional sea level rise policies and endorsed the general policy direction of the Bay Plan amendments proposed by BCDC subject to the refinement of the exact language to incorporate public comment and to encourage a context-sensitive policy approach and innovation in those situations which merit special attention and

Whereas, the San Francisco Bay Conservation and Development Commission has evaluated the environmental impact of revising the San Francisco Bay Plan by adding a new climate change finding and policy section and modifying the tidal marsh and tidal flats safety of fills protection of the shoreline and public access findings and policies under the Commission s functional equivalency regulations authorized by Public Resources Code Section 21080.5 and finds that all avoidable significant adverse environmental impacts as a result of the amendment to the Bay Plan policies are reduced to a less than significant level and that therefore the amendment to the policies will have no significant environmental impact and

Amending the Bay Plan is only a preliminary first step to project review. Each project that comes before the Commission requires further environmental review and specific or potential environmental impacts can be identified and mitigated at subsequent stages. The amendments do not commit the Commission to approve or disapprove any particular project or any particular type of project. They do not specify a particular land use for any area of land. At this stage it is not known what projects will be undertaken under the Bay Plan amendments where they will be located or what impacts they will have on the Bay. The impacts of any particular future development project are speculative.

Because the Bay Plan amendments do not authorize physical alterations or commit the Commission to approve or deny any particular future physical alteration the impacts of the amendments at this stage are very limited in scope and effect. The potential impacts of projects to be considered by the Commission in the future are highly speculative. The Commission will be able to conduct a more detailed review to determine the impacts of specific projects undertaken pursuant to these policies if and when they are proposed on a case-by-case basis. The proposed amendments improve the Commission s program for protecting the environment within its jurisdiction including the built and natural environments. Finally the amendments do not substantially alter the extent to which BCDC may address environmental impacts in permitting decisions under its existing laws and policies that protect the Bay. ndeed the amendments provide the Commission with additional tools to address environmental impacts of future projects. Therefore adoption of these amendments does not have significant adverse environmental effects.

Whereas, the amendment to the Bay Plan including the addition of a new climate change finding and policy section and amendments to the tidal marshes and tidal flats safety of fills shoreline protection and public access findings policies enacted by this resolution is intended to be a revision in the Commission s coastal management program for the San Francisco Bay segment of the California coastal zone as approved by the U.S. Department of Commerce under the federal Coastal one Management Act of 1972 as amended and

Whereas, global climate change has been described as one of the most challenging problems ever faced by humans. The quality of the lives of future generations depends on how the current generation deals with this challenge. The course outlined in Bay Plan Amendment No. 1-08 is an initial cautious and modest step in the long journey the people of the Bay Area will need to take to ensure that our region remains viable sustainable and prosperous in the future and that our beloved San Francisco Bay continues to be protected and

Whereas, these amendments are adopted pursuant to the McAteer-Petris Act (Gov. Code 66600 et seq.) and the Suisun Marsh Preservation Act of 1977 (Pub. Res. Code 29000 et seq.) and they are not intended to and do not increase or decrease BCDC s jurisdiction or authority under either act.

Now, Therefore, Be it Resolved That, the San Francisco Bay Conservation and Development Commission authorizes the Executive Director to make minor non-substantive editorial changes to this Resolution in particular to comply with the determinations of the Office of Administrative Law in its review of the Resolution under the California Administrative Procedures Act and

Be it Further Resolved That the San Francisco Bay Conservation and Development Commission hereby adopts Bay Plan Amendment No. 1-08 which amends the Bay Plan as follows:

1. Amends the Bay Plan tidal marshes and tidal flats findings and policies with the <u>underlined</u> language added and the ~~strikethrough~~ language deleted as follows:

Tidal Marshes and Tidal Flats

Findings

g. The Baylands Ecosystem Habitat Goals report provides a regional vision of the types amounts and distribution of wetlands and related habitats that are needed to restore and sustain a healthy Bay ecosystem including restoration of 65 000 acres of tidal marsh. <u>These recommendations were based on conditions of tidal inundation salinity and sedimentation in the 1990s. While achieving the regional vision would help promote a healthy resilient Bay ecosystem global climate change and sea level rise are expected to</u>

alter ecosystem processes in ways that may require new regional targets for types amounts and distribution of habitats.

i. Tidal marshes are an interconnected and essential part of the Bay s food web. Decomposed plant and animal material and seeds from tidal marshes wash onto surrounding tidal flats and into subtidal areas providing food for numerous animals such as the Northern pintail. n addition tidal marshes provide habitat for insects crabs and small fish which in turn are food for larger animals such as the salt marsh song sparrow harbor seal and great blue heron. Diking and filling have fragmented the remaining tidal marshes degrading the quality of habitat and resulting in a loss of species and an altered community structure.

k. Landward marsh migration may be necessary to sustain marsh acreage around the Bay as sea level rises. As sea level rises high-energy waves erode inorganic mud from tidal flats and deposit that sediment onto adjacent tidal marshes. Marshes trap sediment and contribute additional material to the marsh plain as decaying plant matter accumulates. Tidal habitats respond to sea level rise by moving landward a process referred to as transgression or migration. Low sedimentation rates natural topography development and shoreline protection can block wetland migration.

~~k~~l. Sedimentation is an essential factor in the creation maintenance and growth of tidal marsh and tidal flat habitat. ~~However~~ S~~s~~cientists studying the Bay ~~estimate~~ have observed that ~~sedimentation will not be able to keep pace with accelerating sea level rise due largely to declines in~~ the volume of sediment entering the Bay annually from the Sacramento and San oaquin Delta is declining. As a result the importance of sediment from local watersheds as a source of sedimentation in tidal marshes is increasing. As sea level rise accelerates the erosion of tidal flats may also accelerate thus potentially exacerbating shoreline erosion and adversely affecting the ecosystem and the sustainability of ~~future wetland~~ ecosystem restoration projects. An adequate supply of sediment is necessary to ensure resilience of the Bay ecosystem as sea level rise accelerates.

m. Human actions such as dredging disposal ecosystem restoration and watershed management can affect the distribution and amount of sediment available to sustain and restore wetlands. Research on Bay sediment transport processes is needed to understand the volume of sediment available to wetlands including sediment imported to and exported from the Bay. Monitoring of these processes can inform management efforts to maintain an adequate supply of sediment for wetlands.

n. Buffers are areas established adjacent to a habitat to reduce the adverse impacts of surrounding land use and activities. Buffers also minimize additional loss of habitat from shoreline erosion resulting from accelerated sea level rise and allow tidal habitats to move landward. Buffer areas may be important for achieving the regional goals for the types amounts and distribution of habitats in the Baylands Ecosystem Habitat Goals report or future updates to these targets.

~~l.~~ o. Plant and animal species not present in San Francisco Bay prior to European contact in the late 18th century known as non-native species which thrive and reproduce outside of their natural range have made vast ecological alterations to the Bay and have contributed to the serious reduction of native regulations of certain plants and animals through: (1) predation (2) competition for food habitat and other necessities (3) disturbance of habitat (4) displacement or (5) hybridization. Many non-native species enter the Bay from commercial ship ballast water that is discharged into the Bay. Approximately 170 species have invaded the Bay since 1850 and possibly an additional 115 species have been deliberately introduced. By 2001 over 1 200 acres of recently

restored tidal marshes have been invaded by introduced cordgrass species such as salt meadow cordgrass dense-flowered cordgrass English cordgrass and smooth cordgrass. At present an average of one new non-native species establishes itself in the Bay every 14 weeks. Control or eradication is a critical step in reducing the harm associated with non-native species.

~~m.~~p. Fill material such as rock and sediments dredged from the Bay can enhance or beneficially contribute to the restoration of tidal marsh and tidal flat habitat by: (1) raising areas diked from the Bay to an elevation that will help accelerate establishment of tidal marsh and (2) establishing or recreating rare Bay habitat types.

Policies

4. Where ~~and whenever possible~~feasible former tidal marshes and tidal flats that have been diked from the Bay should be restored to tidal action in order to replace lost historic wetlands or should be managed to provide important Bay habitat functions such as resting foraging and breeding habitat for fish other aquatic organisms and wildlife. As recommended in the Baylands Ecosystem Habitat Goals report around 65 000 acres of areas diked from the Bay should be restored to tidal action to maintain a healthy Bay ecosystem on a regional scale. Regional ecosystem targets should be updated periodically to guide conservation restoration and management efforts that result in a Bay ecosystem resilient to climate change and sea level rise. Further local government land use and tax policies should not lead to the conversion of these restorable lands to uses that would preclude or deter potential restoration. The public should make every effort to acquire these lands ~~from willing sellers~~for the purpose of habitat restoration and wetland migration.

5. The Commission should support comprehensive Bay sediment research and monitoring to understand sediment processes necessary to sustain and restore wetlands. Monitoring methods should be updated periodically based on current scientific information.

~~5~~ 6. Any ecosystem~~tidal~~ restoration project should include clear and specific long-term and short-term biological and physical goals and success criteria and a monitoring program to assess the sustainability of the project. Design and evaluation of the project should include an analysis of: (a) ~~the effects of relative~~how the system s adaptive capacity can be enhanced so that it is resilient to sea level rise and climate change (b) the impact of the project on the Bay s sediment budget (c) localized sediment erosion and accretion (d) the role of tidal flows (e) potential invasive species introduction spread and their control (f) rates of colonization by vegetation (g) the expected use of the site by fish other aquatic organisms and wildlife ~~and~~(h) an appropriate buffer where feasible between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises and (i) site characterization. f success criteria are not met appropriate ~~corrective~~adaptive measures should be taken.

Climate Change (Add New Section to Part IV)

Findings

a. Greenhouse gases naturally reside in the earth s atmosphere absorb heat emitted from the earth s surface and radiate heat back to the surface causing the planet to warm. This natural process is called the greenhouse effect. Human activities since industrialization have increased the emissions of greenhouse gases through the burning of fossil fuels. The accumulation of these gases in the atmosphere is causing the planet to warm at an accelerated rate.

b. The future extent of global warming is uncertain. t will be driven largely by future greenhouse gas emissions levels which will depend on how global development proceeds. The United Nations ntergovernmental Panel on Climate Change (PCC) developed a series of global development scenarios and greenhouse gas emissions scenarios for each development scenario. These emissions scenarios have been used in global models to develop projections of future climate including global surface temperature and precipitation changes.

c. Global surface temperature increases are accelerating the rate of sea level rise worldwide through thermal expansion of ocean waters and melting of land-based ice (e.g. ice sheets and glaciers). Bay water level is likely to rise by a corresponding amount. n the last century sea level in the Bay rose nearly eight inches. Current science-based projections of global sea level rise over the next century vary widely. Using the PCC greenhouse gas emission scenarios in 2010 the California Climate Action Team (CAT) developed sea level rise projections (relative to sea level in 2000) for the state that range from 10 to 17 inches by 2050 17 to 32 inches by 2070 and 31 to 69 inches at the end of the century. The CAT has recognized that it may not be appropriate to set definitive sea level rise projections and based on a variety of factors state agencies may use different sea level rise projections. Although the CAT values are generally recognized as the best science-based sea level rise projections for California scientific uncertainty remains regarding the pace and amount of sea level rise. Moreover melting of the Greenland and Antarctic ice sheet may not be reflected well in current sea level rise projections. As additional data are collected and analyzed sea level rise projections will likely change over time. The National Academy of Sciences is in the process of developing a Sea Level Rise Assessment Report that will address the potential impacts of sea level rise on coastal areas throughout the United States including California and the Bay Area.

d. Climate change will alter key factors that contribute to shoreline flooding including sea level and storm frequency and intensity. During a storm low air pressure can cause storm surge (a rapid rise in water level) and increased wind and wave activity can cause wave run up which will be higher as sea level rises. These storm events can be exacerbated by El Ni o events which generally result in persistent low air pressure greater rainfall high winds and higher sea level. The coincidence of intense winter storms extreme high tides and high runoff in combination with higher sea level will increase the frequency and duration of shoreline flooding long before areas are permanently inundated by sea level rise alone.

e. Shoreline areas currently vulnerable to a 100-year flood event may be subjected to inundation by high tides at mid-century. Much of the developed shoreline may require new or upgraded shoreline protection to reduce damage from flooding. Shoreline areas that have subsided are especially vulnerable to sea level rise and may require more extensive shoreline protection. The Commission along with other agencies such as the National Oceanic and Atmospheric Administration the Federal Emergency Management Agency the United States Army Corps of Engineers cities counties and flood control districts is responsible for protecting the public and the Bay ecosystem from flood hazards. This can be best achieved by using a range of scientifically based scenarios including projections which correspond to higher rates of sea level rise. n

planning and designing projects for the Bay shoreline it is prudent to rely on the most current science-based and regionally specific projections of future sea level rise develop strategies and policies that can accommodate sea level rise over a specific planning horizon (i.e. adaptive management strategies) and thoroughly analyze new development to determine whether it can be adapted to sea level rise.

f. Natural systems and human communities are considered to be resilient when they can absorb and rebound from the impacts of weather extremes or climate change and continue functioning without substantial outside assistance. Systems that are currently under stress often have lower adaptive capacity and may be more vulnerable or susceptible to harm from climate change impacts. Human communities with adaptive capacity can adjust to climate change impacts by taking actions to reduce the potential damages taking advantage of new opportunities arising from climate change and accommodating the impacts. Understanding vulnerabilities to climate change is essential for assessing climate change risks to a project the Bay or the shoreline. Risk is a function of the likelihood of an impact occurring and the consequence of that impact. Climate change risk assessments identify and prioritize issues that can be addressed by adaptation strategies.

g. n the context of climate change mitigation refers to actions taken to reduce greenhouse gas emissions and adaptation refers to actions taken to address potential or experienced impacts of climate change that reduce risks. Adaptation actions that protect existing development and infrastructure can include protecting shorelines promoting appropriate infill development and designing new construction to be resilient to sea level rise. Another option is relocating structures out of flood and inundation zones. Some actions can integrate adaptation mitigation and flood protection strategies and may be cost-effective when implemented before sea level rises. For example restoring tidal marshes sequesters carbon provides flood protection and provides habitat and may protect lives property and ecosystems. dentifying appropriate adaptation strategies requires complex policy considerations. mplementing many adaptation strategies will require action and funding by federal state regional and local agencies with planning funding and land use decision-making authority beyond the Commission s jurisdiction.

h. n the context of sea level rise adaptation it is likely that myriad innovative approaches will emerge likely including financing mechanisms to spread equitably the costs of protection from sea level rise design concepts and land management practices. Effective innovative adaptation approaches minimize public safety risks and impacts to critical infrastructure maximize compatibility with and integration of natural processes are resilient over a range of sea levels potential flooding impacts and storm intensities and are adaptively managed. Developing innovative adaptation approaches will require financial resources testing and refinement to ensure that they effectively protect the Bay ecosystem and public safety before they are implemented on a large scale. Developing the right mix of approaches would best be accomplished through a comprehensive regional adaptation strategy developed though a process involving various stakeholders and local regional state and federal agencies.

i. Adaptive management is a cyclic learning-oriented approach that is especially useful for complex environmental systems characterized by high levels of uncertainty about system processes and the potential for different ecological social and economic impacts from alternative management options. Effective adaptive management requires setting clear and measurable objectives collecting data reviewing current scientific observations monitoring the results of policy implementation or management actions and integrating this information into future actions.

j. The principle of sustainability embodies values of equity environmental and public health protection economic vitality and safety. The goal of sustainability is to conduct human endeavors in a manner that will avoid depleting natural resources for future generations and producing no more than can be assimilated through natural processes while providing for improvement of the human condition for all the people of the world. Efforts to improve the sustainability of natural systems and human communities can improve their resilience to climate change by increasing their adaptive capacity.

k. Shoreline development and infrastructure critical to public and environmental health and the region s economic prosperity may be or may become vulnerable to flooding from sea level rise and storm activity. Public safety may be compromised and personal property and agricultural land may be damaged or lost during floods. mportant public shoreline infrastructure and facilities such as airports ports regional transportation facilities landfills contaminated lands and wastewater treatment facilities are at risk of flood damage that could require costly repairs or result in the interruption or loss of vital services or degraded water quality. A current lack of funding to address projected impacts from sea level rise necessitates a collaborative approach with all stakeholder groups to find strategic and innovative solutions to advance the Bay Area s ability to meet environmental public health equity and economic goals.

l. Waterfront parks beaches public access sites and the Bay Trail are particularly vulnerable to flooding from sea level rise and storm activity because they are located immediately adjacent to the Bay. Flooding of or damage to these areas would adversely affect the region s quality of life if important public spaces and recreational opportunities are lost.

m. The Bay ecosystem contains diverse and unique plants and animals and provides many benefits to humans. For example tidal wetlands improve water quality sequester carbon and can provide flood protection. Tidal high marsh and adjacent ecotones are essential to many tidal marsh species including endangered species. Agricultural lands along the Bay shoreline function as buffers that can reduce the adverse impacts of nearby land uses and activities on the Bay and tidal marshes and can also provide habitat for terrestrial species. The Bay ecosystem is already stressed by human activities that lower its adaptive capacity such as diversion of freshwater inflow and loss of tidal wetlands. Climate change will further alter the ecosystem by inundating or eroding wetlands and ecotones changing sediment dynamics altering species composition raising the acidity of Bay waters changing freshwater inflow or salinity altering the food web and impairing water quality all of which may impair the system s ability to rebound and function. Moreover further loss of tidal wetlands will increase the risk of shoreline flooding.

n. Some Bay Area communities particularly those whose residents have low incomes disabilities or are elderly may lack the resources or capacity to respond effectively to the impacts of sea level rise and storm activity. Financial and other assistance is needed to achieve regional equity goals and help everyone be part of resilient shoreline communities.

o. Approaches for ensuring public safety in developed vulnerable shoreline areas through adaptive management strategies include but are not limited to: (1) protecting existing and planned appropriate infill development (2) accommodating flooding by building or renovating structures or infrastructure systems that are resilient or adaptable over time (3) discouraging permanent new development when adaptive management strategies cannot protect public safety (4) allowing only new uses that can be removed or phased out if adaptive management strategies are not available as inundation threats increase and (5) over time and where feasible and appropriate removing existing development

where public safety cannot otherwise be ensured. Determining the appropriate approach and financing structure requires the weighing of various policies and is best done through a collaborative approach that directly involves the affected communities and other governmental agencies with authority or jurisdiction. Some adaptive management strategies may require action and financing on the regional or sub-regional level across jurisdictions.

p. The Association of Bay Area Governments and the Metropolitan Transportation Commission initiated the FOCUS program to develop a regional strategy that promotes a more compact Bay Area land use pattern. n consultation with local governments the FOCUS program has identified Priority Development Areas for infill development in the Bay Area. These Priority Development Areas along with other sites are anticipated to be key components of the Bay Area s Sustainable Communities Strategy that will be adopted and periodically updated pursuant to the Sustainable Communities and Climate Protection Act of 2008 (SB 375). One of the Commission s objectives in adopting climate change policies is to facilitate implementation of the Sustainable Communities Strategy. Some shoreline areas that are vulnerable to flooding are already improved with public infrastructure and private development that has regionally significant economic cultural or social value and can accommodate infill development.

q. When planning or regulating development within areas vulnerable to flooding from sea level rise allowing small projects such as minor repairs of existing facilities and interim uses may be acceptable if they do not significantly increase overall risks to public safety.

r. n some cases the regional goals of encouraging infill development remediating environmentally degraded land redeveloping closed military bases and concentrating housing and job density near transit may conflict with the goal of minimizing flood risk by avoiding development in low-lying areas vulnerable to flooding. Methods to minimize this conflict include but are not limited to: clustering infill or redevelopment in low-lying areas on a portion of the property to reduce the area that must be protected formulating an adaptation strategy for dealing with rising sea level and shoreline flooding with definitive goals and an adaptive management plan for addressing key uncertainties for the life of the project incorporating measures that will enhance project resilience and sustainability and developing a project-based financial strategy and/or a public financing strategy as appropriate to fund future flood protection for the project which may also protect existing nearby development. Reconciling these different worthy goals and taking appropriate action requires weighing competing policy considerations and would be best accomplished through a collaborative process involving diverse stakeholders similar to that being undertaken by the oint Policy Committee to develop the Sustainable Communities Strategy.

s. Some undeveloped low-lying areas that are vulnerable to shoreline flooding contain important habitat or provide opportunities for habitat enhancement. n these areas development that would have regional benefits could preclude wetland enhancement that would also have regional benefits. Some developed areas may be suitable for ecosystem restoration if existing development is removed to allow the Bay to migrate inland although relocating communities is very costly and may result in the displacement of neighborhoods.

t. There are multiple local state federal and regional government agencies with authority over the Bay and shoreline. Local governments have broad authority over shoreline land use but limited resources to address climate change adaptation. Working collaboratively with local governments including agencies with responsibility for flood protection is desirable to optimize scarce resources and create the flexibility needed to plan amidst a high degree of uncertainty.

u. Government jurisdictional boundaries and authorities in the Bay Area are incongruent with the regional scale and nature of climate-related challenges. The oint Policy Committee which is comprised of regional agencies provides a framework for regional decision-making to address climate change through consistent and effective regionwide policy and to provide local governments with assistance and incentives for addressing climate change. The Commission can collaborate with the oint Policy Committee to assure that the Bay Plan Climate Change policies are integrated with the emerging Sustainable Communities Strategy and other regional agencies policies that deal with climate change issues.

v. The Commission s legal authority and regulatory jurisdiction were created to address the Legislative findings and advance the declarations of state policy established in the McAteer-Petris Act and the Suisun Marsh Preservation Act of 1977. Climate change and sea level rise were not considerations when this authority and jurisdiction were established.

w. The California Ocean Protection Council has endorsed the guiding principles of the California Climate Adaptation Strategy which recommends that state agencies pursue the following policy objectives in their adaptation planning:

- Protect public health and safety and critical infrastructure
- Protect restore and enhance ocean and coastal ecosystems on which the State economy and well-being depend
- Ensure public access to coastal areas and protect beaches natural shoreline and park and recreational resources
- Plan and design new development and communities-for long-term sustainability in the face of climate change
- Facilitate adaptation of existing development and communities to reduce their vulnerability to climate change impacts over time and
- Begin now to adapt to the impacts of climate change.

The California Climate Adaptation Strategy recognizes that significant and valuable development has been built along the California coast for over a century. Some of the development is currently threatened by sea level rise or will be threatened in the near future. Similarly the coastal zone is home to many threatened or endangered species and sensitive habitats. The strategy acknowledges that the high financial ecological social and cultural costs of protecting everything may prove to be impossible in the long run protection of everything may be both futile and environmentally destructive. The strategy recommends that decision guidance strategies frame cost-benefit analyses so that all public and private costs and benefits are appropriately considered.

The strategy further recommends that state agencies should generally not plan develop or build any new significant structure in a place where that structure will require significant protection from sea-level rise storm surges or coastal erosion during the expected life of the structure. However the strategy also acknowledges that vulnerable shoreline areas containing existing development or proposed for new development that has or will have regionally significant economic cultural or social value may have to be protected and infill development in these areas should be closely scrutinized and may be accommodated. The strategy recommends that state agencies should incorporate this policy into their decisions. f agencies plan permit develop or build any new structures in hazard zones the California Climate Adaptation Strategy recommends that agencies employ or encourage innovative engineering and design solutions so that the structures are resilient to potential flood or erosion events or can be easily relocated or removed to allow for progressive adaptation to sea level rise flood and erosion.

The strategy further recommends that the state should consider prohibiting projects that would place development in undeveloped areas already containing critical habitat and those containing opportunities for tidal wetland restoration habitat migration or buffer zones. The strategy also encourages projects that protect critical habitats fish wildlife and other aquatic organisms and connections between coastal habitats. The strategy recommends pursuing activities that can increase natural resiliency such as restoring tidal wetlands living shorelines and related habitats managing sediment for marsh accretion and natural flood protection and maintaining upland buffer areas around tidal wetlands.

Policies

1. The Commission intends that the Bay Plan Climate Change findings and policies will be used as follows:

   a. The findings and policies apply only to projects and activities located within the following areas: San Francisco Bay the 100-foot shoreline band salt ponds managed wetlands and certain waterways as these areas are described in Government Code section 66610 and the Suisun Marsh as this area is described in Public Resources Code section 29101

   b. For projects or activities that are located partly within the areas described in subparagraph a and partly outside such area the findings and policies apply only to those activities or that portion of the project within the areas described in subparagraph a

   c. For the purposes of implementing the federal Coastal one Management Act the findings and policies do not apply to projects and activities located outside the areas described in subparagraph a even if those projects or activities may otherwise be subject to consistency review pursuant to the federal Coastal one Management Act and

   d. For purposes of implementing the California Environmental uality Act the findings and policies are not applicable portions of the Bay Plan for purposes of CE A Guideline 15125(d) for projects and activities outside the areas described in subparagraph a and therefore a discussion of whether such proposed projects or activities are consistent with the policies is not required in environmental documents.

2. When planning shoreline areas or designing larger shoreline projects a risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment. nundation maps used for the risk assessment should be prepared under the direction of a qualified engineer. The risk assessment should identify all types of potential flooding degrees of uncertainty consequences of defense failure and risks to existing habitat from proposed flood protection devices.

3. To protect public safety and ecosystem services within areas that a risk assessment determines are vulnerable to future shoreline flooding that threatens public safety all projects other than repairs of existing facilities small projects that do not increase risks to public safety interim projects and infill projects within existing urbanized areas should be designed to be resilient to a mid-century sea level rise projection. f it is likely the project will remain in place longer than mid-century an adaptive management plan should be developed to address the long-term impacts that will arise based on a risk assessment using the best available science-based projection for sea level rise at the end of the century.

4. To address the regional adverse impacts of climate change undeveloped areas that are both vulnerable to future flooding and currently sustain significant habitats or species or possess conditions that make the areas especially suitable for ecosystem enhancement should be given special consideration for preservation and habitat enhancement and should be encouraged to be used for those purposes.

5. Wherever feasible and appropriate effective innovative sea level rise adaptation approaches should be encouraged.

6. The Commission in collaboration with the oint Policy Committee other regional state and federal agencies local governments and the general public should formulate a regional sea level rise adaptation strategy for protecting critical developed shoreline areas and natural ecosystems enhancing the resilience of Bay and shoreline systems and increasing their adaptive capacity.

   The Commission recommends that: (1) the strategy incorporate an adaptive management approach (2) the strategy be consistent with the goals of SB 375 and the principles of the California Climate Adaptation Strategy (3) the strategy be updated regularly to reflect changing conditions and scientific information and include maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding (4) the maps be prepared under the direction of a qualified engineer and regularly updated in consultation with government agencies with authority over flood protection and (5) particular attention be given to identifying and encouraging the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies.

deally the regional strategy will determine where and how existing development should be protected and infill development encouraged where new development should be permitted and where existing development should eventually be removed to allow the Bay to migrate inland.

The entities that formulate the regional strategy are encouraged to consider the following strategies and goals:

a. advance regional public safety and economic prosperity by protecting: (i) existing development that provides regionally significant benefits (ii) new shoreline development that is consistent with other Bay Plan policies and (iii) infrastructure that is crucial to public health or the region s economy such as airports ports regional transportation wastewater treatment facilities major parks recreational areas and trails

b. enhance the Bay ecosystem by identifying areas where tidal wetlands and tidal flats can migrate landward assuring adequate volumes of sediment for marsh accretion identifying conservation areas that should be considered for acquisition preservation or enhancement developing and planning for flood protection and maintaining sufficient transitional habitat and upland buffer areas around tidal wetlands

c. integrate the protection of existing and future shoreline development with the enhancement of the Bay ecosystem such as by using feasible shoreline protection measures that incorporate natural Bay habitat for flood control and erosion prevention

d. encourage innovative approaches to sea level rise adaptation

e. identify a framework for integrating the adaptation responses of multiple government agencies

f. integrate regional mitigation measures designed to reduce greenhouse gas emissions with regional adaptation measures designed to address the unavoidable impacts of climate change

g. address environmental justice and social equity issues

h. integrate hazard mitigation and emergency preparedness planning with adaptation planning by developing techniques for reducing contamination releases structural damage and toxic mold growth associated with flooding of buildings and establishing emergency assistance centers in neighborhoods at risk from flooding

i. advance regional sustainability encourage infill development and job creation provide diverse housing served by transit and protect historical and cultural resources

j. encourage the remediation of shoreline areas with existing environmental degradation and contamination in order to reduce risks to the Bay s water quality in the event of flooding

k. support research that provides information useful for planning and policy development on the impacts of climate change on the Bay particularly those related to shoreline flooding

l. identify actions to prepare and implement the strategy including any needed changes in law and

m. identify mechanisms to provide information tools and financial resources so local governments can integrate regional climate change adaptation planning into local community design processes.

7. Until a regional sea level rise adaptation strategy can be completed the Commission should evaluate each project proposed in vulnerable areas on a case-by-case basis to determine the project s public benefits resilience to flooding and capacity to adapt to climate change impacts. The following specific types of projects have regional benefits advance regional goals and should be encouraged if their regional benefits and their advancement of regional goals outweigh the risk from flooding:

   a. remediation of existing environmental degradation or contamination particularly on a closed military base

   b. a transportation facility public utility or other critical infrastructure that is necessary for existing development or to serve planned development

   c. a project that will concentrate employment or housing near existing or committed transit service (whether by public or private funds or as part of a project) particularly within those Priority Development Areas that are established by the Association of Bay Area Governments and endorsed by the Commission and that includes a financial strategy for flood protection that will minimize the burdens on the public and a sea level rise adaptation strategy that will adequately provide for the resilience and sustainability of the project over its designed lifespan and

   d. a natural resource restoration or environmental enhancement project.

   The following specific types of projects should be encouraged if they do not negatively impact the Bay and do not increase risks to public safety:

   e. repairs of an existing facility

   f. a small project

   g. a use that is interim in nature and either can be easily removed or relocated to higher ground or can be amortized within a period before removal or relocation of the proposed use would be necessary and

   h. a public park.

8. To effectively address sea level rise and flooding if more than one government agency has authority or jurisdiction over a particular issue or area project reviews should be coordinated to resolve conflicting guidelines standards or conditions.

Safety of Fills

Findings

f. Flood damage to fills and shoreline areas can result from a combination of sea level rise storm surge ~~heavy~~ rainfall high tides and winds blowing onshore. The most effective way ~~T~~to prevent such damage- is to locate projects and facilities~~structures~~ on fill or near the shoreline~~should be~~ above~~the~~ a~~highest expected water level~~ 100-year flood level that takes future sea level rise into account during the expected life of the project.~~or should be protected for the expected life of the project by~~ Other effective approaches that can reduce flood damage include protecting structures or areas with levees ~~of an adequate height~~ seawalls tidal marshes or other protective measures and employing innovative design concepts such as building structures that can be easily relocated tolerate periodic flooding or are adaptively designed and managed to address sea level rise over time.

g. ~~Bay water levels are likely to increase in the future because of a relative rise in sea level. Relative rise in sea level is the sum of: (1) a rise in global sea level and (2) land elevation change (lifting or subsidence) around the Bay. f historic trends continue global sea level should increase between four and five inches in the Bay in the next 50 years and could increase approximately one and one-half to five feet by the year 2100 depending on the rate of accelerated rise in sea level caused by the greenhouse effect the long-term warming of the earth s surface from heat radiated off the earth and trapped in the earth s atmosphere by gases released into the atmosphere. The warming would bring about an accelerated rise in sea level worldwide through thermal expansion of the upper layers of the oceans and melting of some of the earth s glaciers and polar ice packs.~~Sea level is rising at an accelerated rate due to global climate change. Land elevation change caused by tectonic (geologic including seismic) activity consolidation or compaction of soft soils such as Bay muds and extraction of subsurface groundwater or natural gas extraction is variable around the Bay. Consequently some parts of the Bay will experience a greater relative rise in sea level than other areas. Relative rise in sea level is the sum of: (1) a rise in global sea level and (2) land elevation change (lifting or subsidence) around the Bay.~~For example in Sausalito the land area has been gradually lifting while in the South Bay excessive pumping from underground fresh water reservoirs has caused extensive subsidence of the ground surface in the San ose area and as far north as Dumbarton Bridge (map of Generalized Subsidence and Fault ones shows subsidence from 1934 to 1967). ndications are that if heavy groundwater pumping is continued indefinitely in the South Bay area land in the Alviso area (which has already subsided about seven feet since 1912) could subside up to seven feet more if this~~ Where subsidence occurs more extensive ~~levees~~ shoreline protection and wetland restoration projects may be needed to minimize~~prevent inundation~~ flooding of low-lying areas by the extreme high water levels.

Policies

3. To provide vitally needed information on the effects of earthquakes on all kinds of soils installation of strong-motion seismographs should be required on all future major land fills. n addition the Commission encourages installation of strong-motion seismographs in other developments on problem soils and in other areas recommended by the U.S. ~~Coast and Geodetic~~ Geological Survey for purposes of data comparison and evaluation.

4. Adequate measures should be provided ~~T~~to prevent damage from sea level rise and storm activity~~flooding~~ that may occur~~structures~~ on fill or near the shoreline over the expected life of a project. ~~should have adequate flood protection including consideration of future relative sea level rise as determined by competent engineers. As a general rule~~ The Commission may approve fill that is needed to provide flood protection for existing projects and uses. New projects~~structures~~ on fill or near the shoreline should either be ~~above the wave runup level or sufficiently~~ set back from the edge of the shore so that the project~~structure is~~ will not be subject to dynamic wave energy~~.~~ be built so ~~n all cases~~ the bottom floor level of structure~~s should~~will be above a~~the highest estimated tide~~ 100-year flood elevation that takes future sea level rise into account for the expected life of the project~~.~~ be~~Exceptions to the general height rule may be made for developments~~ specifically designed to tolerate periodic flooding or employ other effective means of addressing the impacts of future sea level rise and storm activity. Rights-of-way for levees or other structures protecting inland areas from tidal flooding should be sufficiently wide on the upland side to allow for future levee widening to support additional levee height so that no fill for levee widening is placed in the Bay.

~~5. To minimize the potential hazard to Bay fill projects and bayside development from subsidence, all proposed developments should be sufficiently high above the highest estimated tide level for the expected life of the project or sufficiently protected by levees to allow for the effects of additional subsidence for the expected life of the project utilizing the latest information available from the U.S. Geological Survey and the National Ocean Service. Rights-of-way for levees protecting inland areas from tidal flooding should be sufficiently wide on the upland side to allow for future levee widening to support additional levee height so that no fill for levee widening is placed in the Bay.~~

~~6. Local governments and special districts with responsibilities for flood protection should assure that their requirements and criteria reflect future relative sea level rise and should assure that new structures and uses attracting people are not approved in flood prone areas or in areas that will become flood prone in the future, and that structures and uses that are approvable will be built at stable elevations to assure long-term protection from flood hazards.~~

~~Protection of the~~ Shoreline Protection

Findings

a. Well-designed shoreline protection projects, such as levees, wetlands, or riprap, can prevent shoreline erosion and damage from flooding.

~~a.~~b. ~~Erosion control~~Because vast shoreline areas are vulnerable to flooding and because much of the shoreline consists of soft, easily eroded soils, shoreline protection projects are often needed to ~~protect~~reduce damage to shoreline property and improvements~~from erosion. Because so much shoreline consists of soft, easily eroded soils, protective structures are usually required to stabilize and establish a permanent shoreline. These structures~~ Structural shoreline protection, such as riprap, levees, and seawalls, often requires periodic maintenance and reconstruction.

~~b.~~c. Most ~~erosion control~~ structural shoreline protection projects involve some fill, which can adversely affect natural resources, such as water surface area and volume, tidal circulation, and wildlife use~~, marshes, and mudflats~~. Structural shoreline protection can further cause erosion of tidal wetlands and tidal flats, prevent wetland migration to accommodate sea level rise, create a barrier to physical and visual public access to the Bay, create a false sense of security and may have cumulative impacts. Physical and visual public access can be provided on levees and other protection structures. As the rate of sea level rise accelerates and the potential for shoreline flooding increases, the demand for new shoreline protection projects will likely increase. Some projects may involve extensive amounts of fill.

~~c.~~d. Structural ~~S~~shoreline protection ~~structures, such as riprap and sea walls, are~~is most effective and less damaging to natural resources if ~~they are~~it is the appropriate kind of structure for the project site and erosion and flood problem, and ~~are~~is properly designed, constructed, and maintained. Because factors affecting erosion and flooding vary considerably, no single protective method or structure is appropriate in all situations. When a structure is not appropriate or is improperly designed and constructed to meet the unique site characteristics, flood conditions ~~of~~ and erosion forces at a project site, the structure is more likely to fail, require additional fill to repair, have higher long-term maintenance costs because of higher frequency of repair, and cause greater disturbance and displacement of the site s natural resources.

e. Addressing the impacts of sea level rise and shoreline flooding may require large-scale flood protection projects including some that extend across jurisdictional or property boundaries. Coordination with adjacent property owners or jurisdictions to create contiguous effective shoreline protection is critical when planning and constructing flood protection projects. Failure to coordinate may result in inadequate shoreline protection (e.g. a protection system with gaps or one that causes accelerated erosion in adjacent areas).

~~d.~~f. Nonstructural ~~erosion control~~shoreline protection methods such as tidal marshes~~marsh plantings~~ can provide effective flood control but are typically effective for erosion control only in areas experiencing mild erosion. ~~However i~~n some instances it may be possible to combine ~~marsh~~habitat restoration enhancement or protection with structural approaches to provide protection from flooding and control shoreline erosion thereby minimizing the ~~erosion control~~shoreline protection project s impact on natural resources.

~~e.~~g. Loose dirt concrete slabs asphalt bricks scrap wood and other kinds of debris are generally ineffective in halting shoreline erosion or preventing flooding and may lead to increased fill or release of pollutants. Although providing some short-term shoreline protection protective structures constructed of such debris materials typically fail rapidly in storm conditions because the material slides bayward or is washed offshore. Repairing these ineffective structures requires additional material to be placed along the shoreline leading to unnecessary fill and disturbance of natural resources.

Policies

1. New shoreline ~~erosion control~~protection projects and the maintenance or reconstruction of existing ~~erosion control facilities~~projects and uses should be authorized if: (a) the project is necessary to ~~protect the shoreline from~~provide flood or erosion protection for (i) existing development use or infrastructure or (ii) proposed development use or infrastructure that is consistent with other Bay Plan policies (b) the type of the protective structure is appropriate for the project site the uses to be protected and the erosion and flooding conditions at the site ~~and~~ (c) the project is properly engineered to provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account (d) the project is properly designed and constructed to prevent significant impediments to physical and visual public access and (e) the protection is integrated with current or planned adjacent shoreline protection measures. Professionals knowledgeable of the Commission s concerns such as civil engineers experienced in coastal processes should participate in the design ~~of erosion control projects~~.

2. Riprap revetments the most common shoreline protective structure should be constructed of properly sized and placed material that meet sound engineering criteria for durability density and porosity. Armor materials used in the revetment should be placed according to accepted engineering practice and be free of extraneous material such as debris and reinforcing steel. Generally only engineered quarrystone or concrete pieces that have either been specially cast are free of extraneous materials from demolition debris ~~or~~and are carefully selected for size density and durability ~~and freedom of extraneous materials from demolition debris~~ will meet these requirements. Riprap revetments constructed out of other debris materials should not be authorized.

3. Authorized protective projects should be regularly maintained according to a long-term maintenance program to assure that the shoreline will be protected from tidal erosion and flooding and that the effects of the ~~erosion control~~shoreline protection project on natural resources during the life of the project will be the minimum necessary.

4. Whenever feasible and appropriate shoreline protecti~~ve~~on projects should include provisions for nonstructural methods such as marsh vegetation ~~where feasible~~and integrate shoreline protection and Bay ecosystem enhancement using adaptive management. Along shorelines that support marsh vegetation or where marsh establishment has a reasonable chance of success the Commission should require that the design of authorized protecti~~ve~~on projects include provisions for establishing marsh and transitional upland vegetation as part of the protective structure wherever ~~practicable~~feasible.

5. Adverse impacts to natural resources and public access from new shoreline protection should be avoided. Where significant impacts cannot be avoided mitigation or alternative public access should be provided.

Public Access

Findings

f. Accelerated flooding from sea level rise and storm activity will severely impact existing shoreline public access resulting in temporary or permanent closures. Periodic and consistent flooding would increase damage to public access areas which can then require additional fill to repair raise maintenance costs and cause greater disturbance and displacement of the site s natural resources. Risks to public health and safety from sea level rise and shoreline flooding may require new shoreline protection to be installed or existing shoreline protection to be modified which may impede physical and visual access to the Bay.

Re-letter findings f. and g. to g. and h., respectively.

~~h.~~i. Public access areas obtained through the permit process are most utilized if they provide physical access provide connections to public rights-of-way are related to adjacent uses are designed improved and maintained clearly to indicate their public character and provide visual access to the Bay. Flooding from sea level rise and storm activity increases the difficulty of designing public access areas (e.g. connecting new public access that is set at a higher elevation or located farther inland than existing public access areas).

Re-letter findings i. and j. to j. and k., respectively.

~~k.~~l. Studies indicate that public access may have immediate effects on wildlife (including flushing increased stress interrupted foraging or nest abandonment) and may result in adverse long- term population and species effects. Although some wildlife may adapt to human presence not all species or individuals may adapt equally and adaptation may leave some wildlife more vulnerable to harmful human interactions such as harassment or poaching. The type and severity of effects if any on wildlife depend on many factors including physical site configuration species present and the nature of the human activity. Accurate characterization of current and future site habitat and wildlife conditions and of likely human activities would provide information critical to understanding potential effects on wildlife.

~~l.~~m. Potential adverse effects on wildlife from public access may be avoided or minimized by siting designing and managing public access to reduce or prevent adverse human and wildlife interactions. Managing human use of the area may include adequately maintaining improvements periodic closure of access areas pet restrictions such as leash requirements and prohibition of public access in areas where other strategies are insufficient to avoid adverse effects. Properly sited and/or designed public access can avoid habitat fragmentation and limit predator access routes to wildlife areas. n some cases public access adjacent to sensitive wildlife areas may be set back from the shoreline a greater distance because buffers may be needed to avoid or minimize human disturbance of wildlife. Appropriate siting design and management strategies depend on the environmental characteristics of the site ~~and~~ the likely human uses of the site and the potential impacts of future climate change.

~~m.~~n. Providing diverse and satisfying public access opportunities can reduce the creation of informal access routes to decrease interaction between humans and wildlife habitat fragmentation and vegetation trampling and erosion. Formal public access also provides for more predictable human actions which may increase the ability of wildlife to adjust to human use.

Policies

5. Public access should be sited designed managed and maintained to avoid significant adverse impacts from sea level rise and shoreline flooding.

~~5.~~6. Whenever public access to the Bay is provided as a condition of development on fill or on the shoreline the access should be permanently guaranteed. This should be done wherever appropriate by requiring dedication of fee title or easements at no cost to the public in the same manner that streets park sites and school sites are dedicated to the public as part of the subdivision process in cities and counties. Any public access provided as a condition of development should either be required to remain viable in the event of future sea level rise or flooding or equivalent access consistent with the project should be provided nearby.

~~6.~~7. Public access improvements provided as a condition of any approval should be consistent with the project and the physical environment including protection of Bay natural resources such as aquatic life wildlife and plant communities and provide for the public s safety and convenience. The improvements should be designed and built to encourage diverse Bay-related activities and movement to and along the shoreline should permit barrier free access for persons with disabilities~~the physically handicapped~~ to the maximum feasible extent should include an ongoing maintenance program and should be identified with appropriate signs.

Renumber Public Access Policies 7 through 13 to 8 through 14.

We certify that this resolution was adopted by a vote of yes votes no votes and abstentions at the Commission meeting held October 6 2011 at San Francisco California.

Executed on this day of 2011 at San Francisco California.

R. SEAN RANDOLPH
Chairman

Executed on this _____ day of _____ 2011 at San Francisco California

W LL TRA S
Executive Director

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SECTION 01060
SAFETY AND HEALTH

PART 1 - GENERAL

1.01 GENERAL

A. The construction of this project may expose the contractor's workers to areas that may be considered a confined space and/or hazardous to open flame or sparks. The Contractor shall be experienced and qualified to anticipate and meet the safety and health requirements of this project. The Contractor shall require the workers to observe proper safety and hygienic precautions.

B. The Contractor shall be solely responsible for the storage, usage, handling and application of all hazardous materials encountered or provided in the Contract.

1.02 SAFETY AND HEALTH REGULATIONS

A. The Contractor shall comply with Safety and Health Regulations for Construction, promulgated by the Secretary Standards Act, as set forth in Title 9, C.F.R. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue NW, Washington, DC 20013.

B. The Contractor shall also comply with the provisions of the Federal Occupational Safety and Health Act, as amended, and with all applicable State of California, Department of Industrial Relations, Construction Safety Orders (Cal-OSHA) requirements.

C. Prior to excavation of trenches 5-feet or deeper, the Contractor shall submit to the Construction Manager a copy of the company's annual CalOSHA trenching permit and a copy of the company's letter informing CalOSHA of the time the trenching is commencing and the location of the work.

PART 2 - MATERIALS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**** END OF SECTION ****

SECTION 01071
STANDARD REFERENCES

PART 1 - GENERAL

1.01 Abbreviations

A. Wherever used in these specifications, the following abbreviations will have the meanings listed:

Abbreviation	Definition
AAMA	Architectural Aluminum Manufacturer's Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AFBMA	Anti-Friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute, Inc.
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CALSPEC	Standard Specifications, State of California, Department of Transportation, State of California, Business & Transportation Agency
CDPH	California Department of Public Health
FDCS	Field Data Collection System
FEDSPEC	Federal Specifications, General Services Administration, Specification and Consumer Information Distribution Branch
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MSS	Manufacturers Standardization Society
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NSF	National Safety Foundation

Abbreviation	Definition
OSHA	Occupation Safety and Health Act, U.S. Department of Health, Occupational and Health Administration
SSPWC	Standard Specifications for Public Works Construction
UBC	Uniform Building Code
UL	Underwriter's Laboratories, Inc.
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code

1.02 Applicable Publications

A. Wherever references are made to published specifications, codes, standards, or other requirements, and where no date is specified, it shall be understood that the latest specifications, standards, or requirements of the respective issuing agencies published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**** END OF SECTION ****

SECTION 01620
PROTECTION OF MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Materials and equipment shall be shipped, handled, stored, and installed by methods that will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the County Inspector.

1.02 Pipe and Appurtenances

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with soft coatings, such as coal tar enamel or the like, or pipes of materials which are subject to deterioration by sunlight or heat, such as PVC pipe, shall be stored to protect the coating or pipe from physical damage or other deterioration and shall only be handled with padded, wide slings. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

1.03 Equipment

A. Definition: For the purpose of this section, equipment means any mechanical, electrical, or instrumentation devices, and other items with one or more moving parts requiring an electrical, pneumatic, electronic or hydraulic connection.

B. Packing and Marking: All equipment shall be adequately and effectively protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be clearly marked with the number unique to the specification reference covering the item. Each separate piece of equipment shall receive, as far as practicable, a fitting or distinguishing mark that shall be shown on the packing lists.

C. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or sub-assembled units where possible.

D. Identification of Equipment: All equipment items and valves with an assigned equipment number shall have affixed to them, in a prominent location, a label or tag displaying the assigned equipment number. Equipment item and valves lacking a number shall have a similar tag providing a unique description of the item. Markers shall be of stainless steel or aluminum, affixed to the item in question with stainless steel fasteners or as otherwise approved by the Inspector. Plastic tape labels will not be acceptable. Handwritten labels will not be acceptable.

E. Storage of Equipment: During the interval between delivery and installation, all equipment to be incorporated into the project shall be stored to prevent damage or deterioration. Environmental controls such as heaters or protective encapsulation shall be provided to ensure against condensation and moisture damage. In the event prolonged (more than 90 days) storage is required for any item of rotative equipment, the Contractor shall institute a preventive maintenance program which

shall include grease protection of bare metal surfaces, periodic indexing of rotating parts, renewal of grease in bearings and any procedures recommended by the manufacturer. The Contractor shall maintain adequate records to demonstrate full compliance with these requirements. All equipment shall be available for inspection by the Owner.

F. To ensure adequate protection of all electrical and instrumentation equipment, panels, and electric motors, all such equipment shall be stored in a suitable enclosure designed to protect the equipment from dust and moisture. The Contractor shall be responsible for maintaining the storage facilities and equipment stored therein and shall make provision for all utilities required. Continuous access shall be provided to the Owner for all equipment so stored.

G. Protection of Equipment After Installation: After installation, all equipment shall be protected from damage, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and the fumes, particulate matter, and splatter from welding, brazing, and painting of new or existing piping and equipment. The Contractor is advised that as minimum, vacuum cleaning, blowers with filters, protective shielding, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted.

1.04 Delivery of Material or Equipment

A. The County Inspector will not accept materials or equipment deliveries for the Contractor.

B. Contractor must have Representative to accept all deliveries.

C. All deliveries must be scheduled during normal construction hours.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**** END OF SECTION ****

SECTION 01660
INSTALLATION, TESTING, AND COMMISSIONING

PART 1 - GENERAL

1.01 Description

A. This Section provides specifications for the installation and testing of all mechanical and electrical systems. Additional testing requirements for instrumentation and control systems are included in Section 17010. Additional leakage and other piping testing requirements are included those specified in the County Standard Specifications. All commissioning work for the equipment installed under this Contract shall be performed by a third party authorized representative of the manufacturer.

1.02 Quality Assurance

A. Installation: All mechanical and electrical equipment furnished under this contract shall be installed in conformity with the details shown and specified and with the manufacturer's requirements. Should a manufacturer's installation recommendations conflict with specific requirements of the contract documents, the Contractor shall bring the matter to the attention of the County Inspector prior to install. Any additional costs incurred arising out of changes authorized by the County Inspector to accommodate manufacturer's installation recommendations will not be considered extra work. Any costs, or time, incurred by the Contractor through failure to notify the County Inspector in a timely manner of a difference between contract documents and manufacturer's installation requirements shall be borne by the Contractor.

B. Testing:

1. General Requirements: All materials, equipment, and work included in this contract shall be tested and inspected to prove compliance with the contract requirements. Unless otherwise specified, all costs of testing, including temporary facilities and connections, shall be borne by the Contractor. For the purpose of this section, equipment shall mean any mechanical, electrical, instrumentation, or other device with one or more moving parts or devices requiring an electrical, pneumatic or hydraulic connection. Installed leakage tests and other piping tests shall be as specified in the County standard specifications. Installed tests for instrumentation/ control devices and systems shall be in accordance with Section 17010.

2. No tests specified herein shall be applied until the item to be tested has been inspected and approval has been given for the application of such tests.

3. Tests and inspection shall include:

   a. The delivery acceptance tests and inspections.

   b. The installed tests and inspections of items as installed.

4. Tests and inspections, unless otherwise specified or accepted, shall be in accordance with recognized industry standards and manufacturer requirements.

5. The form of evidence of satisfactory fulfillment of delivery acceptance test and of installed test and inspection requirements shall be, at the discretion of the County

Inspector, either by tests and inspections carried out in the representative's presence or by certificates or reports of tests and inspections carried out by approved persons or organizations. The Contractor shall provide and use forms which include all test information, including specified operational parameters, and which shall be acceptable in content to the County Inspector. The forms shall be submitted to the County Inspector for approval.

6. Delivery Acceptance Tests and Inspections: The delivery acceptance tests and inspections shall be at the Contractor's expense for any materials or equipment specified herein and shall include the following:

   a. All items delivered at the site or to any authorized place of storage may be inspected to satisfy the County Inspector that such items are of the specified quality and workmanship and are in good order and condition at the time of delivery, notwithstanding the requirements of the Supplemental General Provisions. To that end, the Contractor shall be prepared to remove all coverings, containers or crates to permit the County Inspector to conduct an inspection. Should the County Inspector find indication of damage or deficient quality of workmanship, the Contractor shall provide the necessary documentation or conduct such tests deemed necessary by the County Inspector to demonstrate compliance.

7. Installed Tests and Inspection: All equipment shall be tested by the Contractor in accordance with the County Standard Specifications and to the satisfaction of the County Inspector before it is put into operation. Tests shall be as specified by the manufacturer and approved by the County Inspector. Testing plans shall be submitted for approval prior to scheduling of tests.

PART 2 - PRODUCTS AND EQUIPMENT

2.01 Materials

A. Installation: Materials employed in the installation shall conform to the requirements of contract documents and the recommendations of the equipment manufacturers. Where conflict exists between contract document specifications and the manufacturer's recommendations, the Contractor shall bring the matter to the attention of the County Inspector and request a resolution of the conflict. Any costs incurred by the Contractor, through failure to notify the County Inspector in a timely manner of a conflict, shall be borne by the Contractor.

B. Testing:

   1. Gages, Meters, Recorders and Monitors: Gages, meters, recorders and monitors shall be provided by the Contractor as required to supplement or augment the instrumentation system provided under this contract to properly demonstrate that all equipment fully satisfies the requirements of the contract documents. All devices employed for the purpose of measuring the performance of the facility's equipment and systems shall be specifically selected to provide a level of certainty consistent with the variables to be monitored. All instruments shall be recently calibrated, and the Contractor shall be prepared at all times to demonstrate, through recalibration, the certainty of all instruments employed for testing purposes. Calibration procedures shall be conducted in accordance with applicable standards of ASTM, ISA and IEEE. The adequacy of all gages,

meters, recorders and monitors shall be subject to review of the County Inspector.

2. Records: The Contractor shall provide signoff forms for all installed and operational testing to be accomplished under this contract. The signoff forms shall be produced on pressure sensitive paper. Sign off forms shall be provided for each item of mechanical, electrical and instrumentation equipment provided or installed under this contract and shall contain provisions for recording relevant performance data for original testing and not less than three retests. Separate sections shall be provided to record values for the preoperational checkout, initials of representatives of the equipment manufacturers, the Contractor and the County Inspector.
3. The Contractor shall maintain a master file of all equipment sign off sheets, which shall be available for inspection by the County Inspector. Upon completion of testing, the Contractor shall furnish the County Inspector with the original and two (2) copies of the sign off sheet for each equipment item.

PART 3 - EXECUTION

3.01 Methods

A. Installation: All materials and equipment shall be installed by specialists properly skilled in the trades and professions required to assure first-class workmanship. Where required by detailed specifications, the Contractor shall cause the installation of specific equipment items to be accomplished under the supervision of factory-trained installation specialists furnished by the equipment manufacturers. The Contractor shall be prepared to document the skills and training of all workers engaged in the installation of all equipment furnished.

B. Testing: Testing shall proceed on a step-by-step basis in accordance with the Contractor's written testing procedures. Each individual step in the procedures shall be witnessed by the County Inspector.

**** END OF SECTION ****

SECTION 01700
RESTORATION OF IMPROVEMENTS

PART 1 - GENERAL

1.01 Structures

A. The Contractor shall remove existing structures, including paving, sidewalks, curbs, gutters, and pipelines as may be necessary for the performance of the work and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. Concrete structures such as curbs and gutters shall be replaced from joint-to-joint or as directed by the County Inspector. The Contractor shall also repair existing structures that may be damaged as a result of the work under this contract. Requirements for structure restoration are covered in the County Standard Specifications and Standard Details.

1.02 Roads

A. Unless otherwise specified, roads or other paved surfaces in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Requirements for paving restoration are covered in Section 02500 and the County Standard Specifications and Standard Details.

1.03 Cultivated Areas and Other Improvements

A. Cultivated or planted areas and other surface or subsurface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition at the Contractor's expense. Existing guard posts, barricades, and fences shall be protected and replaced if damaged. Contractor shall protect street and site lighting, traffic signals, telephone, power or other existing facilities from damage. Not all existing facilities are shown on the Drawings. Contractor shall restore all existing facilities damaged due to construction. Requirements for restoration of cultivated areas and other improvements are covered in the County Standard Specifications and Standard Details.

1.04 Restoration of Existing Installations

A. The Contractor shall, at no cost to the Owner, immediately correct or replace existing equipment, controls or systems that are damaged as a result of construction or Contractor operations.

B. All curb, gutter and sidewalks saw cut and removed during construction including handicap ramps shall be replaced per the County Standard Specifications and Standard Details within thirty (30) days of completion of the utility work within that portion of the project.

1.05 Warranty of Restoration Work

A. The Contractor shall include all restoration work under the one (1) year guarantee included in the Supplemental General Provisions and Special Provisions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

**** END OF SECTION ****

SECTION 02055
DEMOLITION & SITE PREPARATION

PART 1 - GENERAL

1.01 Summary

A. Demolition and site preparation includes all clearing, grubbing, and demolition work as well as abandonment of pipelines, valves, and other existing structures as shown on plans.

1.02 Quality Assurance

A. General: All work shall be performed in accordance with the local building codes, State Industrial Safety Orders and requirements of the Occupational Safety and Health Act requirements.

B. Schedule: Demolition must be scheduled to allow all existing services and utilities to remain in continuous operation. No interruption in operation will be permitted without previous authorization from the Owner's Representative.

C. Protection

1. Demolition shall be performed in such a manner as to not harm adjacent structures, equipment, existing landscaping or natural vegetation. The Contractor shall assume full responsibility for such disturbance. All costs of any such repair, rehabilitation, or modifications shall be borne by the Contractor.
2. The Contractor shall provide such protection as may be required to transfer material to the ground. Throwing, dropping or permitting the free fall of material and debris from heights which would cause damage to other work, existing structures, or equipment; undue noise or nuisance; or excessive dust will be expressly prohibited.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 General

A. The Contractor shall notify the Owner's Representative when demolition is to begin and when demolition is complete.

3.02 Performance

A. Clearing and Grubbing

1. The site of all open-cut excavations and areas to be cleared as indicated on the Plans shall be cleared and grubbed prior to excavation. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, roots, root balls, heavy sod, vegetation, rock, stones larger than 6 inches by any dimension, broken or old concrete and pavement, debris, and structures.

2. Clearing and grubbing in areas of structural improvement such as concrete structures shall be cleared and grubbed as above except that obstructions larger than 2 inches in any dimension shall be removed.

B. Equipment and Piping Removal

1. All equipment and piping to be removed shall be properly disconnected from structures, piping, electrical, and instrumentation systems.

C. Pipeline/Structure Abandonment:

1. Pipelines are to be abandoned by plugging the ends and filling the entire pipeline with pumped concrete.
2. Pipelines to be abandoned, shall be removed a minimum of three feet from the live portion of the pipeline and securely closed at all pipe ends by a watertight plug of concrete not less than 2-feet thick.
3. Pipelines to be completely filled shall be pumped full with a concrete mix sufficiently workable for the purposes intended.
4. Structures to be abandoned shall have all openings, inlets and outlets sealed off and the structure shall be removed to a point 24-in below the proposed grade or existing ground surface and filled with backfill (compacted as directed) or filled with concrete.

D. Pavement Removal

1. All pavements and concrete pads shall be saw-cut on a neat line and terminated at right angles to the curb face.

E. Utility Interference

1. Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them.

3.03 Salvage

A. The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Owner's Representative five days prior to any salvage or demolition work to determine the disposition of items to be removed. The Owner's Representative will mark items to be salvaged. The Contractor shall be responsible for properly disconnecting, removal from their foundations, cleaning and storing at a location on the site as specified or as directed by the Owner's Representative for all salvage items.

3.04 Removed Material and Debris

A. Where Contractor is directed on the Drawings to "Remove" material or facilities it is understood that the material will be removed and disposed of offsite unless specifically stated otherwise or directed by the Owner's Representative.

B. All removed material not designated for salvage and all debris shall become the property of the Contractor and shall be removed from the site.

C. Materials and debris generated by demolition activities shall not be allowed to accumulate. Debris shall be removed daily and disposed of in a manner allowed by law.

3.05 Backfill

A. Holes or depressions in the ground remaining after demolition of structures, pipelines, or equipment shall be filled with compacted backfill materials as specified in Section 02200-Earthwork.

3.06 Restoration

A. Restore adjacent structures and facilities damaged during demolition or other construction to original or better condition.

****END OF SECTION****

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.01 Summary

A. This section specifies earthwork activities consisting of excavation, filling, grading, and excess material control.

1.02 References

A. The following documents are a part of this section insofar as they are specified and modified herein. In case of conflict between the requirements of this Section, and the following documents, the requirements of this section shall prevail.

Reference	Title
California Test Method 217	Method of Test for Sand Equivalent
ASTM C136	Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM D420	Standard Recommended Practice for Investigating and Sampling Soil and Rock for Construction Purposes
ASTM D1556	Method of Test for Density of Soil in Place by the Sand-Cone Method
ASTM D1557	Method of Test for Moisture-Density Relations of Soils, Using 10 lb. (4.5 kg) Hammer and 18 in. (457 mm) Drop
ASTM D2049	Standard Test Method for Relative Density of Cohesionless Soils
ASTM D2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3017	Method of Test for Moisture Content of Soil and Soil Aggregates in Place by Nuclear Methods (Shallow Depth)
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
Caltrans	Standard Specifications, May 2006

1.03 Definitions

A. Compaction

1. The degree of compaction is specified as percent of relative compaction. The relative compactions refer to the maximum relative densities of dry soil obtainable at optimum moisture content.

1.04 Submittals

A. Submit current technical data for each type of material specified to prove compliance with the specifications in accordance with the requirements of Section 01300 - Submittals.

B. Samples of fill materials to be used shall be submitted 60 days in advance of use. Samples shall consist of 1.0 cubic foot of each type of material proposed.

1.05 Quality Assurance

A. All soils testing will be done by a testing laboratory of the Owner's choice and expense except as otherwise noted.

B. The Owner's Representative will take samples and perform tests for compliance with the specifications including Atterburg limits, specific gravity, sand equivalent, R-value, durability, moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications.

C. The Contractor shall remove surface material at locations designated by the Owner's Representative and provide such assistance as necessary for sampling and testing.

D. The Owner's Representative may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications.

E. The Owner will bear the costs for sampling and testing specified in the above paragraph. The Contractor shall pay costs associated with retesting due to the Contractor's failure to comply with the specifications.

PART 2 - PRODUCTS

2.01 Fill Materials

A. Engineered Fill: Engineered Fill material shall be a select nonexpansive, granular material free from organic matter and of such size and gradation that the specified compaction can be readily obtained. Material "Atterberg" cohesive range will be defined by a liquid limit of less than 20 (% of water content) and a plasticity index of less than 12 (% of water content) and shall conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3 inch	100
3/4 inch	80-100
No. 4	50-100
No. 10	35-95
No. 40	15-75
No. 200	5-35

B. Select Fill: Select Fill material shall be unclassified material and may be obtained from excavation on the Work site.

1. The material shall be free from peat, wood, roots, bark, debris, garbage, rubbish or other extraneous material.
2. The maximum size of stone shall not exceed 3 inches.
3. The percent of rock greater than 1 ½ inches shall not exceed 15 percent.
4. The Expansion Index shall be less than 35 percent.
5. The amount of fines passing a No. 200 sieve shall not exceed 20 percent.

C. Drain Rock: Drain Rock material shall be clean crushed granular material, commonly known as coarse aggregate, conforming to CALTRANS Standard Specification Section 90-3.02.

1. Contractor may propose 1-1/2 inch x ¾ inch gradation or 1 inch x No. 4 gradation. However, once selected the same gradation must be used throughout the project.
2. Drain Rock shall be composed of hard, durable, and sound pieces of rock having a specific gravity of not less than 2.65.

D. Sand: Sand shall be pervious backfill conforming to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3/8 inch	100
No. 4	90-100
No. 50	0-100
No. 100	0-8
No. 200	0-4

E. Class 2 Aggregate Base: Class 2 Aggregate Base shall be ¾-inch maximum size free from organic or other deleterious substances, in conformance with CALTRANS Standard Specifications Section 26.

U.S. Standard Sieve Size	Percent by Weight Passing
1 inch	100
3/4 inch	90-100
No. 4	35-60
No. 30	10-30
No. 200	2-9

Test	Minimum Value
Resistance (R Value)	78
Sand Equivalent	22

U.S. Standard Sieve Size	Percent by Weight Passing
Durability Index	35

PART 3 - EXECUTION

3.01 General

A. Overexcavation

1. At the direction of the Owner's Representative: Where the undisturbed condition of natural soils is inadequate for support of planned construction, the Owner's Representative will direct the Contractor to overexcavate to adequate supporting soils. The excavated space shall be backfilled and compacted to the specified elevation with soil materials in accordance with the fill requirements of this Section.
2. Due to Contractor's Operations: Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require overexcavation and backfill, the Contractor shall backfill such excavated space with a compacted material in accordance with the fill requirements of this Section. Backfill and compaction shall be at Contractor's expense.

B. Removal of Obstructions

1. The Contractor shall remove all rocks, stones, broken concrete and pavement, debris and all obstructions of whatsoever kind or character, whether natural or artificial, encountered in the Work.
2. Material that is removed as hereinbefore specified, and is not to be incorporated in the Work, shall be properly disposed of off the site.

C. Surplus Material

1. Unless otherwise specified, surplus excavated material shall be disposed of in accordance with applicable ordinances and environmental requirements. The Contractor may dispose of surplus excavated material on-site with the written permission of the Owner's Representative. Spoils area left on-site shall be graded and compacted as directed by the Owner's Representative.
2. The Contractor shall satisfy himself that there is sufficient material available for the completion of the required earthwork before disposing of any material inside or outside the site. The Contractor shall replace shortage of material, caused by premature disposal of any material by the Contractor.
3. Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure except for those areas designated to be preconsolidated. For these areas, the depth of stockpiled material shall be as specified. The Contractor shall maintain stability of the soil adjacent to any excavation.

D. Borrow Material

1. If the quantity of acceptable material from excavation is not sufficient to construct the embankments required by the work, the quantity of material needed to complete the embankments shall consist of imported borrow conforming to specified fill requirements.

E. Hauling

1. When hauling is done over highways and/or private streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

F. Haul Roads

1. If required, Contractor shall construct haul roads required to transport materials on the Work site. Alignment of haul roads shall be selected to avoid interference with concurrent construction operations and facility operations. Haul roads shall be removed after completion of embankment construction.

G. Finish Grading

1. Finish surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.
2. Finished grade will be as specified by the contours, plus or minus 0.10 foot, except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.
3. When the Work is at an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.
4. If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

H. Control of Erosion

1. The Contractor shall maintain earthwork surface true and smooth and protected from erosion. Where erosion occurs, the Contractor shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.02 Fill

A. Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer depth, relative compaction, and general application are specified in the following table:

B. <u>Fill Requirements</u>

Material Type	Maximum Loose Layer Depth, Inches	Minimum Relative Compaction, Percent	General Application
Class 2 Aggregate	8	90	Slabs on grade

Material Type	Maximum Loose Layer Depth, Inches	Minimum Relative Compaction, Percent	General Application
Base			
Sand or 1” x No. 4 Drain Rock	6	90	Bedding and initial backfill for ductile iron, C900, and C905 pipe
Sand	6	90	Bedding and initial backfill for plastic pipe
Engineered Fill or Select Fill	8	90	Subsequent pipeline backfill
Class 2 Aggregate Base	8	95	Upper 1 foot of pipeline backfill in all roadways of asphalt concrete pavement
Engineered Fill or Class 2 Aggregate Base	8	95	Below structures except as shown on the Drawings
Engineered Fill or Select Fill or Class 2 Aggregate Base	6	90 95	Structural backfill adjacent to structures Upper 1 foot of structural backfill
Engineered Fill or Class 2 Aggregate Base	8	90 95	Roadway subgrade Upper 1 foot of roadway fill
Select Fill or Engineered Fill	8	90	General fill or Pond fill
Select Fill	8	85	Areas to receive landscaping

3.03 Earthwork for Structures

A. Structure Fill and Backfill

1. Structural Fill and Backfill shall conform to the requirements of this Section or as shown on the Drawings. In the case of a conflict the more restrictive requirement shall govern.
2. After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of debris.
3. Structure backfill shall not be placed until the subgrade portions of the structure have been inspected. No backfill material shall be deposited against concrete

structures until the concrete has developed a compressive strength of not less than the specified 28 day concrete strength is reached.

4. Backfill material shall be placed in uniform layers with uncompacted thickness of not more than 6 inches and shall be brought up uniformly on all sides of the structure. Each layer of backfill shall be compacted to a relative compaction of not less than 90 percent. The top 12 inches shall be compacted to at least 95 percent relative compaction. Where the backfill is under roadway or traffic area, the material within 12 inches below the roadbase shall be compacted to a relative compaction of not less than 95 percent. Compaction by means of water jetting or water ponding shall not be permitted.
5. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

B. Drain Rock

1. Drain rock below and around structures shall be completely encased in filter fabric.
   a. Seams shall be overlapped a minimum of 3 feet.
   b. Repair all tears and cuts in fabric prior to backfill.
   c. Take precautions to not damage fabric during backfill.
2. Drain rock to be placed under structures shall be compacted with 2 to 4 passes of a vibrating compactor into an even surface to minimize migration of finer material that may be placed on top of the rocks.

3.04 Excavation and Backfill for Pipelines and Conduits

A. Excavation

1. Unless otherwise specified or indicated, excavation for pipelines and conduits shall be open cut. Trenching machines may be used except where their use will result in damage to existing facilities.
2. Where, in the opinion of the Owner's Representative, the undisturbed condition of the natural soils below the excavation grades indicated or specified is inadequate for the support of the planned pipeline, the Owner's Representative will direct the Contractor to overexcavate to adequate supporting soils and backfill the excavated space to the proper elevation.
3. Unless otherwise shown, trenches shall be excavated at least 6 inches below the final elevation of the barrel of the pipe.

B. Trench Width

1. The maximum and minimum allowable width of trench shall be as shown. The maximum width shall be inclusive of all sheeting, lagging and bracing.
2. Wherever the maximum allowable trench width is exceeded for any reason, the Contractor shall provide improved bedding and/or extra strength pipe, as directed by the Owner's Representative.
3. All pipelines shall have minimum of 6 inches bedding material below the barrel of the pipe. Bedding shall be placed and compacted as specified for initial trench backfill and shall be placed to provide uniform support for the pipe.

4. Where, in the opinion of the Owner's Representative, stabilization of the undisturbed foundation below the 6-inch bedding of the overexcavated depth as shown is required because of the soft, spongy or unstable condition, backfill selected by the Owner's Representative shall be placed in the trench bottom.

C. Initial Backfill

1. After the pipe has been properly laid and inspected, initial backfill shall be placed as shown in the Drawings or called for by Manufacturer literature. The backfill material shall be placed in horizontal layers and compacted by power-operated tampers, rollers, or vibratory equipment to the relative compaction in accordance with Fill Requirements. Jetting of bedding or initial backfill is not allowed.

2. Each layer shall be compacted to the specified relative compaction prior to placing subsequent layers. The thickness of the loose layer may be increased when in-place compaction tests satisfactory to the Owner's Representative show that the specified relative compaction can be obtained. No further backfilling will be permitted until the Owner's Representative has accepted the initial backfill.

D. Subsequent Backfill

1. Above the level of initial backfill, the trench shall be filled with material as specified unless otherwise indicated on the Drawings. The backfill material shall be placed in horizontal layers and shall have a moisture content such that the required degree of compaction may be obtained. Each layer shall be compacted by power-operated tampers, rollers or other suitable equipment to the relative compaction as indicated in same table. Each layer shall be compacted to the specified relative compaction prior to placing subsequent layers.

3.05 Paving Subgrade Preparation

A. The prepared subgrade shall be scarified to a depth of at least 12 inches, moisture conditioned as necessary, and recompacted to at least 95 percent of the maximum relative compaction based on the ASTM D1557 test method.

B. Any localized zones of soft or pumping soils observed within the excavation base should either be scarified and recompacted as discussed above or be overexcavated and replaced with suitable material.

C. Aggregate base course shall be compacted to at least 95 percent of the maximum relative compaction based on the ASTM D1557 test method.

3.06 Site Fill

A. Unless otherwise specified general site fill material shall be Select Fill or Engineered Fill compacted to a relative compaction of at least 90 percent. If the existing slope in an area to be filled is steeper than 5:1, the Contractor shall bench the area prior to filling.

****END OF SECTION****

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SECTION 02350
SHEETING, SHORING, AND BRACING

PART 1 - GENERAL

1.01 Scope

A. This Section provides specifications for sheeting, shoring, bracing, or other excavation supports.

1.02 Payment

A. All sheeting, shoring, and bracing necessary shall be included as a separate Bid Schedule item.

1.03 References

A. This Section references the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the most stringent requirement shall prevail.

Reference	Title
OSHA	Occupation Safety and Health Act, US Department of Health
CAL/OSHA	State of California Construction Safety Orders - California State Labor Code

1.04 Quality Assurance

A. Design Requirements:

1. Protection and Trench Safety: Pursuant to Section 6705 of the State Labor Code, all open excavations greater than five (5) feet in depth shall be constructed with bracing, sheeting, shoring, or other equivalent method designed for the protection of life and limb. The trench excavation and support system shall comply in all respects with the requirements of Article 6, of the Construction Safety Orders of the Division of Industrial Safety. The Contractor's attention is directed to the provisions of Subarticle 1540 (4), Article 6 of the California Construction Safety Orders for alternative shoring and sloping system. It shall be the Contractor's responsibility to provide the additional strength required to support the sides of the excavation against loads that may exceed those employed to derive the criteria set forth in the Industrial Safety Orders. The Contractor shall submit to the City Inspector a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards, the plan shall be prepared by a registered civil engineer. Plans must be accepted by the City Inspector.

2. It shall be understood that the above stipulated requirements are to be considered to be the minimum to be provided. The Contractor shall be solely responsible for any and all liabilities which may arise from the Contractor's failure to provide adequate shoring, bracing, or sheeting as necessary to support the

excavation under any or all of the conditions of loading which may exist, or which may arise during the construction of the project.

3. Excavation for Structures: All excavations shall be properly shored, sheeted and braced or cut back to the proper slope to furnish safe working conditions, to prevent shifting of material, to prevent damage to structures or other work, and to avoid delay to the work, all in accordance with applicable safety and health regulations. Before starting excavation for structures, the Contractor shall submit for record purposes complete design calculations and working drawings of proposed sheeting and bracing arrangements which have been prepared, signed, and sealed by a registered civil engineer. Bracing shall be arranged so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength. If the City Inspector is of the opinion that, at any point, the sheeting or supports are inadequate or unsuited for the purpose, the City Inspector may order the Contractor to resubmit design calculations and working drawings for that point, taking into consideration the observed field conditions. If the new calculations show the need for additional sheeting and bracing, the Contractor shall immediately install it. The sole responsibility for the design, methods of installation, and adequacy of the sheeting and supports shall be and shall remain that of the Contractor. The working drawings for shoring, sheeting and bracing will not be checked by the City Inspector.

4. Sequencing: The Contractor shall not start excavation until the trench support drawing has been returned to the Contractor. When the construction sequence of structures requires the transfer of bracing to the completed portions of any structure, the Contractor shall secure the written acceptance of the City Inspector prior to the installation of such bracing.

1.05 Submittals

A. Trench/Slope Support Drawings: In accordance with the requirements of Section 6705 of the Labor Code of the State of California, the Contractor shall submit detailed drawings to the City Engineer before excavation, showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of any trench, trenches or slope five (5) feet or more in depth. The design shall be signed by a registered civil engineer.

B. Certification: The minimum required protection will be that described in the Construction Safety Orders of the Division of Industrial Safety. If the Contractor presents excavation plans that vary from the shoring system standards established by the Construction Safety Orders, the Plans shall be prepared and signed by a registered civil engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 Installation

A. The design, planning, installation and removal of all lagging, sheeting, shoring, sheet piling, and bracing shall be accomplished in such a manner as to maintain the undisturbed state of the soils adjacent to the trench and at and below the excavation bottom.

B. The use of horizontal strutting below the barrel of a pipe or the use of a pipe as a support will not be permitted.

C. Sheet piling and timbers in trench excavations shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe or additional backfill loadings that might overload the pipe. Trench sheeting below the top of the pipe shall be left in place.

**** END OF SECTION ****

SECTION 02350
SHEETING, SHORING, AND BRACING

PART 1 - GENERAL

1.01 Scope

A. This Section provides specifications for sheeting, shoring, bracing, or other excavation supports.

1.02 Payment

A. All sheeting, shoring, and bracing necessary shall be included as a separate Bid Schedule item.

1.03 References

A. This Section references the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the most stringent requirement shall prevail.

Reference	Title
OSHA	Occupation Safety and Health Act, US Department of Health
CAL/OSHA	State of California Construction Safety Orders - California State Labor Code

1.04 Quality Assurance

A. Design Requirements:

1. Protection and Trench Safety: Pursuant to Section 6705 of the State Labor Code, all open excavations greater than five (5) feet in depth shall be constructed with bracing, sheeting, shoring, or other equivalent method designed for the protection of life and limb. The trench excavation and support system shall comply in all respects with the requirements of Article 6, of the Construction Safety Orders of the Division of Industrial Safety. The Contractor's attention is directed to the provisions of Subarticle 1540 (4), Article 6 of the California Construction Safety Orders for alternative shoring and sloping system. It shall be the Contractor's responsibility to provide the additional strength required to support the sides of the excavation against loads that may exceed those employed to derive the criteria set forth in the Industrial Safety Orders. The Contractor shall submit to the City Inspector a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards, the plan shall be prepared by a registered civil engineer. Plans must be accepted by the City Inspector.

2. It shall be understood that the above stipulated requirements are to be considered to be the minimum to be provided. The Contractor shall be solely responsible for any and all liabilities which may arise from the Contractor's failure to provide adequate shoring, bracing, or sheeting as necessary to support the

excavation under any or all of the conditions of loading which may exist, or which may arise during the construction of the project.

3. Excavation for Structures: All excavations shall be properly shored, sheeted and braced or cut back to the proper slope to furnish safe working conditions, to prevent shifting of material, to prevent damage to structures or other work, and to avoid delay to the work, all in accordance with applicable safety and health regulations. Before starting excavation for structures, the Contractor shall submit for record purposes complete design calculations and working drawings of proposed sheeting and bracing arrangements which have been prepared, signed, and sealed by a registered civil engineer. Bracing shall be arranged so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength. If the City Inspector is of the opinion that, at any point, the sheeting or supports are inadequate or unsuited for the purpose, the City Inspector may order the Contractor to resubmit design calculations and working drawings for that point, taking into consideration the observed field conditions. If the new calculations show the need for additional sheeting and bracing, the Contractor shall immediately install it. The sole responsibility for the design, methods of installation, and adequacy of the sheeting and supports shall be and shall remain that of the Contractor. The working drawings for shoring, sheeting and bracing will not be checked by the City Inspector.

4. Sequencing: The Contractor shall not start excavation until the trench support drawing has been returned to the Contractor. When the construction sequence of structures requires the transfer of bracing to the completed portions of any structure, the Contractor shall secure the written acceptance of the City Inspector prior to the installation of such bracing.

1.05 Submittals

A. Trench/Slope Support Drawings: In accordance with the requirements of Section 6705 of the Labor Code of the State of California, the Contractor shall submit detailed drawings to the City Engineer before excavation, showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of any trench, trenches or slope five (5) feet or more in depth. The design shall be signed by a registered civil engineer.

B. Certification: The minimum required protection will be that described in the Construction Safety Orders of the Division of Industrial Safety. If the Contractor presents excavation plans that vary from the shoring system standards established by the Construction Safety Orders, the Plans shall be prepared and signed by a registered civil engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 Installation

A. The design, planning, installation and removal of all lagging, sheeting, shoring, sheet piling, and bracing shall be accomplished in such a manner as to maintain the undisturbed state of the soils adjacent to the trench and at and below the excavation bottom.

B. The use of horizontal strutting below the barrel of a pipe or the use of a pipe as a support will not be permitted.

C. Sheet piling and timbers in trench excavations shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe or additional backfill loadings that might overload the pipe. Trench sheeting below the top of the pipe shall be left in place.

**** END OF SECTION ****

SECTION 02924
HYDROSEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Hydroseeding and seedbed preparation.

1.02 REFERENCES

A. Association of Official Analytical Chemists (AOAC):

   1. Official Methods of Analysis.

B. U.S. Department of Agriculture (USDA):

   1. FSAR – Federal Seed Act Regulations.

C. Federal Specifications (FS):

   1. O-F-241 – Granular Fertilizer.

1.03 DESCRIPTION

A. Erosion control hydroseeding to be applied over final backfill, finished grading, and cut slopes where natural ground has been disturbed. Hydroseeding shall be the last activity conducted by the CONTRACTOR prior to project acceptance.

1.04 DELIVERY AND STORAGE

A. Ensure that seed packages are packed to provide adequate protection against injury during transit.

B. Deliver undamaged sealed seed bags with legible labels showing weight, analysis, vendor's name and address, and point of origin. Label seed bags per variety.

C. Deliver dry commercial process or packaging, such as fertilizer, in undisturbed original unopened containers with legible labels showing manufacturer's guaranteed analysis or description.

D. Inspect materials and packages upon delivery. Discard damaged packages or containers immediately.

E. Store materials in protected and covered storage until application or use.

PART 2 - PRODUCTS

2.01 HYDROMULCHING EQUIPMENT

A. Manufacturers: One of the following or equal:

1. Bowie Industries, Inc., Bowien, TX.

2. Rienco, Plainfield, NJ.

3. Finn Equipment Co., Cincinnati, OH.

B. With built-in agitation system sufficient to agitate, suspend and homogeneously mix slurry containing fiber, fertilizers, chemical, and seed mix.

C. Capable of slurry distribution line large enough to prevent stoppage.

D. Equipped with set of hydraulic spray nozzles, which provide continuous nonfluctuating discharge of minimum 225 pounds per square inch at end of spray nozzle.

2.02 MATERIALS

A. Seed Mix: Seed mix from latest crop. Minimum pure live seed content to be 80 percent, and tested within the preceding 6 months. Do not use seed mix after expiration date.

1. Erosion Control
   a) Blando Brome: 20 pounds per acre.
   b) Annual Rye: 25 pounds per acre.
   c) Rose Clover: 20 pounds per acre.
   d) Zorro Annual Fescue: 10 pounds per acre.

B. Fiber Mulch: Wood fiber manufactured for hydroseeding. Manufacturers: One of the following or equal:

1. Grass Growers, Plainfield, NJ.

2. Conwed Corp., Fibers Div., St. Paul, MN.

3. Eva Cell Co., Evadale, TX.

C. Granular Fertilizers: Fertilizer to be 16-20-0, commercial grade, free flowing, uniform in composition, inorganic. Manufacturers: One of the following or equal:

1. Sierra Chemical Co., Milpitas, CA.

2. Green Light Co., Wonder Grow Chemicals, San Antonio, TX.

3. Kay-Fries Chemicals, Montvale, NJ.

D. Water: Use potable water for making up seed mixture.

PART 3 - EXECUTION

3.01 PREPARATION

A. Area to be seeded to be weed free and have a firm seed bed which has previously been roughened by scarifying, discing, harrowing, chiseling, or otherwise worked to a depth of 2 to 4 inches.

B. Do not use any implements that will create an excessive amount of downward movement or clods on sloping areas.

C. Seedbed may be prepared at time of completion of earth-moving work.

3.02 FERTILIZER

A. Distributed uniformly over seed bed and incorporated into the soil. Incorporation may be part of the seedbed preparation or as part of the seeding operation, unless seed is broadcast. If fertilizing is a part of the seedbed preparation, do not fertilize more than 15 days prior to seeding.

B. Apply fertilizer at 250 pounds per acre.

3.03 APPLICATION

A. Mark test plots to calibrated equipment and rate of vehicle. Continue test operations until satisfied with performance of even, smooth application.

B. Apply seed with wood cellulose fiber at 500 pounds per acre. Do not allow seed to stay within slurry longer than 30 minutes.

C. Immediately after seeding, apply wood fiber mulch at 3000 pounds per acre with a tachifier adhesive at 75 pounds per acre. Mixture to be sufficiently green in color to determine coverage. Use nontoxic dye that is water-soluble.

D. Foot traffic on hydroseeded area is not permitted.

3.04 SLURRY PREPARATION

A. Prepare slurry at project site, using potable water.

B. Dispose of any slurry that has not been used within two hours at a location off-site at Contractor's expense.

3.05 HYDROSEED WATERING

A. Provide temporary watering system or apply water with a water truck acceptable to the engineer.

B. Germination Stage:

1. Initiate watering sequence within 24 hours after hydromulching planted areas. Leave water on long enough to moisten soil thoroughly to a depth of the fiber taking care not to supersaturate or wash fiber or soil particles off the slopes. Observe irrigation system continually while in operation.

2. CONTRACTOR to repair all seed washing or erosion immediately.

3. Irrigate fiber and seed lightly and frequently to maintain optimum moisture content for maximum germination. Determine irrigation sequence according to air temperature, prevailing wind velocity, soil texture, orientation and other logistical problems.

4. Keep soil moist at all times during germination period. Continue irrigation sequence until seedlings have grown beyond the germination stage, approximately 30 to 60 days.

C. Establishment Stage:

1. Reduce watering frequency while increasing duration of the water sufficiently to allow for maximum water penetration for the expanding root system. Take care not to cause erosion.

2. Precise watering reduction program to be determined by the CONTRACTOR.

D. Hardening-off Stage:

1. Reduce irrigation frequency while increasing the duration of each water cycle.

3.06 GUARANTEE

A. CONTRACTOR to be responsible for the quality of all labor and materials as provided by Subcontractors, and suppliers, including seed mix, hydroslurry ingredients, hydroseed application, and maintenance of areas.

****END OF SECTION****

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 Summary

A. The work of this Section includes providing concrete formwork, bracing, shoring, and supports.

B. Related Sections

Section	Title
03200	Reinforcement Steel
03280	Joints in Concrete Pavement
03290	Joints in Concrete Structures
03300	Cast-in-Place Structural Concrete
03310	Cast-in-Place Sitework Concrete
03315	Grout

1.02 References

A. Except as otherwise indicated, the current editions of the following apply to the work of this Section:

Reference	Title
PS 1	U.S. Product Standard for Concrete Forms, Class I
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 318	Building Code Requirements for Reinforcing Concrete
ACI 347	Recommended Practice for Concrete Formwork

1.03 Submittals

A. The following shall be submitted in compliance with Section 01300 - Submittals:

1. Falsework Calculations and Drawings: The Contractor's attention is directed to the provisions of the California Division of Industrial Safety, Construction Safety Orders, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.
2. Catalog information on:
   a. Form ties and all related accessories, including taper tie plugs, if taper ties are used
   b. Form gaskets
   c. Form release (“bond breaker”).

PART 2 - PRODUCTS

2.01 General

A. Materials for concrete forms and falsework shall be new or in new condition.

B. Except as otherwise expressly accepted, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material or in new condition. All forms shall be smooth surface forms except as specified on contract drawings.

2.02 Form and Falsework Materials

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20.
2. Plywood for concrete formwork shall be waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.
3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown.
4. Unless otherwise indicated, all exterior corners in concrete members shall be provided with either 5/8-inch or 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
5. Forms and falsework to support the roof and floor slabs shall be designed based on nationally recognized standards, but in no circumstance be less than the total dead load, plus a live load of 50 psf for horizontal surfaces, and a lateral load of 100 lbs per foot at top of forms.

PART 3 - EXECUTION

3.01 General

A. Tolerances: The variation from established grade or lines shall not exceed the tolerances of ACI 117.

B. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the work and replaced at the Contractor's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

C. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete within 1/8” at exposed surfaces and ¼” elsewhere.

D. At exposed surfaces, plywood, grain, or other formwork irregularities shall not imprint concrete surface.

3.02 Form Design

A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03300 - Cast-in-Place Structural Concrete. The size, number, and location of such form windows shall be acceptable to the Engineer.

3.03 Construction

A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Where soil slope or face cannot hold its shape during concrete operations, formwork shall be used.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete.

C. Pipe stubs and anchor bolts shall be set in the forms where required.

D. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as indicated in Section 03300 - Cast-in-Place Structural Concrete. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: The larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout

for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3. Factor of safety = 2.0 against tensile failure

3.04 Reuse of Forms

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces that are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.05 Removal of Forms

A. Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section 03300 - Cast-in-Place Structural Concrete; provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by test cylinder results from concrete used in the first pour. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 1 day after the concrete has been placed, provided that average air temperature is between 10 degrees F and 115 degrees F and concrete has sufficient strength to maintain form.

B. Apply curing as required after form removal. For liquid curing compound, use industrial sprayer approved by curing compound manufacturer.

3.06 Maintenance of Forms

A. Forms shall be cleaned, treated with a releasing agent, and maintained in accordance with ACI 347 and the following. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.07 Falsework

A. Falsework, including staging, walkways, forms, ladders, and similar appurtenances, shall be designed, engineered, constructed, and maintained according to the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements of the Construction Safety Orders of the California Division of Industrial Safety.

****END OF SECTION****

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 Summary

A. The work of this Section includes providing concrete formwork, bracing, shoring, and supports.

B. Related Sections

Section	Title
03200	Reinforcement Steel
03280	Joints in Concrete Pavement
03290	Joints in Concrete Structures
03300	Cast-in-Place Structural Concrete
03310	Cast-in-Place Sitework Concrete
03315	Grout

1.02 References

A. Except as otherwise indicated, the current editions of the following apply to the work of this Section:

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ACI 117	Standard Tolerances for Concrete Construction and Materials
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2. Catalog information on:
   a. Form ties and all related accessories, including taper tie plugs, if taper ties are used
   b. Form gaskets
   c. Form release (“bond breaker”).

PART 2 - PRODUCTS

2.01 General

A. Materials for concrete forms and falsework shall be new or in new condition.

B. Except as otherwise expressly accepted, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material or in new condition. All forms shall be smooth surface forms except as specified on contract drawings.

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3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown.
4. Unless otherwise indicated, all exterior corners in concrete members shall be provided with either 5/8-inch or 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
5. Forms and falsework to support the roof and floor slabs shall be designed based on nationally recognized standards, but in no circumstance be less than the total dead load, plus a live load of 50 psf for horizontal surfaces, and a lateral load of 100 lbs per foot at top of forms.

PART 3 - EXECUTION

3.01 General

A. Tolerances: The variation from established grade or lines shall not exceed the tolerances of ACI 117.

B. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the work and replaced at the Contractor's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

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D. At exposed surfaces, plywood, grain, or other formwork irregularities shall not imprint concrete surface.

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3.03 Construction

A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Where soil slope or face cannot hold its shape during concrete operations, formwork shall be used.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete.

C. Pipe stubs and anchor bolts shall be set in the forms where required.

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1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as indicated in Section 03300 - Cast-in-Place Structural Concrete. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: The larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout

for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3. Factor of safety = 2.0 against tensile failure

3.04 Reuse of Forms

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces that are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

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A. Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section 03300 - Cast-in-Place Structural Concrete; provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by test cylinder results from concrete used in the first pour. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls and columns shall remain in place at least 1 day after the concrete has been placed, provided that average air temperature is between 10 degrees F and 115 degrees F and concrete has sufficient strength to maintain form.

B. Apply curing as required after form removal. For liquid curing compound, use industrial sprayer approved by curing compound manufacturer.

3.06 Maintenance of Forms

A. Forms shall be cleaned, treated with a releasing agent, and maintained in accordance with ACI 347 and the following. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.07 Falsework

A. Falsework, including staging, walkways, forms, ladders, and similar appurtenances, shall be designed, engineered, constructed, and maintained according to the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements of the Construction Safety Orders of the California Division of Industrial Safety.

****END OF SECTION****

SECTION 03300
CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 Summary

A. Section Includes

1. Cast-in-place structural reinforced concrete
2. Concrete accessories

B. Related Sections

Section	Title
02670	Testing of Hydraulic Structures
03100	Concrete Formwork
03200	Reinforcement Steel
03280	Joints in Concrete Pavement
03290	Joints in Concrete Structures
03315	Grout
03400	Precast Concrete
07900	Sealants
09900	Coatings

1.02 References

A. American Concrete Institute (ACI)

Reference	Title
ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305	Hot Weather Concreting
ACI 306	Cold Weather Concreting
ACI 308	Guide to Curing Concrete
ACI 309	Consolidation of Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Environmental Engineering Concrete Structures

B. American Society for Testing and Materials (ASTM)

Reference	Title
ASTM C31	Practices for Making and Curing Concrete Test Specimens in the Field

ASTM C33	Specification for Concrete Aggregates
ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Specification for Ready-Mixed Concrete
ASTM C143	Test Method for Slump of Portland Cement Concrete
ASTM C150	Specification for Portland Cement
ASTM C157	Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
ASTM C172	Standard Method of Sampling Freshly Mixed Concrete
ASTM C192	Method of Making and Curing Concrete Test Specimens in the Laboratory
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C289	Test Method For Potential Reactivity of Aggregates (Chemical Method)
ASTM C309	Specifications for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction & Criteria for Laboratory Evaluation

1.03 Definitions

A. “Contractor” includes the general contractor in direct contract with the owner, subcontractor, or any tradesman responsible for construction.

B. “Owner’s Representative” includes the Inspector, Engineer of Record, or Construction Manager representing the owner’s interests, and not directly compensated by the Contractor.

C. “Cold Weather” is defined as a period when, for more than 3 consecutive days, the following conditions exist:

   1. Average daily air temperature is less than 40 F degrees (5 C) and
   2. Air temperature is not greater than 50 F degrees (10 C) for more than one-half of any 24-hour period.

D. “Hot weather” is defined by any one of the following conditions:

   1. Ambient air temperature above 90 F degrees (32 C).

E. “Mass Concrete” refers to single pour cast-in-place concrete that is greater than 2’-10” thick, or is 2’-6” thick or greater, with an area larger than 500 square feet.

1.04 Submittals

A. General: All submittals must be provided for Engineer of Record approval at least 3 weeks prior to construction.

B. Submit concrete mix design for each concrete type per ACI 301:

   1. Mix proportions
   2. Concrete materials
   3. Admixtures

4. Water test results
5. Waterstop samples for hydraulic structures

C. Shrinkage test results from prior test mixes per ASMT C157 for hydraulic structures.

D. Curing methods and product data per ACI 301.

E. Repair procedures for repair per ACI 224.1 and ACI 301.

F. Special procedures for hot weather concreting.

G. Special procedures for cold weather concreting.

H. Special procedures for mass concrete.

1.05 Quality Assurance

A. Qualifications: All foremen supervising construction shall have a minimum of 3 years experience in similar work, and at least 3 previous projects of similar type, and shall be familiar with ACI 301.

B. Field Testing

1. Daily inspection written reports shall be provided to the Owner's Representative and engineer of record providing detailed information of work completed within 24 hours.
2. During concrete placement, the following duties shall be performed by the Inspector:
   a. Ambient air temperature test
   b. Concrete temperature test
   c. Concrete slump test
   d. Collection of samples for lab testing
   e. Confirm accuracy of batch ticket
3. Pre-pour conference: after submittals have been provided and before construction has been commenced, a concrete conference shall be coordinated between the Inspector, Engineer of Record, and Contractor.

C. Lab Testing

1. Compression testing per ACI 318 chapter 5.
2. Shrinkage testing per ASTM C157 for hydraulic structures.
   a. One shrinkage test is required for the first batch of concrete, and every 500 cubic yards of fresh concrete thereafter.
   b. Acceptance criteria is 0.035% (0.00035) shrinkage at 28 days.

1.06 Project Conditions

A. Soil subgrade

1. Prior to setting reinforcing and pouring concrete on soil, the geotechnical engineer of record shall approve of the soil.

B. Environmental Requirements:

1. Concrete placement shall be limited to temperature ranges per ACI 301.
2. Concrete placement shall be limited to weather conditions per ACI 301.

PART 2 - PRODUCTS

2.01 General

A. Except as noted below, all products and materials used in proportioning, mixing, transport, placement, consolidation, curing, and repair shall satisfy ACI 301 and the Construction Drawings.

2.02 Materials

A. Concrete materials
   1. Aggregate per ACI 301
   2. Cementious materials per ACI 301
      a. Cement shall be portland cement.
      b. Fly ash shall be provided at 15% minimum, 25% maximum of cementious materials.
   3. Admixtures
      a. Provide as necessary to meet design and workability requirements
      b. Mixes for hydraulic structures require shrinkage-reducing admixture, such as Eclipse by W.R. Grace.

B. Water shall be potable, and have the following limitations:
   1. Chlorides (as Cl) no more than 250 mg/L per EPA method 300.
   2. Sulfates (as S04) no more than 250 mg/L per EPA method 300.
   3. Total dissolved solids no more than 500 mg/L per EPA method 160.
   4. Water quality shall be analyzed by EPA methods. Test results shall be provided to the Engineer of Record for the first batch of concrete, and every 500 cubic yards of fresh concrete thereafter.

C. Curing compounds per ACI 301.

D. Miscellaneous Materials
   1. Waterstops are Greenstreak PVC 6” tall flat ribbed.
   2. Plugs for formwork wall tie holes are Dayton Sureplug A-58.
   3. For formwork ties that are left in place, provide plastic cone spacers for 1.5 inch breakback.

2.03 Equipment

   1. Equipment shall conform to ACI 301.

PART 3 - EXECUTION

3.01 Preparation

A. Construction shall not be commenced until the applicable submittals have been approved by the Engineer of Record, and the Inspector has been scheduled.

B. Reinforcing, embedded items, sleeves, and inserts shall be set and secured prior to fresh concrete placement. Interconnect anchor bolt groups with steel templates.

C. Construction Joints:

1. Construction joints shall be water-blasted prior to casting fresh concrete against existing concrete.
2. New concrete shall not be placed adjacent to existing concrete younger than 3 days old.

D. Bonding agent shall not be used except where specially required on the Construction Drawings.

E. Formwork temperature is verified per ACI 301.

F. Subgrade or hardened concrete to be cast against conforms to ACI 301.

3.02 Installation

A. Placement of fresh concrete in forms per ACI 301.

B. Placement of fresh concrete on soil per ACI 301.

C. Placement of fresh concrete shall be limited to weather constraints per ACI 301.

D. Depositing fresh concrete per ACI 301 with the following requirements:

1. For hot weather conditions, maximum time from batching to discharge shall not exceed 45 minutes.
2. For normal weather conditions, maximum time from batching to discharge shall not exceed 60 minutes.

E. Consolidate fresh concrete per ACI 301.

F. Construction joints: Contractor shall not move construction joints from locations shown on Construction Drawings without approval by Engineer of Record.

G. Finishing formed surfaces

1. Exposed edges shall have 5/8 inch chamfers.
2. Filling Tie Holes:
   a. No sooner than 14 days after formwork removal, clean and roughen the entire tie hole, and cone taper zone where exists, using an aggressive wire brush.
   b. Use Dayton Sure Plug A-58 to plug round tie holes on both wall faces.
   c. Recess plug back 1.0 inches deeper than face of wall or recess cone taper.
   d. Use Sikatop 123 Plus mortar or approved equal to fill and patch hole.

H. Finishing Unformed Surfaces:

1. Fresh concrete placement per ACI 301.
2. Finishes definitions per ACI 301 with the following requirements:
   a. Broom finish coarseness shall not exceed 1/16 inch amplitude, and shall be applied perpendicular to the predominate slope of the finished concrete.
   b. Scratch Finish may also be termed “Roughened Surface” on the Construction Drawings.
3. Finish schedule
   a. Scratch Finish shall be applied to:
      1) Construction joints.
      2) Surfaces intended to received bonded cementious mixtures.
   b. Float Finish shall be applied to:

1) Walks, drives, steps, ramps, and for surfaces intended to receive waterproofing, roofing, insulation, or tiling.

c. Trowel Finish shall be applied to:

1) Floor intended as interior walking surfaces.

2) Exterior walking surfaces with less than 2 percent slope.

d. Boom Finish shall be applied to:

1) Exterior walking surfaces with more than 2 percent slope.

2) Elevated slabs, overhangs, bridges where guardrailing is required.

I. Curing shall conform to ACI 301 with the following additional requirements

1. Where a protective coating will be applied to the concrete after curing, liquid ("membrane") curing compounds shall not be used.

2. Where a liquid curing compound is used, the compound shall be pigmented. Pigmentation shall be removable without special chemicals. Use industrial sprayer approved by curing compound manufacturer.

J. Tolerances per ACI 117.

3.03 Protection

A. Protection shall be per ACI 301.

3.04 Repair

A. Repair shall be per ACI 301 with the following requirements:

1. Patching mortar shall be Sikatop 123 Plus or approved equal.

2. Use Sikadur 32 HiMod bonding agent or approved equal.

3. Honeycombs and defects deeper than 38 mm (1.5 inches) shall require approval by Engineer of Record prior to commencing repair work.

4. Cracks wider than 0.5 mm (0.02 inches) for hydraulic structures shall be repaired prior to leak testing.

5. Cracks wider than 1 mm (0.04 inches) shall be repaired.

****END OF SECTION****

SECTION 03315
GROUT

PART 1 - GENERAL

1.01 Summary

A. The work of this Section includes providing grout other than that required for masonry work.

B. The following types of grout are included in the work of this Section:

1. Non-Shrink Grout: This type of grout shall be used wherever grout is required, unless another type is specifically indicated.
2. Cement Grout
3. Epoxy Grout
4. Topping Grout and Concrete Fill

C. Related Sections

Section	Title
03300	Cast-in-Place Structural Concrete
03310	Cast-in-Place Sitework Concrete

1.02 References

A. Except as otherwise indicated, the current versions of the following apply to the work of this Section:

Reference	Title
CRD-C 621	Corps of Engineers Specification for Non-shrink Grout
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens)
ASTM C531	Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical- Resistant Mortars, Grouts, and Monolithic Surfacings
ASTM C579	Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings
ASTM C827	Test Method for Early Volume Change of Cementitious Mixtures
ASTM D696	Test Method for Coefficient of Linear Thermal Expansion of Plastics

1.03 Submitalls

A. The following shall be submitted in compliance with Section 01300 - Submittals:

1. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of non-shrink and epoxy grouts proposed for use in the work.
2. Certified test results verifying the compressive strength, shrinkage, and expansion properties.

1.04 Quality Control

A. Field Tests

1. When a project is used without documentation, compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the Engineer to insure continued compliance with these specifications.
2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109. A set of three specimens will be made for testing at 7 days, 28 days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Owner's representative. A set of three specimens will be made for testing at 7 days, and each earlier time period as appropriate.

B. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Owner's representative in obtaining specimens for testing. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens.

PART 2 - PRODUCTS

2.01 Cement Grout

A. Cement grout mix design shall satisfy the same requirement as structural concrete, except that cement grout has no large aggregate (larger than 1/4 inch) requirement when the grout thickness is less than 3".

2.02 Prepackaged Grouts

A. Non-Shrink Grout

1. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout indicated herein shall be that recommended by the manufacturer for the particular application.
2. Class A non-shrink grouts shall have a minimum 28 day compressive strength of 5000 psi; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRD C 621.
3. Class B non-shrink grouts shall have a minimum 28 day compressive strength of 5000 psi and shall meet the requirements of CRD C 621.

B. Application

1. Class A non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where grout is specified in the contract documents; except, for those applications for Class B non-shrink grout and epoxy grout indicated herein. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications.

2. Class B non-shrink grout shall be used for the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

2.03 Topping Grout and Concrete Fill

A. Grout for topping of slabs and concrete fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement grout. All materials and procedures specified for concrete in Section 03300 - Cast-in-Place Structural Concrete shall apply except as indicated otherwise herein.

B. Topping grout and concrete fill shall contain a minimum of 564 pound of cement per cubic yard with a maximum water cement ratio of 0.45. Where concrete fill is thicker than 3 inches, structural concrete as indicated in Section 03300 - Cast-in-Place Structural Concrete may be used.

C. Strength: Minimum compressive strength of topping grout and concrete fill at the end of 28 days shall be 4000 psi.

2.04 Curing Materials

A. Curing materials shall be as indicated in Section 03300 - Cast-in-Place Structural Concrete for cement grout and as recommended by the manufacturer of prepackaged grouts.

2.05 Consistency

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

B. Unless otherwise noted on contract dwgs, grout for base plates and equipment leveling shall have flowable, semi-flowable, and packable viscosities. Flowable and semi-flowable consistencies requires formwork.

2.06 Measurement of Ingredients

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement is not an acceptable method of measurement.

PART 3 - EXECUTION

3.01 General

A. All surface preparation, curing, and protection of cement grout shall be as required. The finish of the grout surface shall be troweled smooth unless noted otherwise.

B. Where pre-packaged product is used, the manufacturer's representative shall provide on-site technical assistance upon request.

C. Base concrete or masonry must have attained its design strength before grout is placed. When bonding to an existing cementious material is expected, waterblasting or sandblasting to roughen the substrate is required.

3.02 Grouting Procedures

A. Base Plate Grouting

1. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a grout thickness not exceeding 2x the anchor bolt diameter.

2. After the base plate has been set in position at the proper elevation double nutted on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The grout shall be placed so there a no voids between the bottom of the base plate and the concrete.

B. Topping Grout

1. All mechanical, electrical, and finish work shall be completed prior to placement of topping or concrete fill. The base slab shall be given a roughened textured surface by sandblasting or waterblasting to ensure bonding to the base slab.
2. The minimum thickness of grout topping and concrete fill shall be one inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2-inches deep.
3. The base slab shall be thoroughly cleaned and wetted prior to placing topping and fill. No topping concrete shall be placed until the slab is complete free from standing pools or ponds of water. The topping and fill shall be compacted by rolling or tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement or mixture of dry cement and sand shall be applied to the surface.

****END OF SECTION****

SECTION 03400
PRE-CAST CONCRETE

PART 1 - GENERAL

1.01 Summary

A. The Contractor shall provide and install all pre-cast items as required including all appurtenances necessary to make a complete installation. Electrical pre-cast pullboxes and vaults are excluded from this section.

B. References

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACPA	Concrete Pipe Handbook
ACPA	Design Manual
AWS D1.1	Structural Welding Code – Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
NPCA	QC Manual Quality Control Manual for Precast Concrete Plants
PCI	Design Handbook

1.02 General Requirements

A. Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least 5 years.

1.03 Submittals

A. The following items shall be submitted in compliance with Section 01300 - Submittals:

1. Quality control procedures established by the precast manufacturer in accordance with the NPCA Quality Control Manual for Precast Concrete Plants.
2. Shop Drawings
   a. The drawings for precast concrete units shall be shop drawings furnished by the precast concrete producer for approval by the owner's representative and engineer of record. These drawings shall demonstrate that the applicable industry design standards have been met. These drawings shall show complete design, installation, and construction information in such detail as to enable the owner's representative and engineer of record to determine the adequacy of the proposed units for the intended purpose. The precast concrete units shall be produced in accordance with the approved drawings.
3. Precast Concrete Unit Data
   a. The precast concrete producer shall supply cut sheets showing conformance to project drawings and requirements and to applicable industry design standards listed in this

specification. The precast concrete producer shall provide sufficient information as to demonstrate that such products will perform the intended task.

4. Anchorage, Lifting Inserts and Devices
   a. For anchors, lifting inserts and other devices, the precast concrete producer shall provide product data sheets and proper installation instructions upon request. The precast concrete unit dimensions and safe working load shall be clearly indicated.
   b. Steel anchors exposed to long term weather or soil shall be protected by hot dip galvanization.
5. Accessory Items
   a. For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks and other items installed before or after delivery, the precast concrete producer shall include proper installation instructions and relevant product data upon request.

B. Design Data
   1. Upon request, the precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be signed by a licensed professional engineer.

C. Test Reports
   1. Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.
   2. Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze-thaw durability, abrasion and absorption.
   3. Upon request, the precast concrete producer will supply copies of in-plant QA/QC inspection reports.

D. Certificates
   1. Submit quality control procedures established in accordance with NPCA Quality Control Manual for Precast Concrete Plants or verification of current NPCA Plant Certification.

1.04 Design

A. Precast Concrete Unit Design
   1. Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318, ACI 350, ACPA Design Manual, PCI MNL-120, and AASHTO. Design must also consider stresses induced during handling, shipping and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on the shop drawings. All calculations shall be prepared by a registered engineer.
   2. Minimum design loading for soil: As defined by the geotechnical report, but not less than 100 psf / foot depth, with 2’ soil surcharge.
   3. For buried fluid-containing structures, walls must carry hydrostatic loading without the lateral support of backfill soils. Considerations shall be given to unbalanced loading due to uneven backfill loading; 3’-0” soil height difference between opposing sides shall be a design load case.

B. Joints and Sealants

1. Joints and sealants between adjacent units shall be of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

C. Durability and performance requirements

1. Concrete Compressive Strength-

a. Precast concrete units shall have a 28-day compressive strength (f'c) of 4,000 psi, except where otherwise noted on the approved drawings.

D. Water-Cement Ratio

1. Concrete that will be exposed to freezing and thawing shall contain entrained air and shall have water-cement ratios of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be watertight, shall have a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or seawater shall have a water-cement ratio of 0.42 or less.

E. Air Content

1. The air content of concrete that will be exposed to freezing conditions shall be within the limits given below.

Nominal Maximum Aggregate Size (in)	**Air Content %**	
	Severe Exposure	**Moderate Exposure**
3/8	6.0 to 9.0	4.5 to 7.5
½	5.5 to 8.5	4.0 to 7.0
¾	4.5 to 7.5	3.5 to 6.5
1	4.5 to 7.5	3.0 to 6.0
* For specified compressive strengths greater then 5000 psi, air content may be reduced 1%		

1.05 Quality Assurance

A. Precast concrete producer shall demonstrate adherence to the standards set forth in the NPCA Quality Control Manual for Precast Concrete Plants. NPCA Plant Certification-the precast concrete producer shall be certified by the NPCA Plant Certification Program prior to and during production of the products for this project.

1.06 Handling, Storage and Delivery

A. Handling: Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on shop drawings.

B. Storage: -precast concrete units shall be stored in a manner that will minimize potential damage.

C. Delivery: Precast concrete units shall be delivered to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite all precast concrete units shall be inspected by the customer or customer's agent for quality and final acceptance.

PART 2 - PRECAST CONCRETE UNITS

2.01 Maintenance Holes and Catch Basins

A. Pre-cast Concrete Maintenance Hole Sections: Standard maintenance holes shall be constructed of pre-cast reinforced maintenance hole sections conforming to ASTM C478 and as shown. Pre-cast concrete rings, cones, and flat slabs shall be manufactured by a process that will produce a dense, homogeneous concrete section of first quality. Cement used in all pre-cast sections shall conform to State Specifications "Type II Modified."

B. Catch Basins: Catch basins shall be 3' x 3' x 6" wall thickness. Catch basins shall have progressive webbed knock-outs to provide maximum flexibility, permitting pipe of any size to be neatly and quickly grouted at the job site. All reinforcing steel shall meet ASTM specifications. Catch basins shall be model U43CP as manufactured by Christy Concrete Products, Inc., Model 1-M as manufactured by Santa Rosa Cast, or equal.

C. Joint Sealer: Shall meet all the requirements of Federal Specifications SS-S-00210 and shall be Ram-Nek by K.T. Snyder Company, Inc.; Kent-Seal by Hamilton-Kent, or equal.

D. Mortar: One part Portland Cement, 1 part hydrated lime, and 6 parts sand.

2.02 Concrete Utility Boxes

A. Design Loads: Design loads shall consist of live load, dead load, impact load, hydrostatic load, and other loads that may occur unless otherwise indicated on the drawings. Live loads shall be for H-20 per AASHO Standard Specifications for Highway Bridges with revisions. Design wheel loads shall be sixteen (16) KIPS.

B. Floors: Unless otherwise indicated on the drawings, pre-cast vaults shall have concrete floors.

C. Forms: All forms used in placing concrete shall be sufficiently designed and braced to maintain alignment under pressures of concrete placement.

D. Concrete

1. Aggregates used in the concrete mix either coarse or fine, excluding light-weight aggregates, shall conform to specifications as outlined by ASTM C33-64.
2. All light-weight aggregates, fine or coarse, shall conform to specifications as outlined by ASTM C330-64T.
3. Both types of aggregates shall be properly graded and free of any deleterious substances so as to produce a homogeneous concrete mix when blended with cement.

E. Cement: The cement shall be Type II low alkali Portland Cement and shall meet ASTM C150 Type II standards, except where Construction Drawings require Type V cement.

F. Compressive Strength: Sufficient cement content shall be used per batch so as to produce a minimum strength of 4,000 psi at 28 days or other strength by design when required.

G. Placing: Concrete shall be made by properly proportioned parts of sand, aggregate and cement with sufficient water to produce a concrete mix of uniform quality and slump. Handling from the mixer or the transport vehicle to the forms for deposit will be in a continuous manner, as rapidly as practicable without segregation or loss of ingredients, until the unit or segment pouring is completed. Compaction by either external or internal mechanical vibration shall be used during the placement of the concrete mix.

H. Curing: Concrete while still in the forms may be steam cured after an initial set has taken place. Steam temperature shall not exceed 160°F, nor raised from normal ambient temperature at a rate exceeding 40°F per hour. Steam curing shall be considered complete after sufficient time has elapsed to produce adequate strength to withstand any structural strain that may be subjected

during the form stripping operation. Additional curing may be applied by means of water spraying or membrane curing compound to reach the ultimate strength requirements.

I. Reinforcing Steel: All reinforcing steel, including welded wire mesh, shall be of the size and in the location required for design loads. All reinforcing shall be sufficiently tied to withstand any displacement during the pouring operation. All bars shall be intermediate grade, or as specified, billet steel conforming to ASTM A615.

J. Preformed Joint Sealant: The joint sealing compound shall be Quik-Seal, a preformed, cold applied, ready to use plastic joint sealing compound as supplied by Quikset Utility Vaults, Santa Ana, California; Ram-Neck by K.T. Snyder Company; or approved equal.

PART 3 - EXECUTION

3.01 Pre-Cast Concrete Maintenance Hole and Catch Basin Sections

A. Pre-cast concrete sections shall be set so as to be vertical, with sections in true alignment. The joint of the previously set section shall be covered with mortar and joint sealant before the next section is placed. Before the mortar is set, joints shall be pointed, and exterior joints shall be thoroughly tooled so as to be slightly concave with a hard polished surface, free of cracks, Interior joints shall be tooled flush in a similar manner.

3.02 Pre-Cast Vaults

A. Pre-cast vaults shall be installed in accordance with the manufacturer's recommendations, unless otherwise required by the drawings. All joints shall be sealed by the use of preformed sealant and mortar or non-shrink grout so as to be water tight.

3.03 Connections

A. Connections to manufactured, pre-cast items shall be made by casting sections of pipe into the items, using non-shrink grout as shown on the drawings, and/or using an approved resilient connector. All such connections shall be water-tight.

3.04 Soil backfill

A. Engineered soil backfilling operations next to precast concrete structures shall follow the same requirements as cast-in-place structures.

****END OF SECTION****

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SECTION 05910
HOT-DIP ZINC COATING

PART 1 - GENERAL

1.01 Summary

A. This Section specifies hot-dip zinc coating. Unless otherwise specified, steel items not fully encased in a building envelope shall be hot-dip zinc coated. Also termed hot dip galvanized.

B. References

Reference	Title
ASTM A90	Standard Test Methods for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A123	Zinc Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip
ASTM A153	Zinc Coating on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High Quality Zinc Coatings on Assembled Products
ASTM A386	Zinc Coating on Assembled Steel Products
MILSPEC	Paint, High Zinc Dust Content, Galvanizing
DOD-P-21035	Repair

PART 2 - PRODUCTS

2.01 Materials

A. The coating material shall be as specified in ASTM A153 or ASTM A123.

PART 3 - EXECUTION

3.01 Galvanizing

A. The thickness, chemistry, and all other engineering properties of galvanizing shall be defined by ASTM A153 and ASTM A123.

3.02 Field Repairs

A. Where zinc coating has been damaged, substrate surface shall be cleaned and repaired with zinc dust-zinc oxide coating in accordance with MILSPEC DOD-P-21035. Field repair of zinc coated surfaces, including Unistruts shall be accomplished with Z.R.C., as manufactured by Z.R.C. Chemical Products Co.; Galvicon as manufactured by Galvicon Co.; or equal.

3.03 Post-Galvanizing Coating

A. When paint is required over a hot-dip galvanized coating, the galvanized surface requires special preparation. Chemical or abrasive methods may be used, with care exercised to not remove too much of the galvanized coating.

****END OF SECTION****

SECTION 05910
HOT-DIP ZINC COATING

PART 1 - GENERAL

1.01 Summary

A. This Section specifies hot-dip zinc coating. Unless otherwise specified, steel items not fully encased in a building envelope shall be hot-dip zinc coated. Also termed hot dip galvanized.

B. References

Reference	Title
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ASTM A123	Zinc Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip
ASTM A153	Zinc Coating on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High Quality Zinc Coatings on Assembled Products
ASTM A386	Zinc Coating on Assembled Steel Products
MILSPEC	Paint, High Zinc Dust Content, Galvanizing
DOD-P-21035	Repair

PART 2 - PRODUCTS

2.01 Materials

A. The coating material shall be as specified in ASTM A153 or ASTM A123.

PART 3 - EXECUTION

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A. When paint is required over a hot-dip galvanized coating, the galvanized surface requires special preparation. Chemical or abrasive methods may be used, with care exercised to not remove too much of the galvanized coating.

****END OF SECTION****

SECTION 09900
PROTECTIVE COATING SYSTEMS

PART 1 - GENERAL

1.01 Description

A. Scope

1. Furnish all labor, materials, equipment and incidentals required to provide protective coatings as shown or specified.
2. The work includes the coating and finishing of all interior and exterior items and surfaces throughout the project <u>except</u> as otherwise shown or specified. Surface preparation, priming and coatings may be in addition to shop priming and surface treatment specified under other Sections.
3. Where items are factory-coated, repair or touch-up the factory coating and/or apply additional field coatings to achieve a complete coating system complying with the type and thickness of the coatings specified in this Section.
4. The term “coating” as used herein means all coating systems materials, which includes but is not necessarily limited to pretreatments, primers, intermediate coats, finish coats, emulsions, enamels, varnishes, stains, sealers, fillers, and other applied materials whether used as prime, intermediate or finish coats.
5. The term “exposed” as used herein means all items not covered with concrete, plaster, fireproofing or similar material.
6. Where items or surfaces are not specifically mentioned, coat these items or surfaces the same as adjacent similar materials or surfaces.
7. “Typical Examples” of items to be coated are provided on each coating system description sheet. These examples are intended to show the general scope of items to be coated are not intended to be exhaustive of all items to be coated by that particular coating.
8. Items which must be coated under this section include but are not necessarily limited to the following:
   1) Interior walls and ceiling of screen building including all exposed structural elements.
   2) Overhead bridge crane and accessories unless specified otherwise elsewhere
   3) Overhead coiling doors and man doors unless specified otherwise elsewhere
   4) Bollards
   5) Valves not otherwise factory finish to match piping systems (note: do not paint SST nuts and bolts on valves or flanges)
   6) Exposed PVC pipe
   7) All other surfaces not otherwise excluded herein.

B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be field coated or painted.
2. Coordinate the coating of areas to be coated that will be inaccessible once equipment has been installed.

3. Provide finish coats that are compatible with the primers used. Contractor shall be responsible for the compatibility of all shop primed and field coated items in this Contract. Barrier coats shall be provided over incompatible primers or primers shall be removed and re-primed as required.

C. Pre-Finished Items: Unless otherwise shown or specified, coating shall not be included when factory finishing such as baked-on enamel, porcelain, polyvinylidene fluoride, fusion bonded epoxy, or other similar finish is specified for such items.

1. Touch up factory-finished items only with coatings supplied by the item manufacturer per the requirements and instructions of the manufacturer.
2. If a factory-finished coating is applied to an item, which is not specified to receive a factory finish coat, acceptance of the factory finish coat shall be at the discretion of the Engineer. The color shall be noted with the equipment submittals.

D. Items Not to be Coated: The following items are excluded from coating unless otherwise specified or show:

1. Ducts, conduits and other materials with corrosion resistant surfaces that are in chases or other inaccessible areas unless specified or shown on drawings.
2. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts unless otherwise specified.
3. Code-required labels, such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
4. Stainless steel.
5. Copper.
6. Aluminum.
7. Fiberglass.
8. Pipe supports except those installed in submerged or spash zone areas.
9. Manhole covers.
10. HVAC equipment.
11. Instrumentation and galvanized instrument supports
12. Electrical switchgear, motor control centers, panels, transformers and other similar equipment.
13. Chemical metering pumps.
14. Polyethylene storage tanks unless specified or shown on drawings.
15. Exterior or interior concrete.
16. Exterior concrete unit masonry unless specified or shown on drawings.
17. Interior concrete unit masonry unless specified or shown on drawings.

1.02 Reference Standards

A. Applicable provisions and recommendations of the following shall be complied with, except where otherwise shown or specified:

1. ANSI A13.1, Scheme for the Identification of Piping Systems
2. OSHA 1910.144 Safety Color Code for Marking Physical Hazards

3. SSPC Volume 2, Systems and Specification, Surface Preparation Guide and Paint Application Specifications

1.03 Submittals

A. Shop Drawings: The following shall be submitted for approval:

1. Manufacturer's technical information, including coating label analysis and application instructions for each material proposed for use. Each material shall be listed and cross-referenced to the specific coating system and application, and shall be identified by manufacturer's catalog number and general classification.
2. Provide itemized schedule of all the surfaces to be coated. After approval of submittals and prior to beginning work, Owner's Representative will note on the schedule the colors to be furnished.
3. Manufacturer's complete color charts for each coating system.
4. Certifications from manufacturers shall be provided, verifying that the factory applied prime coats are compatible with specified finish coatings.

1.04 Product Delivery, Storage, and Handling

A. Delivery of Materials: All materials shall be delivered to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.

1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Contents by volume, for major pigment and vehicle constituents
5. Thinning instructions where recommended
6. Application instructions
7. Color name and number

B. Storage of Materials

1. Only acceptable project materials shall be stored on project site.
2. Store materials in compliance with manufacturer's requirements in a location approved by the Owner's Representative. Area shall be kept clean and accessible.
3. Storage shall be restricted to coating materials and related equipment only.

1.05 Warranty

A. Warrant all work against defects in materials and workmanship, including application, for a period of one (1) year from the date of final acceptance of the project. Contractor shall, within 30 days after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same. Warranty shall include all materials and labor required.

PART 2 - PRODUCTS

2.01 Qualified Manufacturers:

A. Products manufactured by one of the following shall be provided:

1. Carboline Company
2. Tnemec Company, Incorporated
3. ICI Devoe Coatings
4. Or equal

2.02 Material Quality

A. Only the best grade of the various types of coating suitable for use in water and wastewater treatment plants, as regularly manufactured by acceptable coating material manufacturers, shall be provided. Material not displaying the manufacturer's identification as a best-grade product will not be acceptable.

B. Primers shall be produced by the same manufacturer as the intermediate and finish coats. Use only thinners recommended by the manufacturer, and use only to recommended limits.

C. Coatings and pipe markers of durable and washable quality shall be provided. Materials that will withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining, or other damage shall be used.

2.03 Substitutions

A. No substitutions shall be considered that decrease the film thickness, the number of coats, the surface preparation or the generic type of coating specified. Approved manufacturers must furnish the same color selection as the manufacturers specified, including accent color in all coating systems.

2.04 Colors and Finishes

A. Surface treatments, and finishes, are shown under Coating Systems below. All substrates indicated shall be coated whether or not shown on the Drawings, or in Schedules, unless an item is specifically scheduled as not requiring coating.

B. Color Selection

1. The Owner reserves the right to select non-standard colors for all coating systems specified within the ability of the manufacturer to produce such non-standard colors. Selection of non-standard colors shall not be cause for the Contractor rejecting Owner's color selections and the Contractor shall supply such colors at no additional expense to the Owner.

C. <u>Piping Color Code</u>:

1. In general, all color coding of piping, ducts and equipment shall comply with applicable standards of ANSI A13.1 and OSHA 1910.144.
2. Primary Influent (PI) to be FBE Green.
3. Ion Piping (1 ½" PVC air supply line) White.
4. Drains, vents, water and recycled water above ground piping to be SST and remain uncoated.

D. <u>Color Pigments</u>: Pure, non-fading, applicable types to suit the substrates and service indicated.

2.05 Coating Systems

A. Refer to the following Coating System Sheets.

B. The Contractor shall coat all items, which fall into the categories described. The examples given on the coating system sheets are presented for the Contractor's convenience, and may not include all items which require coating. In general all exposed ferrous materials shall be coated.

This includes galvanized materials and shop primed material unless specifically excluded elsewhere.

Coating System 1

A. Service:

1. Structural steel, miscellaneous metals, and steel, ductile iron, or cast iron piping
2. Interior exposure
3. Non-submerged applications (greater than 3' above highest possible water level).

B. Typical Examples:

1. All exposed structural steel including but not limited to columns, beams, roof joists, purlins and other supporting members.
2. Equipment including but not limited to pumps, blowers, air compressors, valves, and other process equipment, motors, gear reducers, and equipment guards.
3. Bridge crane, trolleys, hoist, motor, brackets, and underhung girders.
4. Steel, ductile, or cast iron piping not otherwise coated as specified in piping sections.

C. Surface Preparation:

1. Shop: SSPC-SP 6 Commercial Blast, as specified in herein.
2. Field: Sandblasting of field welds and other imperfections. Owner's Representative may require all areas to be blasted at his discretion, SSPC-SP 6, commercial blast as specified in herein.

D. Product and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Carboguard 890 - one or more coats, 4.0 - 6.0 total dry mils thickness
   b) Finish: Carboguard 890 - one or more coats, 4.0 - 6.0 total dry mils thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mils thickness
   b) Finish: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mils thickness
3) ICI Devoe
   a) Primer: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mils thickness
   b) Finish: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mils thickness
4) Or equal

Coating System 2

A. Service:

1. Structural steel, miscellaneous metals, and steel, ductile iron, or cast iron piping
2. Exterior exposure
3. Non-submerged applications (greater than 3' above highest possible water level)

B. Typical Examples:

1. All exposed structural steel including but not limited to columns, beams, roof joists, purlins and other supporting members.
2. Equipment including but not limited to pumps, blowers, air compressors, valves, other process equipment, motors, gear reducers, and equipment guards.
3. Bridge crane, trolleys, hoist, motor, brackets, and underhung girders.
4. Overhead coiling and man doors if not specified door elsewhere.
5. Steel, ductile, or cast iron piping not otherwise coated as specified in piping sections.

C. Shop Surface Preparation:

1. Shop: SSPC-SP 6 Commercial Blast as specified in herein
2. Field: Sandblasting of field welds and other imperfections. Owner's Representative may require all areas to be blasted at his discretion, SSPC-SP 6, commercial blast as specified in herein.

D. Products and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Carboguard 890 - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Intermediate: Carboguard 890 - one or more coats, 4.0 - 6.0 total dry mil thickness
   c) Finish: Carbothane 134VOC - one or more coats, 3.0 - 5.0 total dry mil thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Intermediate: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mil thickness
   c) Finish: Series 1075 Endura-Shield - one or more coats, 3.0 - 5.0 total dry mil thickness
3) ICI Devoe
   a) Primer: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Intermediate: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
   c) Finish: Devthane 378H - one or more coats, 3.0 - 5.0 total dry mil thickness
4) Or equal

Coating System 3

A. Service:

1. Galvanized structural steel, galvanized miscellaneous metals, and galvanized steel pipe.
2. Interior exposure
3. Non-submerged applications (greater than 3' above highest possible water level)

B. Typical Examples:

1. All exposed galvanized structural steel including but not limited to columns, beams, roof joists, purlins and other supporting members.
2. Flashing.
3. Galvanized rigid conduit.

C. Surface Preparation:

1. Solvent Cleaning, SSPC-SP 1 as specified in herein, followed by brush off blast to provide an anchor profile of 1.5 to 2.0 mils minimum

D. Product and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Rust bond penetrating sealer - one or more coats, 1.0 - 2.0 total dry mil thickness
   b) Finish: Carboguard 890 - two or more coats, 4.0 - 6.0 total dry mil thickness, 8.0 - 12.0 total dry mil thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Finish: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 dry total dry mil thickness
3) ICI Devoe
   a) Primer: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Finish: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
4) Or equal

Coating System 4

A. Service:

1. Galvanized structural steel, galvanized miscellaneous metals, and galvanized steel pipe.
2. Exterior exposure
3. Non-submerged applications (greater than 3' above highest possible water level)

B. Typical Examples:

1. All exposed galvanized structural steel including but not limited to columns, beams, roof joists, purlins and other supporting members.
2. Flashing
3. Galvanized rigid conduit
4. Bollards

C. Surface Preparation:

1. Solvent Cleaning, SSPC-SP 1 as specified in herein, followed by brush off blast to provide an anchor profile of 1.5 to 2.0 mils minimum

D. Product and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Rust bond penetrating sealer - one or more coats, 1.0 - 2.0 total dry mil thickness
   b) Intermediate: Carboguard 890 -- two or more coats, 4.0 - 6.0 dry mill per coat, 8 to 12 total dry mil thickness
   c) Finish: Carbothane 134VOC -- one or more coats, 3.0 - 5.0 total dry mil thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II -- one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Intermediate: Series V69 Hi-Build Epoxoline II -- one or more coats, 4.0 - 6.0 total dry mil thickness
   c) Finish: Series 1075 Endura-Shield -- one or more coats, 3.0 - 5.0 total dry mil thickness
3) ICI Devoe
   a) Primer: Bar-Rust 235H -- one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Intermediate: Bar-Rust 235H -- one or more coats, 4.0 - 6.0 total dry mil thickness
   c) Finish: Devthane 378H -- one or more coats, 3.0 - 5.0 total dry mil thickness
4) Or equal

Coating System 5

A. Service:

1. Structural steel, miscellaneous metals and steel, ductile iron, or cast iron piping
2. Submerged, intermittently submerged, or splash zone applications (within 3' of highest possible water level).

B. Typical Examples:

1. Structural steel
2. Steel, ductile, or cast iron piping not otherwise coated as specified in piping sections.
3. Pump base elbows, pumps, mixers and other process equipment
4. Pipe supports

C. Surface Preparation:

1. Shop: SSPC-SP 10 Near-White Blast Cleaning
2. Field: Sandblasting of field welds and other imperfections. Owner's Representative may require all areas to be blasted at his discretion, SSPC-SP 6, commercial blast as specified in herein.

D. Product and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Carboguard 890 - one or more coats, 4.0 – 6.0 total dry mil thickness
   b) Finish: Carboguard 890 - one or more coats, 4.0 – 6.0 total dry mil thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Finish: Series V69 Hi-Build Epoxoline II - one or more coats, 4.0 - 6.0 total dry mil thickness
3) ICI Devoe
   a) Primer: Bar-Rust 233H - one or more coats, 4.0 – 6.0 total dry mil thickness
   b) Finish: Bar-Rust 233H - one or more coats, 4.0 – 6.0 total dry mil thickness
4) Or equal

Coating System 6

A. Service:

1. Galvanized structural steel, galvanized miscellaneous metals, and galvanized steel pipe.
2. Submerged, intermittently submerged, or splash zone applications (within 3' of highest possible water level).

B. Typical Examples:

1. Structural steel
2. Steel, ductile, or cast iron piping not otherwise coated as specified in piping sections.
3. Pump base elbows, pumps, mixers and other process equipment
4. Pipe supports

C. Surface Preparation:

1. Solvent Cleaning, SSPC-SP 1 as specified in herein, followed by brush off blast to provide an anchor profile of 1.5 to 2.0 mils minimum

D. Product and Manufacturer: One of the following shall be provided:

1) Carboline
   a) Primer: Rust bond penetrating sealer -- one or more coats, 1.0 - 2.0 total dry mil thickness
   b) Finish: Carboguard 890 -- two or more coats, 4.0 - 6.0 total dry mil thickness, 8.0 - 12.0 total dry mil thickness
2) Tnemec
   a) Primer: Series V69 Hi-Build Epoxoline II -- one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Finish: Series V69 Hi-Build Epoxoline II – one or more coats, 4.0 - 6.0 total dry mil thickness
3) ICI Devoe
   a) Primer: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
   b) Finish: Bar-Rust 235H - one or more coats, 4.0 - 6.0 total dry mil thickness
4) Or equal

Coating System 7

A. Service:

1. Plastics including PVC and CPVC Piping
2. Interior or exterior exposure
3. Non-submerged applications

B. Typical Example:

1. Exposed PVC and CPVC piping.
2. Notable Exceptions:
   1) Do not coat submerged or partially submerged plastic piping.
   2) Do not coat plastic valves, unions, valve handles or other similar plastic items.
   3) Do not coat exposed PVC conduit or exposed rigid steel with PVC coating conduit.

C. Surface Preparation:

1. Plastic shall be prepared in accordance with SSPC SP-1 (Solvent Cleaning) followed by SSPC-SP 2 (Hand Tool cleaning). Contractor shall use a solvent compatible with the specified coating and roughen surfaces by sanding.

D. Product and Manufacturer: One of the following shall be provided:

a) Finish: Carbothane 134VOC – two coats, 5.0 total dry mil thickness
b) Finish: Tnemec Series 1075 – two coats, 5.0 total dry mil thickness
c) Finish: ICI Devoe Devthane 378H - two coats, 5.0 total dry mil thickness
d) Or equal

Coating System 8

A. Service:

1. Masonry block
2. Interior exposure
3. Process Areas only as shown on drawings

B. Typical Example:

1. Process room with corrosive atmosphere and or frequent washdown.

C. Surface Preparation:

1. Prepare all surfaces to receive coating per manufacturer's recommendations.

D. Product and Manufacturer

1) Carboline
   a) Primer: Sanitile 100 -- one or more coats, 12.0 total dry mil thickness apply by roller or by spray application followed immediately by backrolling with roller
   b) Finish: Sanitile 255 -- one or more coats, 2.0 – 3.0 total dry mil thickness
2) Tnemec
   a) Primer: Series 130 Envirofill – apply at 85 to 110 sq. ft. per gallon by roller or by spray application followed immediately by backrolling with roller
   b) Finish: Series 113 H.B Tneme-Tufcoat -- one or more coats, 4.0 – 6.0 total dry mil thickness
3) ICI Devoe
   a) Primer: Bloxfil 4000 -- one or more coats, 7.0 – 14.5 total dry mil thickness apply by roller or by spray application followed immediately by backrolling with roller
   b) Finish: Tru-Glaze-WB 4406 -- one or more coats, 2.0 – 2.5 total dry mil thickness
4) Or equal

PART 3 - EXECUTION

3.01 Examination

A. The Contractor and his applicator shall examine the areas and conditions under which coating work is to be performed and notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner's Representative.

B. Do not coat over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable film.

3.02 Surface Preparation

A. General

1. All preparation and cleaning procedures shall be performed as specified herein and in strict accordance with the manufacturer's instructions for each particular substrate and atmospheric condition.
2. All hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish coated shall be removed or provided surface applied protection prior to surface preparation and coating operations. Remove, if necessary, for the complete coating of the items and adjacent surfaces. Following completion of coating of each space or area, the removed items shall be reinstalled by workmen skilled in the trades involved.
3. Surfaces to be coated shall be cleaned before applying coating or surface treatments. Oil and grease shall be removed with clean cloths and cleaning solvents prior to mechanical cleaning. The cleaning and coating shall be programmed so that dust and other contaminants from the cleaning process will not fall in wet, newly coated surfaces.
4. All surfaces that were not shop coated or that were improperly shop coated, and all abraded or rusted shop coated surfaces, which are to be coated, as determined by the Owner's Representative, shall be prepared as specified below.

B. Masonry Surfaces

1. Masonry block to be coated and sealed with clear finish shall be prepared by removing all efflorescence, chalk, dust, dirt, grease and oils with soap and water.
2. The alkalinity and moisture content of the surfaces to be coated shall be determined by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish coating, this condition shall be corrected before application of coating. The Owner's Representative shall be provided with suitable testing materials to carry out alkalinity and moisture tests.
3. Do not coat over surfaces where the moisture content exceeds 8 percent, unless otherwise permitted in the manufacturer's printed directions.
4. Block surfaces that cannot be adequately cleaned by soap and water shall be acid etched. Exceedingly dense concrete may require a second etching.
5. Brush blast clean shall be equivalent to SSPC-SP 7, to open bug holes and remove all non-adhering materials. All areas so prepared shall be thoroughly cleaned before beginning coating work.

C. Ferrous Metals

1. Non-submerged ferrous surfaces, including structural steel and miscellaneous metal to be shop primed, shall be cleaned of all oil, grease, dirt, mill scale and other foreign matter by commercial blast cleaning complying with SSPC-SP 6.
2. Submerged ferrous surfaces, including structural steel and miscellaneous metal to be shop primed, shall be cleaned of all oil, grease, dirt, mill scale and other foreign matter by near-white blasting complying with SSPC-SP 10.
3. Non-submerged, ferrous surfaces that have not been shop-coated shall be cleaned of all oil, grease, dirt, loose mill scale and other foreign substances by commercial blasting, complying with SSPC-SP 6.
4. Submerged ferrous surfaces that have not been shop-coated or that, in the opinion of the Owner's Representative, have been improperly shop-coated, shall be cleaned of all oil, grease, dirt, mill scale and other foreign matter by near-white blasting complying with SSPC-SP 10.
5. Bare and blasted or pickled clean metal shall be treated with metal treatment wash coat, prior to priming only if recommended by the coating manufacturer.
6. Shop applied prime coats that have damaged or bare areas shall be touched-up with primer recommended by the coating manufacturer after commercial blasting complying with SSPC-SP 6.
7. Weld Preparation: Remove weld spatter and slag by chipping or grinding. Grind all sharp edges and corners to a smooth contour. Welds to be ground free from undercuts, recesses and pinholes.

D. Non-Ferrous Metal Surfaces: Non-ferrous metal surfaces shall be cleaned in accordance with the coating system manufacturers instructions for the type of service, metal substrate, and application required.

E. Galvanized Surfaces

1. Clean free of oil and surface contaminants with solvent or other methods recommended by the coating manufacturer, complying with SSPC-SP 1.
2. All coated galvanized ferrous metal, interior and exterior, shall be cleaned of all oil, grease, dirt, mill scale and other foreign matter by a brush-off blast cleaning complying with SSPC-SP 7 with 1.5 to 2.0 mils profile.

3.03 Materials Preparation

A. General

1. Coating materials shall be mixed and prepared in strict accordance with the manufacturer's directions.
2. Coating materials produced by different manufacturers shall not be mixed, unless otherwise permitted by the manufacturer's instructions.
3. Materials not in actual use shall be stored in tightly covered containers. Containers used in storage, mixing, and application of coating shall be maintained in a clean condition, free of foreign materials and residue.
4. All materials shall be stirred before application to produce a mixture of uniform density, and as required during the application of the materials. Any film that may form on the surface shall not be stirred into the material. The film shall be removed and, if necessary, the material shall be strained before using.

B. Tinting: Each undercoat shall be tinted a lighter shade to facilitate identification of each coat where multiple coats of the same material are to be applied. Undercoats shall be tinted to match the color of the finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat. A code number shall be provided to identify material tinted by the manufacturer.

C. Mixing

1. The Contractor shall mix only in mixing pails placed in a suitably sized non-ferrous or oxide resistant metal pans to protect concrete floor from splashes or spills which could stain exposed concrete or react with subsequent finish floor material.
2. Materials shall be mixed and applied only in containers bearing accurate product name of material being mixed or applied.

3.04 Application

A. General

1. Coatings shall be applied by mechanical application techniques such as roller, brush, trowel, air spray, or airless spray in accordance with the manufacturer's directions and recommendations of Paint Application Specifications No. 1 in SSPC Vol. 2, where applicable, or as required in these Specifications. Brushes best suited for the type of material being applied shall be used. Where approved by the Owner's Representative, rollers of carpet, velvet back, or high pile sheep's wool shall be used, as recommended by the manufacturer for material and texture required.
2. The number of coats and film thickness required is the same regardless of the application method. Succeeding coats shall not be applied until the previous coat has completely dried.
3. Where multiple coats of the same material is used, tint prime and intermediate coats in order to distinguish each coat.
4. Additional coats shall be applied when undercoats, stains, or other conditions show through the final coat, until the film is of uniform finish, color and appearance. This is of particular importance regarding intense primary accent colors. The Contractor shall insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.
5. Surfaces not exposed to view do not require color coding but require the same coating systems specified for exposed surfaces. Exposed to view surfaces are defined as those areas visible when permanent or built-in fixture, convector covers, covers for finned tube radiation, grilles, etc., are in place in areas scheduled to be coated.
6. The backs of access panels and removable or hinged covers shall be coated to match the exposed surfaces.
7. Aluminum parts in contact with dissimilar materials shall be coated as specified with appropriate finish.
8. Brush stripe welds; bolts; nuts; edges and corners to achieve proper coating thicknesses.

B. Minimum/Maximum Coating Thickness: Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified. Extra coat shall be applied if required to obtain specified total dry film thickness or uniform opacity. If the recommended maximum coating thickness is exceeded, the excess amount will be removed and repaired as specified.

C. Scheduling Coatings

1. The first-coat material shall be applied to surfaces that have been cleaned, pretreated or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration. Abrasive blasted ferrous metal surfaces shall be coated within eight (8) hours on the same day of abrasive blasting.
2. Subsequent coats shall be applied as per manufacturer's written recoat parameters as detailed on their product data sheet. Sufficient time between successive coatings shall be allowed to permit proper drying.

D. Prime Coats: Primed and sealed walls and ceilings shall be recoated where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finish: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application

1. All brush coats shall be brushed-out and worked onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. All glass and color break lines shall be neatly drawn.

G. Mechanical Applicators

1. Mechanical methods shall be used for coating application as suggested by the manufacturer. Conduct spray coating under controlled conditions. Protect adjacent structure for overspray.
2. For spray application, apply coating to thickness not greater than suggested in manufacturer's instruction.
3. Wherever spray application is used, each coat shall be applied to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of 2 coats in one pass.

H. Completed Work: Match approved samples for color, texture and coverage. Work not in compliance with specified requirements shall be removed, refinished or recoated, as required by the Owner's Representative.

3.05 Field Quality Control

A. The right is reserved by the Owner's Representative to invoke the following material testing procedure at any time, and any number of times during the period of field coating:

1. Engage the service of an independent testing laboratory to sample any of the coating being used. Samples of materials delivered to the project site will be taken, identified and sealed, and certified in the presence of the Contractor.
2. The testing laboratory will perform appropriate tests for any or all of the following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative material analysis.
3. If the test results show that the material being used does not comply with the specified requirements, the Contractor may be directed to stop the coating Work, and remove the non-complying coating; pay for testing; recoat surfaces coated with the rejected coating; remove rejected coating from previously coated surfaces if, upon recoating with the specified coating, the two coatings are non-compatible.

B. Prior to initial coat and after completion of each successive coat, the Contractor shall notify the Owner's Representative. After inspection, checking of film thickness and approval by the Owner's

Representative, proceed with the succeeding coat. Contractor shall supply the Owner's Representative for his use a Gardner dry-film thickness gage.

C. Adequate illumination and ventilation shall be provided in all areas where operations are in progress.

3.06 Protection

A. Before coating is started in any area, it shall be broom cleaned and excessive dust shall be removed. After coating operations begin in a given area, broom cleaning will not be allowed; cleaning shall then be done only with commercial vacuum cleaning equipment.

B. Work of other trades shall be protected, whether to be coated or not, against damage by the coating and finishing work. All such work shall be left undamaged. All damage shall be corrected by cleaning, repairing or replacing, and recoating, as acceptable to the Owner's Representative.

C. Wet Paint signs shall be provided as required to protect newly coated finishes. All temporary protective wrapping provided for protection of this Contract shall be removed after completion of coating operations.

3.07 Clean-Up

A. During the progress of the Work, all discarded materials, rubbish, cans and rags shall be removed from the site at the end of each work day.

B. Upon completion of coating work, all spattered surfaces shall be cleaned. Spattered coatings shall be removed by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. At the completion of work of other trades, all damaged or defaced coated surfaces shall be touched-up and restored, as determined by the Owner's Representative.

D. Pipe markers shall be installed only after all coating, painting, and finish work has been completed.

****END OF SECTION****

SECTION 11004
EQUIPMENT CONTROL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies electrical and instrumentation devices specified as part of equipment systems.

1.02 QUALITY ASSURANCE

A. General: Control devices shall be listed by Underwriters Laboratories Inc., Factory Mutual, or Canadian Standards Associations for their intended purpose where such listing has been applied to similar products.

B. References: This Section references the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. JIC EMP-1-67, Electrical Standards for Mass Production Equipment

2. NEMA ICS Series, latest edition, Industrial Controls and Systems (NEMA-ICS)

3. National Electrical Code, Latest Edition

4. Division 16

1.03 SUBMITTALS

A. The following shall be provided in accordance with Section 01300-SUBMITTAL PROCEDURE:

1. Sufficient data for materials and components to demonstrate compliance with the specifications.

2. Location of ancillary devices, conduit, junction boxes, safety and control devices, and conduit entries for feeding or controlling the equipment.

3. Electrical elementary diagrams, internal connection diagrams, and external interconnection diagrams, drawn in accordance with JIC and/or ICS standards. Connection diagrams shall be the conventional type with lines showing point-to-point wiring and must show terminals and devices as viewed by the electrician; wireless or wire schedule types are not acceptable.

4. Process flow diagrams and process and instrumentation diagrams (P&IDs) using ISA symbols for equipment which interfaces with the instrumentation system or has internal control loops.

5. Range and setting of indicators, instruments, timers, and devices.

PART 2 - PRODUCTS

2.01 POWER RATINGS

A. Control devices shall be suitable for the voltage and current on the electrical and instrumentation drawings or as specified.

B. Where more than one piece of equipment (each having its own power source) have a common control power system, provision shall be made for transferring the control power system to an active source should the main source of control power fail.

2.02 PILOT DEVICES

A. Electrical pilot devices including switches, relays, and contacts shall be heavy-duty industrial quality devices. Contacts which provide alarm, malfunction or control to external systems shall be rated NEMA A600 (10 amps continuous at 600 volts AC), except that pressure switches and temperature switches shall be rated NEMA B600 (5 amps continuous at 600 volts AC). Range of switches shall be that recommended by the mechanical equipment manufacturer.

2.03 ALARM AND MALFUNCTION DETECTION

A. Devices that are used to directly signal alarm or malfunction conditions shall be externally manually reset. The devices shall have a minimum of one contact that shall open on malfunction or alarm condition, as scheduled. Other output relays and devices shall have a minimum of one normally open and one normally closed contact, which may be a NEMA Form C contact. If the contact of the device is required for internal equipment control as well as to signal alarm or malfunction conditions, then the manufacturer may make the reset function a part of his equipment's master shutdown system. However, each source of shutdown shall be shown by local trouble lights or flags which are manually reset at the equipment control panel. Trouble output contacts shall open and remain open until manually reset when equipment is shut down due to a malfunction. Trouble contacts shall not indicate abnormal conditions when the equipment has been manually shut down. Alarm and malfunction signals shall be initiated by a contact opening.

2.04 CABLE

A. Rubber covered multiconductor cable shall not be used on stationary equipment for any voltage exceeding 250 volts AC, nor shall it be used for connections to any motor rated 1/4 horsepower or larger. For these purposes, JIC EMP-1-1967 E12.4.4 through E12.4.8 and E13.3 shall apply.

2.05 LIQUID TIGHT CONDUIT

A. Flexible conduit shall be Liquid tight flexible metal conduit, formed from spirally wound galvanized steel strip with successive convolutions securely interlocked, jacketed with Liquid tight plastic cover. Minimum size shall be ½ inch. Fittings for Liquid tight conduit shall have cadmium-plated malleable iron body and gland nut, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and isolated

throat. Forty-five and 90-degree fittings shall be used where applicable. Maximum length of flexible conduit shall be 36 inches.

2.06 INDICATING LIGHTS

A. Indicating lights shall be oil-tight transformer type with low voltage lamps and push-to-test features and shall be equipped with colored lenses in accordance with the following schedule:

Color	Typical Function	Example
Red	Danger, abnormal condition, fault condition	Voltage applied; cycle in automatic; faults in air, water lubricating or filtering systems; ground detector circuits.
Amber (yellow)	Attention	Motors running; machine in cycle; unit or head in forward position.
Green (security)	Safe Condition	End of cycle; unit or head returned; motors stopped; motion stopped; contractors open.
White	Normal Condition	Normal pressure of air, water, or clear lubrication.

2.07 GROUNDING

A. A separate ground conductor shall be run in each power conduit. The conductor shall be sized in accordance with NEC Table 250-95. The conductor shall be bonded to the inside of the device junction box.

B. Free-standing control panels shall be equipped with a 1/4-inch by 1-inch copper ground bus running the length of the panel, with the steel structure connected to the bus so as to effectively ground the entire structure. A compression fitting shall be provided at each end of the ground bus for accepting plant ground connections.

2.08 DEVICES WITH MOTOR STARTERS AND CONTRACTORS

A. Equipment which is provided with control devices having motor starters or contractors shall also comply with the following:

1. Disconnect Switches: Equipment shall be provided with a disconnect switch. If the disconnect switch is not located within sight of the drive, it shall be provided with a padlock hasp. The disconnect shall be a horsepower rated disconnect switch or molded case circuit breaker, except that a manual motor starter may be used for drives less than 2kVA. Horsepower rated disconnect switches for equipment 2kVA or greater shall be provided with UL Class RK1 fuses. Circuit breaker interrupting ratings shall be 10,000 symmetrical amperes for service at 240 volts or below and shall be 22,000 symmetrical amperes for service above 240 volts unless otherwise noted. When the disconnecting

device is not a circuit breaker or fused disconnect, the circuit feeding the disconnecting device shall have adequate overcurrent and short circuit protection.

2. Overload Protection: Protection shall be provided for full motor running overload in ungrounded conductors for motors.

3. Overload Relay Contacts: Overload relay contacts shall not be connected in the line having provision for grounding. Grounding connections shall be provided in the un-fused side of control circuits and shall be connected.

4. Power: Power will be supplied at one voltage as shown or specified. Additional voltage requirements, such as 120 volt control power, shall be derived from transformers provided internal to the control device as required. Each control power transformer shall be rated at least 150 percent of the calculated maximum load it serves.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Control devices, when installed, shall comply with the requirements of the NEC and the ESO. Where these differ, the more stringent shall take precedence.

3.02 FIELD WIRING

A. Conduit, wiring, or mounting of devices not shown on the electrical or instrumentation drawings but required for a complete and operable system shall be provided under this section.

**** END OF SECTION ****

SECTION 11050
EQUIPMENT MOUNTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section includes mounts, supports, and anchorage for all equipment, piping and accessories.

1.02 DESIGN REQUIREMENTS

A. Requirements Of Regulatory Agencies: All tanks, piping, equipment, supports and anchorages shall be designed by the Contractor in accordance with requirements of the Uniform Building Code (UBC) and Structural Engineering Association of California (SEAOC), latest edition, unless specified otherwise herein. The Contractor shall provide all elements required to resist the calculated forces described herein.

1.03 SUBMITTALS

A. The following items shall be submitted in accordance with the requirements of Section 01300-SUBMITTAL PROCEDURE:

1. Calculations: Calculations for all of the work required above. All calculations must be made and signed by a civil or structural engineer currently registered in the State of California. Inasmuch as all anchorage of equipment will be made to cast-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete placement. If calculations and anchorage details are not submitted prior to placing of concrete, the Contractor will become responsible for any strengthening of concrete elements because of superimposed seismic loading.

PART 2 - PRODUCTS

2.01 GENERAL

A. Equipment mountings shall be as shown. All equipment located on floor slabs shall be mounted on concrete pads. Where a steel or cast base is shown or specified between the equipment and the concrete pedestal, it shall be hot-dip galvanized after fabrication.

2.02 CAST IRON BASES

A. Cast iron bases do not require galvanizing but must be sealed in accordance with the requirements specified in Section 09900-COATING SYSTEMS. All fasteners requiring connections to the base shall be terminated by nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or acorn nuts. In no case shall the fastener terminate only into the metal base.

2.03 CONCRETE PEDESTALS

A. Concrete pedestals shall be 2 inches larger than the steel or cast base. All conduits, piping connections, drains, etc., shall be enclosed by the concrete base. No conduits, piping connections, drains, etc., will be accepted which rise directly from the floor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment:

1. Except where a higher lateral force is required by code, each piece of equipment installed shall be anchored to resist a minimum lateral seismic force of 60 percent of the operating weight of the equipment. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the Construction Manager.

2. Non-vibrating isolation equipment shall be anchored directly to the supporting floor system. In addition to the anchorage, all equipment shall be internally designed so that all static and moving parts are anchored to the supporting framework to resist the imposed seismic force. All forces must be transmitted to the base in order to be anchored as required.

3. Equipment, tanks, piping supports and anchorage located outside the buildings shall be designed to comply with the UBC, latest edition.

B. Piping:

1. All piping, raceways, accessories, and appurtenances, furnished with equipment shall be anchored to resist a lateral seismic force of 60 percent of its operating weight without excessive deflection. This force shall be considered acting at the center of gravity of the piece under consideration.

2. Piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system.

**** END OF SECTION ****

SECTION 11060
ELECTRIC MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope: This Section provides specifications for all electric motors furnished under this contract.

B. Type: Motors specified herein are 3-phase, squirrel cage, 1/2 HP and above; or single phase types smaller than 1/2 HP.

1.02 QUALITY CONTROL

A. Performance And Design Requirements:

1. General: The motors shall, in general, be premium quality high efficiency motors and shall be suitable for continuous duty operation.

2. Rating:

   1) Each motor shall develop ample torque for its required service throughout its acceleration range at impressed voltages in the range between 10 percent above and below nameplate rating. In addition, all motors shall be selected to be nonoverloading at all points along the driven machines' full speed characteristic curves. Motors employed with variable frequency drives shall be suitable for inverter duty.

   2) Motors with a 1.0 service factor shall not be required to deliver more than 87 percent of rated nameplate horsepower under the specified loading conditions. Motors with 1.15 service factor shall not be required to deliver more than its rated nameplate horsepower under the specified loading condition.

3. Application:

   1) General: Motors supplied under this specification shall be, in general, be premium efficiency (P.E.) and premium quality suitable for continuous duty operation and, as indicated, for use with inverters (variable frequency drives) in a municipal wastewater treatment plant where ambient temperatures may range between 20 degrees F and 115 degrees F. Ambient relative humidities will range between 10 and 100 percent. The plant will be located at an elevation of approximately 1400 feet above sea level. Details regarding environmental conditions for specific applications will be found in the detailed specifications for the driven equipment.

   2) Enclosure Types: Enclosures shall be as defined by NEMA, and for the purpose of this specification shall be identified in the following manner:

TYPE	ENCLOSURE
A	OPEN DRIP PROOF (ODP)
B	TOTALLY ENCLOSED FAN COOLED (TEFC)
C	TOTALLY ENCLOSED NONVENTILATED (TE)
D	WEATHER PROTECTED NEMA TYPE II (WP-II)
E	EXPLOSION-PROOF
F	SUBMERSIBLE

3) Application Types:

TYPE	APPLICATION
I.	Process motors
II.	Nonprocess motors
III.	Process motors (same as Type I) except with low noise levels
IV.	Nonprocess motors (same as Type II) except with low noise levels

4. Unless noted otherwise, all motors in these specifications shall be Type I (process motors). Type I motors shall be employed for the operation of all process-related equipment, equipment mounted below grade and all ventilation equipment serving process equipment areas.

5. Unless otherwise specified, Type II (nonprocess) motors are those driving heating and ventilating equipment located above grade and servicing nonprocess related areas, equipment with "built-in" or integral construction motors; and fractional horsepower motors below 1/2 HP.

6. Unless otherwise specified, Type III motors shall meet the specifications for Type I motors (process) and have additional special low noise level requirements.

7. Type IV motors shall meet the specifications for Type II motors (nonprocess) and have additional special low noise level requirements.

B. Standards: Motors shall be designed and built in accordance with the latest revisions of the following reference standards:

1. NEC; Environmental Operating Requirements.

2. ANSI Requirements for Numbering and Schematic Representation.

3. IEEE Standards for Electric Motors.

4. NEMA MG1 - latest revision.

5. NEMA 4; Requirements for Watertight Equipment.

6. NEMA 4X; Requirements for Outdoor Installations.

7. NEMA 7D; Requirements for Explosive Environments.

8. EC Requirements for Hazardous Locations.

9. UL Requirements for Motors and Their Appurtenances.

10. UL Requirements for Explosive Environments.

C. Performance Tests:

1. General: Should any motor exhibit indication of questionable performance, the Inspector, may request information or load test at any time after delivery of a motor to the job site. If any motor proves to be defective, all costs of testing and repair or replacement of defective motor shall be borne by the Contractor. If any motor proves to be in accordance with recommendations or manufacturer's tolerances, the cost of testing will be borne by the Agency.

2. Insulation: Insulation resistance tests shall be performed by the Contractor. Tests for acceptability shall be made using a 1000-volt megohm meter (megger). Interpretations of test results for minimum acceptable values of insulation resistance will be made in accordance with IEEE Publication 43.

3. Load Testing: Load tests shall be performed to determine the motor's ability to meet service factor loading conditions within the temperature limits of the manufacturer's submittal data. Tests shall be conducted in accordance with IEEE Publication 112A. In the event that a motor does not meet the load test requirements, the Contractor shall replace the motor at no cost to the Agency.

1.03 SUBMITTAL DATA

A. The following material shall be submitted for each size and type of electric motor furnished under this contract:

1. Descriptive bulletins, including full description of insulation system.

2. Manufacturer's connection diagrams for motors furnished with over temperature protectors, heaters, or other auxiliary devices.

3. Sufficient data on over temperature devices verify required protection.

4. Service factor.

5. Efficiency at 1/2, 3/4 and 4/4 nameplate horsepower.

6. Power factor at 1/2, 3/4 and 4/4 nameplate horsepower.

7. Temperature rise at service factor horsepower.

PART 2 - PRODUCTS

2.01 GENERAL

A. Open drip proof motors shall have openings constructed so that falling liquids or solid particles striking or entering the enclosure at any angle from 0 to 15 degrees from vertical will not interfere with the performance.

B. Totally enclosed fan cooled and totally enclosed nonventilated motors shall be provided with drilled and tapped holes to drain all cavities within the motor. Motors with frames 286T or smaller and with frame 324T or larger shall be provided with automatic breather-drain devices.

C. Weather protected NEMA Type II (WP-II) motors shall be provided with screens to prevent objects larger than 1/2 inch from entering the enclosure. If weather-protected NEMA Type II enclosures cannot be supplied for the required frame sizes, subtypes B or C motor enclosures may be substituted.

D. Explosion-proof motors shall be UL listed for Class I, Division 1 Group D hazardous locations and be provided with UL approved combination breather drains suitable for hazardous locations.

E. Submersible motors shall be watertight and supplied with a continuous flexible electrical cable of the correct capacity of sufficient length to reach the junction box shown.

F. Heaters shall be provided to prevent moisture condensation after shutdown on all motors 50 HP and above and for all other motors where specified. Heaters shall be cartridge type or flexible wrap-around type installed adjacent to core iron. Heaters shall be rated 120 volts, single phase, and rating in watts and volts shall be noted on motor nameplate or an a second nameplate. The space heater terminals shall be brought to a separate terminal in the box.

G. The motor manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall indicate clearly all the items of information enumerated in NEMA Standards MG1-10.37, MG1-10.38, or MG1-20.60, as applicable.

H. The nameplate shall be positioned to be readily visible for inspection in the complete machine.

2.02 THREE PHASE MOTORS - 1/2 THROUGH 250 HORSEPOWER

A. General: All motors 1/2 HP through 250 HP shall be 3 phase, squirrel cage, induction motors on NEMA frame 143T or larger. Type A motors shall be open drip proof motors with modification to obtain premium quality motors. Types B, C, and D motors shall be of the type generally designated by Westinghouse as "Mill and Chemical," by Reliance as "Model XT," or equal. Conductors shall be copper.

B. Rating: Motors shall be designed for 230/460 volt, 3 phase, 60 Hz operation. All leads shall be brought to the motor terminal box for reconnection as required. Motors shall be reconnected for voltage as shown on the electrical drawings. All motors shall have a 1.15 continuous duty service factor at 50 degrees C ambient temperature and shall be suitable for 65 degrees C ambient with a 1.0 service factor, unless noted otherwise. Starting kVA/HP shall not exceed the values given in NEMA Standard MG1-12.34. The motors shall be suitable for operation in either direction (clockwise or counterclockwise) of rotation.

C. Insulation: Motor rating shall be based on Class B, 80 degrees C, temperature rise above an ambient of 40 degrees C. Insulation systems shall be NEMA Class F, nonhygroscopic, and shall be suitable for use in moisture laden atmospheres and atmospheres containing acid or alkali vapor. Insulation systems shall be manufacturer's premium grade, capable of withstanding contaminated atmospheres.

D. Current Balance:

1. Motor current unbalance on polyphase motors shall not exceed the values tabulated below when motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

Under 5 horsepower	25 percent
5 HORSEPOWER AND ABOVE	10 PERCENT

2. If, however, the unbalanced currents cause mechanical vibrations, the Contractor shall correct the problem even if the measured unbalance is less than listed above.

E. Over temperature Protection:

1. Winding over temperature devices shall be provided for all motors rated 50 horsepower and larger, for all Type E (explosion-proof) motors, and for all other motors where specified.

2. Over temperature devices shall provide a normally closed contact suitable for wiring into the motor control circuit. Any relays or solid state contacts which are required shall be provided in an enclosure on or near the motor. These enclosures shall be NEMA 12 for Type A motors, NEMA 4 for Type B, C, or D motors, NEMA 7D for Type E, and NEMA 4X for Type F motors.

F. Enclosures:

1. All motors shall have cast iron housing, bearing brackets, fan guard and conduit box. Open drip proof and totally-enclosed motors shall be furnished with silicon rubber gaskets at the base of the conduit box and between the halves of the motor terminal box.

2. All motors shall be provided with a pad with a drilled and tapped hole, not less than 1/4 inch diameter, inside the conduit box for a motor frame grounding stud.

3. Motors weighing more than 50 pounds shall be equipped with two lifting eyes. All hardware shall be corrosion-resistant. Motors shall be delivered with the manufacturer's standard epoxy enamel finish.

G. Reduced Voltage Starting: Where shown on the drawings, motors 125 HP and larger shall be suitable for autotransformer starting.

H. Bearings: Three-phase motor bearings shall be conservatively designed to withstand all stresses of the service specified. Antifriction motor bearings shall be designed to be regreasible and initially shall be filled with grease suitable for ambient temperatures to 60 degrees C. If a higher ambient temperature is specified for motor insulation rating purposes, bearings shall be sized and designed for the same ambient. Bearing identification by AFBMA number shall be indicated on the motor nameplate.

I. Efficiency: Motors shall have the following full load efficiencies:

Motor HP	ODP Nominal Efficiency	TEFC Nominal Efficiency
1	82.5	82.5
1.5	84.0	84.0
2	84.0	84.0
3	86.5	87.5
5	87.5	89.5
7.5	88.5	89.5
10	89.5	89.5
15	91.0	91.0
20	91.0	91.0
25	91.7	92.4
30	92.4	92.4
40	93.0	93.0
50	93.0	93.0
60	93.6	93.6
75	94.1	94.1
100	94.1	94.1
125	94.5	94.5
150	95.0	95.0
200	95.0	95.0

2.03 SINGLE-PHASE MOTORS

A. General:

1. Unless otherwise specified, single-phase motors shall be capacitor-start induction motors. Small single-phase fan motors may be split-phase or shaded-pole type, if such is standard for the equipment. Universal (AC-DC) type single-phase motors are not acceptable unless their specific characteristics are necessary for the application. Conductors shall be copper.

2. Single-phase motors shall be designed and connected for operation on a 115 volt, 60 Hz alternating current electrical system, or 208 volt where indicated.

B. Rating:

1. Unless otherwise specified, single-phase motors shall not be required to deliver more than its rated nameplate horsepower under any condition of required loading. Type IB and IIB single-phase motors shall be continuous-time rated in conformity with NEMA Standard MG1-10.35.

2. Single-phase motor locked rotor current shall not be greater than that specified in NEMA Standard MG1-12.32, Design "N."

C. Enclosures: Unless otherwise specified, single-phase motors shall be Type IB or IIB. Small single-phase fan motors may have open-type enclosures if they are suitably protected from moisture, dripping water and lint buildup.

D. Insulation: Unless otherwise specified, single-phase motor insulation systems shall be as recommended by the motor manufacturer.

E. Construction: Unless otherwise specified, single-phase motor construction shall be as recommended by the motor manufacturer.

F. Bearings: Unless otherwise specified, single-phase motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

2.04 TYPE III AND IV MOTORS

A. Application Type III and IV motors shall be specially designed for quiet operating conditions in accordance with the limitations specified below. Limiting sound power levels, as set forth in the table, shall be the average of four measurements taken 3 feet from the motor's case as per IEEE 85 at no load as follows:

1. Each side, parallel to the axis of and level with, the motor shaft.

2. Directly above, and parallel to, the axis of the motor shaft.

3. Normal to the axis of the shaft and behind the motor.

B. Limiting sound power levels, dBA shall be as follows:

	Enclosure Type		
Frame Size	**A and D**	**B and E**	**C**
3600 rpm			
143T, 145T	66	79	70
182T, 184T	66	81	72
213T, 215T	71	79	72
254T, 256T	76	80	72
284T, 286T	82	84	74
324T, 326T	83	88	76
364T, 365T	90	94	72
404T, 405T	94	89	74
444T, 445T	96	89	76
1800 rpm			
143T, 145T	60	63	56
182T, 184T	64	67	60
213T, 215T	75	73	64
254T, 256T	72	78	64
284T, 286T	74	78	64
324T, 326T	74	74	64
364T, 365T	80	76	64
404T, 405T	80	78	68
444T, 445T	85	84	69

1200 rpm

143T, 145T	60	65	53
182T, 184T	60	67	52
213T, 215T	66	69	54
254T, 256T	74	66	56
284T, 286T	76	73	56
324T, 326T	74	78	58
364T, 365T	76	78	58
404T, 405T	75	79	65
444T, 445T	86	80	65

900 rpm

143T, 145T	58	63	50
213T, 215T	59	64	50
254T, 256T	61	64	50
284T, 286T	72	65	55
324T, 326T	76	71	55
364T, 365T	76	76	54
404T, 405T	78	76	55
444T, 445T	84	78	55

**** END OF SECTION ****

SECTION 11315
SUBMERSIBLE WELL PUMP

PART 1 - GENERAL

1.01 Summary

A. This section includes submersible deep well turbine pumping units to be installed in new wells. The pumps shall be furnished and installed complete with pumps, columns, discharge head surface plate and submersible motors for pumping groundwater. The pumps shall be multi-stage, enclosed or open impeller, turbine type with discharge from the pumping element coaxial to the pump line shaft. The units shall be driven by submersible constant speed electric motors.

1.02 Equipment List

A. The equipment in this section is for the pump in the new well.

1.03 Performance and Design Requirements

A. General: The pumps will be used to pump groundwater. The pump shall be designed for installation in new well casings.

B. The pumps shall be capable of pumping fluids without cavitation or damaging vibration within the range of operating conditions specified herein.

C. Each pump shall have characteristics as indicated on the drawings.

D. The total head requirements specified above shall be as measured at the discharge of the pump bowls. The pump characteristic curve shall be continuously rising towards the shutoff head without dipping.

E. Seismic Consideration: The anchoring of the pumps and motors shall be designed in accordance with the requirements for the site in UBC and/or SEAC. Each piece of equipment shall be anchored to resist a minimum lateral seismic force per the seismic requirements for the site. This force shall be considered acting at the center of gravity of the piece under consideration. The pump characteristics shall be such that the motor nameplate horsepower rating is not exceeded at any point on the pump curve for the pump.

1.04 Submittals

A. Product Data, Shop Drawings: The following shall be submitted in accordance with Section 01300-*SUBMITTALS*:

1. Drawings and descriptive information in sufficient detail to show the kind, size, weight, arrangement, operation, component materials and devices; external connections, anchorages, and supports required; performance characteristics; and dimensions.
2. Electrical characteristics, control panel layout, and schematic and wiring diagrams.

B. Shop drawing submittals shall also include:

1. Outline installation drawings for each pumping unit
2. Certified calculations for design of the equipment anchoring system to demonstrate compliance with Subsection 1.3, Paragraph E
3. Other data as required for complete installation of the pumps

4. Net weight of complete pumps
5. Maximum pump downthrust
6. Complete shaft dimensions
7. Impeller diameter
8. Pump performance curves for (head-capacity, horsepower-capacity, efficiency-capacity) and head loss for the pump column and discharge elbow
9. Drawings showing outline dimensions and arrangement of bearings, mechanical seal, wearing rings and suction and discharge nozzles
10. Details of pump support
11. Radial and thrust bearings selected and their AFBMA B-10 rating life for continuous operation conditions of service

C. Shop Tests: A manufacturer's certification report that the screen has been tested for a minimum of eight (8) hours and was found to operate satisfactorily shall be submitted prior to shipment of the unit.

D. Manufacturer's Field Reports: A manufacturer's certification report shall be submitted in accordance with Section 01660-*SYSTEM TESTING.*

E. Operation and Maintenance: Operation and maintenance information shall be submitted in accordance with Section 01700-*CONTRACT CLOSEOUT*.

1.05 Project Conditions

A. The equipment furnished under this section will be installed at the location shown. The motors will be submerged. The ambient temperatures are expected to range between 10 degrees F and 115 degrees F with relative humidity which varies from 20 to 100 percent.

B. Project Elevation: 375 ft ±

PART 2 - PRODUCTS

2.01 Manufacturers

A. The pumps shall be as manufactured by Grundfos, Berkeley, Floway, Pleuger, or equal.

2.02 Pump Construction

A. Materials for the vertical turbine pump shall conform to the following requirements:

Component	Material
Suction case and bowl assembly:	Cast iron, ASTM A48 Class 30 or 304 stainless steel
Impeller:	Bronze, ASTM B584 or 304 stainless steel
Pump shaft, lineshaft and couplings:	Stainless steel, ASTM A276 Type 416 or Type 431
Pump bowl:	Cast iron, ASTM A48 Class 30 or 304 stainless steel

Component	Material
Pump bearings:	Bronze, ASTM B584
Pump column:	Schedule 40, galvanized steel
Lineshaft bearing:	Cutless rubber, ASTM C425
Discharge head:	Fabricated steel, ASTM A36 or cast iron, ASTM A48, Class 30
Bolts, studs and nuts:	Stainless steel

2.03 Vertical Turbine Pump

A. Pump Suction: The pump suction shall include a pipe and a galvanized steel cone strainer. The net inlet area shall be equal to at least five times the impeller inlet area. The maximum opening shall be not more than 75 percent of the minimum opening of the water passage through the bowl and impellers.

B. Bowl Assembly: The pump bowl inlet bell shall be designed to provide conservative entrance velocities and direct the flow to the impeller. The inner surfaces of the inlet shall be smooth and free of sharp projections or cavities which might cause turbulence or cavitation. A streamlined housing, centered and held in the bell by means of rigid vanes shall be provided to properly direct the flow to the impeller. The inner surfaces of the pump bowls and inlet bell shall be lined with vitreous enamel epoxy and the exterior shall be coated with not less than 16 mils of epoxy. Stainless steel components shall not be coated.

C. Impellers: Impellers shall be mounted on their shafts and statically and dynamically balanced prior to final assembly. They shall be free of sharp projections, cavities or abrupt transitions which could encourage or incite cavitation or excessive turbulence. Impellers shall be of the open or closed type. Impellers shall be securely fastened to their shafts with keys.

D. Shafts: Shafts shall be of ample size to operate without distortion in both the forward and reverse direction and shall have a first critical speed not less than 50 percent above maximum operating speed. Sections of shafting rotating in bearings shall be fitted with a hardened stainless steel sleeve.

E. Bearings: Lineshaft bearings shall be extra length cutless rubber sleeve type. Lineshaft bearings shall be spaced not more than 5 feet apart. Lower bowl guide bearings on the first stage shall be grease lubricated. All others shall be lubricated by the water being pumped.

F. Discharge Columns: Discharge columns shall be Schedule 40 galvanized steel pipe. Sections of columns shall not exceed 20 feet in length and shall be joined with threaded couplings.

G. Surface Plate: The surface plate shall be fabricated of 1-1/4 inch steel plate with a flat face base flange to match the casing flange terminating in a 250-pound raised face steel discharge flange. The surface plate shall be fitted with a properly sized electrical junction box to allow splicing surface cables and well cables. Provide a 1-1/4 inch casing vent fitting to allow connection of the vent pipe.

H. Well Seal: Provide sanitary well for each well.

I. Couplings: Lineshaft coupling shall be a perfect butt-fit for the shaft which shall be designed with a safety factor of 1-1/2 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation.

2.04 Electric Motors

A. The electric motors shall be 240-volt or 480-volt, 3-phase, 60-Hertz as is available in the field. The motor shall be designed for continuous submersible operation inside the casing. At no point on the operational curve shall the pump exceed the motor's nameplate rating. The motor shall be provided with a cooling shroud.

PART 3 - EXECUTION

3.01 Installation

A. Equipment shall be installed in strict conformance with manufacturer's installation instructions.

3.02 Field Tests

A. After the installation of the units and all appurtenances, each unit shall be subjected to a field running test under actual operating conditions. The field tests shall be made by the Contractor in the presence of and as directed by the Construction Manager. The field tests shall demonstrate that under all conditions of operation each unit:

1. Has not been damaged by transportation or installation
2. Has been properly installed
3. Has no mechanical defects
4. Is in proper alignment
5. Has been properly connected
6. Is free of overheating of any parts
7. Is free of all objectionable vibration
8. Is free of excessive noise
9. Is free of overloading of any parts
10. Shall operate as specified

B. Any defects in the equipment or failure to meet the requirements of the Specifications shall be promptly corrected by the Contractor.

3.03 Manufacturer's Representative

A. The service of a qualified representative of the manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments, and test and place the equipment in satisfactory operating condition.

****END OF SECTION****

SECTION 13220
BOLTED STEEL TANK

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Supply and installation of factory-coated bolted steel tank and appurtenances.

B. Related Sections

1. Section 01300 – *SUBMITTALS*
2. Section 02200 – *EARTH WORK*

1.02 REFERENCES

A. AWWA D103-97 - Bolted steel tank fabrication and erection.

B. API 12B - Principles of standard specification for bolted steel tank.

C. Factory Mutual - Fire protection tanks

D. NFPA 22 - Chapter 4 - Water tanks for private fire protection, factory coated, bolted steel tanks.

E. Uniform Building Code - latest edition.

1.03 SYSTEM DESCRIPTION

A. Design Criteria

1. Job site location:	See plans
2. Product to be stored:	Domestic Water
3. Specific gravity:	1.00
4. pH of product:	7 to 8
5. Temperature of product:	15°C
6. Nominal capacity:	See plans
7. Nominal diameter:	See plans
8. Nominal height:	See plans
9. Minimum freeboard:	24 in.
10. Deck live load:	15 PSF
11. Wind speed:	100 MPH when completely erected

12. Seismic zone: 4
13. Design standard: AWWA D103-97

1.04 SUBMITTALS

A. Shop Drawings and Product Data:

1. Submit drawings covering tank, anchors, accessories, appurtenances and coatings provided in accordance with Section 01300-*SUBMITTALS*.

2. Submit structural, foundation, anchorage and seismic calculations stamped and signed by a civil or structural engineer registered in the State of California. Design ringwall foundation per AWWA D103.

1.05 QUALITY ASSURANCE

A. Qualifications

1. The Tank Manufacturer shall be a specialist in the design, fabrication, and erection of factory-coated bolted steel tanks. The manufacturer shall be quality certified, having an active API-Q1 certification.

1.06 DELIVERY, STORAGE AND HANDLING

A. Preparation for Transport

1. Material to be marked or tagged with part number and order number for field assembly requirements.

2. Tank material to be placed in racks or on pallets to facilitate transportation to jobsite.

B. Shipping

1. All plates, supports, members, and miscellaneous parts shall be packaged for shipment in such manner to prevent abrasion or scratching of the finished coating.

1.07 WARRANTY

A. The tank manufacturer shall warrant the tank against any defects in workmanship and materials for a period of one (1) year from the date of acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The steel tank and accessories furnished under this section shall be as manufactured by Columbian Steel Tank Company, Allstate Brand, Superior Tank Company, Inc., or approved equal.

2.02 MATERIALS

A. Tank Structure

The materials, design, fabrication, and erection of the bolted steel tank shall conform to AWWA D103-97.

1. Steel

   a. Sheet. Steel sheets shall conform to or shall be at least equal to hot-rolled quality per ASTM A570 Grade 33 with a minimum yield strength of 33,000 psi. Minimum thickness shall be 12 gauge (0.0972" minimum).

   b. Plate. Steel plates shall conform to or at least be equal to the requirements of ASTM A36 with a minimum yield strength of 36,000 psi.

   c. Rolled Structural Shapes. Rolled structural shapes shall conform to ASTM A36.

2. Bolts

   a. Galvanized bolts, nuts and washers used in tank joints shall be minimum 1/2 inch bolt diameter and shall meet the minimum requirements of API 12B, Appendix A, except that bolt heads and nuts may be other than square at the option of tank manufacturer.

   b. Polycapped bolt heads shall be used for additional corrosion protection.

   c. Other bolts shall conform to or at least be equal to the latest revision of ASTM A307.

   d. Any steel nuts that are in contact with the liquid in the tank shall be factory-encapsulated so that the nut forms one piece with the corrosion-resistant encapsulating material.

   e. Tank anchor bolts shall be 1 1/4" diameter minimum. For corrosion allowance, bolts shall be 1/4" larger than required by analysis.

   f. Covers shall be provided for all exterior bolts.

3. Gaskets

   All bolted connections shall incorporate an EPDM prefabricated gasket minimum width 1-3/4". A single piece double-punched gasket shall be used at vertical seams which require two vertical rows of punching. Field caulking will be allowed when joining a discontinuous gasket section and at certain joint connections. Neoprene backed steel washers shall be provided at all bolts in contact with the stored liquid.

4. Multiple Row Punching

   All sheets in the shell of the tank that require multiple vertical row punching (double or triple) must be in single stroke to insure proper alignment.

2.03 COMPONENTS

A. Appurtenances

1. The Contractor shall furnish and install the appurtenances as shown on the contract drawings and as specified below.

2. Unless otherwise noted, standard appurtenances shall be as follows:

a. Hatch. The tank roof hatch shall have a curbed, upward opening 24" square. The curb shall extend at least four inches above the tank. The hatch cover lip shall be hinged and provisions made for locking. The hatch cover lip should extend for a distance of two inches down on the outside of the curb.

b. Nozzles and Connections. Inlet, outlet, drain, air line, level and overflow connections shall conform to the sizes and locations specified on the plans.

c. Vent. A mushroom-screened vent shall be furnished above maximum water level of sufficient size to accommodate normal inlet and outlet flow. The overflow pipe shall not be considered to be a tank vent. The vent shall be so designed and constructed as to prevent the entrance of birds or animals. Vent screen shall be 316 stainless steel: 16 x 16 x 0.018 mesh.

d. Tank Ladders

(1) An exterior galvanized steel OSHA ladder shall be furnished at the location designated.

(2) An interior galvanized steel ladder with a Safe-T-Climb assembly. Location to be determined by owner.

e. Liquid Level Indicator. Provide a liquid level indicator with 316 stainless steel internals complete with float and target board assembly.

f. Passive Cathodic Protection. Tank manufacturer shall provide.

B. Tank Foundation

1. Steel Bottom Tanks: The foundation shall be installed per AWWA D103-97, Section 11.4. Supplying and installing these foundation materials shall be the responsibility of the Contractor.

2. The foundation shall be level with differential not exceeding +1/8 inch in any 30-foot circumference under the shell. The levelness on the circumference shall not vary more than +1/4 inch from an established plane.

2.04 FABRICATION

A. Shop/Factory Finishing - Option A

1. All metal plates, supports, members, and miscellaneous parts, except bolts, certain accessories, and appurtenances, shall be factory coated in accordance with the provisions of these specifications. Field coating, except for touch-up will not be permitted.

a. Interior: Thermally cured epoxy or equal.

b. Exterior: Amine Epoxy primer with urethane finish coat or equal.

2. Application Procedures for Factory Coating

a. Surface Preparation

(1) Tank parts are thoroughly washed and rinsed to remove grease, oil and foreign matter.

(2) Parts are then immediately oven-dried.

(3) Parts are grit-blasted to SSPC-SP10-63T (near white blast cleaning) to 2-3 mils profile.

(4) All parts must be coated within 15 minutes after blasting, and no further processing other than coating application shall be done.

b. Interior Coating (Includes underneath side of steel bottom)

(1) First coat electrostatic application of FDA and NSF approved thermoset epoxy (as primer), 2.5 mils average dry film thickness.

(2) Second coat electrostatic application of FDA and NSF approved thermoset epoxy, as topcoat, 2.5 mils average dry film thickness.

(3) Coating system to have 5.0 mils average dry film thickness.

c. Exterior Coating - Thermoset epoxy and urethane finish.

(1) One coat epoxy primer, 2.5 mils average dry film thickness, electrostatically applied.

(2) One or more coats urethane, 1-2 mil average dry film thickness.

(3) Coating system to have 4.5 mils average total dry film thickness.

d. Curing

Baking ovens to be used after each coat. Final coat is to be cured in bake oven for at least 15 minutes.

B. Shop/Factory Finishing - Option B

1. General: All metal plates, supports, members and miscellaneous parts, except bolts, shall be Factory Powder Coated in accordance with AWWA D103, Section 10.6 and this Section. Field coating, other than touch-up, will not be permitted.

2. Surface Preparation:

a. Prior to application of coating, all metal plates, supports, members and miscellaneous parts, other than fasteners shall be thoroughly cleaned by a hot-rinse wash process followed immediately by hot air drying.

b. All steel surfaces shall be sandblasted to equivalent of a SP 6 commercial blast metal finish. The surface anchor pattern shall be no less than 1.5 mils.

c. All steel surfaces shall receive an iron phosphate coating applied with a power spray washer no less than 25 psi pressure, followed by a warm water rinse and by an acidulated sealant. Then spray a final deionized water rinse to prevent rusting prior to the powder coating application.

d. All steel surfaces shall drip dry for seven (7) minutes prior to entering the dry off oven for eight (8) minutes at 425 degrees F.

3. Coating:

a. All interior steel surfaces, support members and miscellaneous parts shall receive 5 mils minimum average dry film thickness using an NSF 61 Approved, Thermal Set Epoxy Powder Coating.

b. All exterior steel surfaces, support members and miscellaneous parts shall receive 3 mils minimum average dry film thickness using a Thermal Set TGIC-Polyester Powder Coating.

C. Color –

1. Interior color: Manufacturer's standard.

2. Exterior color: To be selected by Owner.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION

A. Field erection of factory-coated bolted steel tanks shall be in strict accordance with the tank manufacturer's recommendations.

B. Particular care shall be exercised in handling and bolting of the tank plates, supports, and members to avoid abrasion or scratching of the coating. Touch-up coating shall be done in accordance with tank manufacturer's recommendations where and as directed.

3.02 FIELD QUALITY CONTROL

A. Testing

1. Tank Bottom:

   a. Vacuum test seams in floor plates.

2. Hydrostatic Test:

   a. Following completion of erection and cleaning of the tank, the tank shall be tested for liquid-tightness by filling the tank to its overflow elevation.

   b. Any leaks disclosed by this tank test shall be corrected by the Contractor in accordance with the tank manufacturer’s recommendations.

   c. Clean water required for testing shall be furnished by Owner without charge at the time of erection completion. Filling the tank is also the responsibility of Owner.

****END OF SECTION****

SECTION 13310
WELDED STEEL STORAGE TANK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

1. Provide a welded steel potable water storage tank with sizing and location as shown on the Design Drawings.

2. Provide tank foundation design and installation for tank.

3. Provide rigid rail fall prevention system for tank.

4. Provide accessories as specified and illustrated on Drawings for tank.

5. Provide a sacrificial anode and cathodic protection system for tank.

B. Related sections:

1. Section 01300 - Submittals

2. Section 01620 - Protection of Materials:

3. Section 09900 – Protective Coating Systems:

1.02 QUALITY ASSURANCE

A. Acceptable Tank Manufacturers/Erectors:

1. Spiess Construction Company, Inc.

2. Pitt-Des Moines, Inc.

3. CB&I Trusco Tank

4. Or equal

B. Manufacturers/Erector Qualifications:

1. Regularly engaged in the manufacture and erection of AWWA D100-11 welded steel water storage tanks.

2. Bids will be considered only from manufacturers that have furnished and erected at least three (3) tanks of equal or greater capacity.

3. Supplier of cathodic protection system to have minimum five (5) years experience and five (5) separate installations of system specified herein.

C. Coating Applicator Qualifications:

1. Recommended and approved by tank manufacturer.

2. Experienced in applying the type of coatings specified to steel water storage tanks.

D. Welders Qualifications:

1. All welders shall be qualified by ASME requirements in all positions.

E. Reference Standards:

1. AWWA D100-96 or latest revision: American Water Works Association, "AWWA Standard for Welded Steel Tanks for Water Storage".

2. AWWA D102-97 or latest revision: "AWWA Standard for Coating Steel Water Storage Tanks".

3. AWWA C652-86 or latest revision: "AWWA Standard for Disinfection of Water Storage Facilities".

1.03 SUBMITTALS

A. Shop Drawings:

1. Complete detailed steel Drawings of:
    1) Plates
    2) Rafters
    3) Columns
    4) Connections
    5) Exterior stairs
    6) Pipe supports
    7) Accessories
    8) Foundation design

B. Provide Product Data Describing:

1. All tank materials

2. Coatings:
    1) Include Material Safety Data Sheets for each component of internal coating

3. Erection methods and procedures

4. Accessories

5. Sacrificial anode-type cathodic protection system

C. Calculations:

1. Structural, including wind and seismic:

1) Verification of suitability of foundations for seismic consideration, including uplift and overturning.
2) Confirm if anchor bolts are required for the design as submitted and verify suitability of anchor bolts and anchor chair design as submitted.
3) Provide depth/capacity table for tank in increments of 0.10 feet of water depth.
4) Prepared and stamped by a Professional Structural Engineer registered in California.

D. Test Reports and Certificates for testing specified herein:

1. Provide certified mill test reports covering all steel plates prior to fabrication.

2. Welder certification and WPS documentation.

1.04 JOB CONDITIONS

A. Elevation: per Drawings

B. Site Access: Paved road to front of site.

C. Geotechnical Report attached in Appendix B.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Coatings:

1. Deliver to job in original unopened containers.

2. Store inside and protect against freezing.

3. Containers labeled describing product and formulation.

4. Do not add any unauthorized thinner or other material not included in formulation.

5. Store and handle in accordance with manufacturer's recommendations and Specification Section 09900.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. Codes

1. California Building Code, latest edition.

2. AWWA D100

B. Additional Structural Design Criteria:

1. Roof live load: No less than 30 psf

2. Wind load:
    1) 90 mph minimum 3-second gust wind speed:
3. Design outside air temperature: 25 Degrees F to 110 degrees F
4. Minimum thickness: Greatest of the following:
    1) Design thickness per AWWA D100 minimum
    2) Minimum plate thickness: 1/4 inch minimum, including corrosion allowance, or greater as required to resist design loadings
    3) Combined corrosion allowance: 1/16 inch (all surfaces) in addition to minimum design thickness or code thickness.
5. Maximum allowance deflection in roof supporting members under dead load and live load: L/240

C. Dimensional-Potable Water Storage Tank:

1. Approximate capacity, measured below overflow to waste, gallons: 148,000 gallons
2. Diameter: Per Drawings
3. Elevation of top of foundation: Per Drawings
4. Pipe connections: Per Drawings
5. Roof slope: Per tank manufacturer
6. Base slope upwards to center: 1 inch per 10 feet
7. Roof type: Low cone, column and rafter supported, with a “knuckle” radius of 3 feet tangent to both the roof and shell plates
8. Flow rate:
    1) Maximum withdrawal rate: 3500 gpm. Vents shall be designed in accordance with specified maximum withdrawal rate.

2.02 MATERIALS

A. Steel Water Reservoir: Per AWWA D100 latest revision.

B. Steel Pipe: Per Section 15061.

C. Vents:

1. Steel: Minimum 3/16 inch thick
2. Screens: 1/2 inch mesh, bronze or aluminum, covered with a 20 mesh aluminum insect screen.

D. Railings:

1. 1-1/2 inch standard weight galvanized steel pipe

2. Connectors: Flush welded type, R.B. Wagner, or equal

2.03 FABRICATION AND MANUFACTURE

A. General:

1. Tanks shall be of welded construction throughout and manufactured per AWWA D100.
2. Whenever there is a change in thickness greater than 1/16 inch in sidewall, plates shall be joined so offset is on inside and outside face is flush
3. Design roof structure with consideration for cathodic protection equipment specified herein.
4. All welds inside tank and below water line to be seal welded.
5. Provide welded tabs for mounting:
    1) Conduit run up side of tank for level monitor.

B. Accessories:

1. Per AWWA D100 except as modified below.
2. Manholes:
    1) Provide two (2), 24-in x 46-in.
    2) Within first (bottom) ring of tank shell at locations indicated on Drawings
    3) One of the manholes shall have provisions for attachment of a mechanically operated exhauster per AWWA Standard
    4) Provide hinge for swing-out of manway cover
    5) Provide 3/4-inch thick backing ring for tank shell support of manway
3. Inlet-outlet connections: as indicated on Drawings.
4. Overflow and drop pipe:
    1) As indicated on Drawings
    2) Provide supports and anchors as required
5. Roof hatch:
    1) Rainproof
    2) At locations indicated on Drawings
    3) Provide handrail as indicated on Drawings
    4) Provide hasp and padlock
6. Vents:
    1) Size to handle pressure differential caused by water entering or leaving tank
    2) Mushroom type

3) Screened

4) Mount on roof curbs a minimum of 24 inches above roof

7. Railings:

1) Plan location as indicated on Drawings

2) Members smooth, continuous over posts

3) Field joints kept to a minimum

4) Rigidly attached to tank

5) Three (3) rails

6) Maximum post spacing: 6 feet

8. Treated sand layer:

1) Provide as indicated on Drawings

9. Handhole access port:

1) Galvanized steel handhole covers

2) Covers 7 inches diameter by 1/8-inch thick

3) Provide covers with 7-inch diameter by 1/8-inch thick rubber gaskets

4) Handholes to be 6-inch diameter openings at locations determined by cathodic protection supplier.

5) Handhole covers served by 1/2-inch galvanized bolts with clamping bars

10. Ladders:

1) Provide outside access ladder, complete with safety cage per Drawings and OSHA's latest requirements. Ladder shall be provided with a locking entry restraint system. The entry restraint system shall consist of an outward opening steel hinged plate to prohibit access to the ladder and cage assembly by unauthorized personnel. Tank supplier shall submit shop drawings for approval.

2) Provide inside ladder per OSHA requirements and with rigid rail fall prevention system.

3) Interior ladders 304 SS, bolted with 304 SS hardware to carbon steel mounting tabs welded to inside wall and floor. Provide complete dielectric isolation between dissimilar metals, using gaskets, nylon tubular bolt sleeves, etc., as required.

11. Neoprene pad:

1) Install under center column base plate

12. Weather enclosure box for ultrasonic level probe unit on tank roof:

1) Welded steel

2) Hinged lid for access

3) Sized for ultrasonic unit, approximately 12-inch by 12-inch by 12-inch

4) Provide sidewall coupling for water-tight electrical connection

C. Sacrificial cathodic protection system:

1. Designed and furnished by cathodic protection system manufacturer with minimum 10 installations

2. Provide for potable water tanks.

3. Materials:

    1) Magnesium anodes shall be 1.315 inches in diameter and length as specified. Rods shall have a 1/8-inch iron wire core.

    2) Anode cable shall be AWG No. 8 high molecular weight, polyethylene cathodic protection type. The cable shall be permanently attached to the top of each anode and a heat shrinkable cap applied.

D. Installation:

1. Each anode shall be suspended in the tank, using the cable, from an insulator bolted through the roof. The free end of the cable shall be grounded under the insulator mounting with a heavy-duty lug.

2. A 6-inch-diameter handhole shall be installed within reach of each anode mounting. The handhole cover shall be gasketed and held in place by a bolt and retaining bar. All parts o f the handhole shall be galvanized. The handhole shall be cut in the tank prior to tank painting.

E. Layout:

1. Coordinate to provide adequate number and arrangement of anodes suspended in equal segments of a circle as required in the steel tanks to provide passive cathodic protection for minimum 7-year service life

2. The bottom of all anodes shall be 3 feet off the bottom of the tank

F. Testing:

1. After filling each reservoir, the cathodic voltage between the structure and a saturated copper - copper sulfate reference electrode suspended in the tank liquid shall be measured and verified to be in an acceptable range

2. If necessary, supplier to provide corrective actions as necessary to bring voltage potential within acceptable range

PART 3 - EXECUTION

3.01 ASSEMBLY

A. General:

1. Per AWWA D100.

B. Railings:

1. Grind smooth all field welds

2. All posts plumb and longitudinal members parallel

3. Check alignment with tightly drawn wire. Maximum tolerance out of plane: 1/8 inch

4. Replace bent, deformed, or out of alignment rails

3.02 COATINGS

A. Coatings per AWWA D102:

1. Outside Coating System (OCS) No. 2 (three coat) Moisture cure Polyurethane.

2. Inside Coating System (ICS) No. 1 (two coat) two component Epoxy.

B. Preparation:

1. Per AWWA D102 as modified herein:
   1) Exterior of tank: Clean by SSPC-SP6 "commercial blast cleaning".
   2) Interior of tank: Clean by SSPC-SP10 "near white blast cleaning".

2. Apply primers immediately after preparation, before visible rust appears.

3. Remove all slag and weld spatter from welds by scraping, chipping, and brushing.
   1) Do not use tools that cause excessive roughness, cuts, or burrs.

C. Mixing and Thinning:

1. Per AWWA D102 as modified below:
   1) Factory mix all paint to proper consistency for hot weather application without thinning
   2) Thinning of paint will only be permitted to obtain recommended coverage at lower application temperatures
   3) Thoroughly mix paint any time it is withdrawn from container
   4) Keep containers tightly closed except when withdrawing paint
   5) Use only manufacturer recommended thinner

D. Application:

1. Coatings:
   1) Apply coatings after erection and testing, except paint before assembly:
   a) Top sides of roof support beams and undersides of roof plates that will come into contact
   b) Underside of center column base plate and top of floor plates in area of center column
   c) Primer and finish coats per interior paint system Specification 09900.
   2) Per AWWA D102 as modified below:
   a) By spraying, except a brush may be used for touch-ups
   b) Free of runs, sags, ridges, and laps
   c) Do not apply at rate of coverage per gallon in excess of that recommended by manufacturer

d) Remove, repair, and repaint any defective areas

e) Consistent with paint manufacturer's specifications for application

3) Weather conditions:

a) Do not apply during wet, damp, or foggy weather

b) Do not apply when windblown dust, dirt or debris will collect on fresh paint

c) Protect spray applied paint from being carried away by wind

d) Do not apply when air temperature or surface tempaturess are below 40 Degrees F or when condensation occurs on surface of metal

4) Weather condition monitoring:

a) Paint system installer to provide the following:

i) Thermometer with high and low temperature indication

ii) Humidity

5) Protection:

a) Do not allow paint to be dropped, spilled, or windblown onto adjacent surfaces

b) All surfaces so damaged shall be cleaned, replaced, or repaired to satisfaction of Engineer

6) Safety precautions:

a) Per AWWA D102

3.03 DISINFECTION

A. Per AWWA C652-86 or Latest Revision

B. Provide all necessary equipment, supplies, and materials necessary for disinfection. All safety precautions shall be observed

C. Dechlorinate All Highly Pre-Chlorinated Water Prior to Discharge from Storage Tank

D. Personnel working inside the tank during disinfection shall be equipped with suitable air masks and safety lines leading through a manway to personnel outside the tank. All safety precautions shall be observed.

E. Upon completion of the disinfection procedure, the owner shall arrange for any bacteriological testing of water samples from the tank that may be required. The tank shall not be put in service until safe test results are obtained.

3.04 FOUNDATIONS

A. Treated Sand Layer:

1. Grade uniformly to slope upwards to center of tank bottom, 1 inch per 10 feet

2. Provide uniform smoothly raked and compacted surface for tank to rest on

3. Provide under entire tank bottom to specified depth

B. Reservoir Perimeter Seal:

1. Provide a continuous 1-inch thick grout seal around perimeter of tank per AWWA D100

2. Provide between top of ringwall, foundation wall, and underside of reservoir as indicated on Drawings

3. Trim flush any projections beyond outside edge of reservoir

3.05 FIELD TESTING

A. Welding and Leak Testing:

1. Prior to Painting

2. Per AWWA D100, Section 11, as Modified Herein:

    1) The written report required in the AWWA Standard will be prepared and stamped by a qualified and registered Engineer certifying welding was inspected in accordance with AWWA D100

3. Test for both quality of welding and for leaks per the AWWA D100 Sections 11.3 through 11.12 and Appendix C, Section C.4

B. Solvent Residue Testing:

1. Conform to latest requirements of Department of Health Services

2. Fill tank and soak for five (5) full days

3. Collect water samples in appropriate vials

4. Analyze samples for volatile aromatics per EPA Test Method 502.2:

5. Test at state certified laboratory

6. Report results to Engineer

7. Additional tests as required upon review of specific MSDS submittal for paint type and manufacturer proposed

C. Paint Dry Film Thickness Gauge:

1. Maintain one magnetic style dry film thickness testing gauge onsite during all painting operations. The contractor shall furnish, until final acceptance of painting, owner approved inspection devices in good working condition for detection of holidays and measurement of dry film thickness of coating and paint. Said devices shall be operated in accordance with the manufacturer's instructions. The contractor shall also furnish U.S. Department of Commerce, National Bureau of Standards Certified Thickness Calibration Plates to test the accuracy of the dry film thickness gauge and shall provide certified instrumentation to test the accuracy of the holiday detector.

2. Provide dry film thickness monitoring as requested by Engineer.

3. Provide Holiday testing per AWWA D102 and as requested by Engineer. Holiday detection devices shall be operated in presence of inspector. All pinholes and holidays shall be marked, repaired in accordance with manufactures recommendations, and re-tested.

3.06 MANUFACTURER'S FIELD SERVICES

A. Supervision:

1. Tank manufacturer shall employ a supervisor who will remain on-site and supervise operations of assembly and welding throughout erection

B. Tank Manufacturer Shall Provide a Qualified Representative to be Present During Testing

3.07 WARRANTY INSPECTION

A. Provide warranty inspection of storage tank interior approximately 11 months after substantial completion and before expiration of one (1)-year warranty period. Prior to inspection the storage tank shall be drained of all contents. At Contractor's option, tank may be inspected while full through use of divers and supply of videotape adequately showing tank bottom, walls, weld seams, connections and underside of roof.

B. Contractor to Coordinate Inspection with Owner Four (4) Weeks Prior to Tank Drawdown

C. Inspection to be Witnessed by Owner, Contractor, and Painting Subcontractor

D. All defects and separations, blisters to be repaired and painted in accordance with the Project Specifications and the manufacturer's recommendations

****END OF SECTION****

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SECTION 15200
DOMESTIC WATER WELL

A. SCOPE OF WORK

The work to be done hereunder includes the furnishing of all materials, transportation, tools, supplies, plant, equipment, and appurtenances necessary for the complete and satisfactory construction and development of a domestic water supply well in accordance with these Specifications and all Federal, State, and Local well construction standards.

1. Qualifications
   The Contractor shall be of established good reputation, regularly engaged in such works and licensed in accordance with the provisions of the Contractors License Law Chapter 9, Division 3, of the Business and Professions Code.

2. Permits, Laws, Ordinances and Insurance
   The Contractor shall, at his own expense, procure the well permit, and all certificates and licenses required of him by law for the execution of his work. He shall comply with all federal, state and local laws, ordinances or rules and regulations relating to the performance of the work, including the State General Permit for Storm Water Compliance During Construction. The Contractor must conform to State Prevailing Wage requirements and submit certified payroll to the State of California's Compliance Monitoring Unit using the eCPM system, at least monthly. Insurance and bonding requirements are outlined in the RFP document and General Conditions.

3. Location
   The well site is as shown on the plans included with these Specifications. This location will be staked in the field. Prior to drilling the well, this location shall be confirmed in the field by the Engineer and the Owner. The Owner shall arrange for access to the well site, and make suitable provisions for ingress and egress. The Contractor shall not enter on or occupy with crew, tools, equipment or material, any ground outside the property designated by the Owner without the written consent of the Owner of such ground.

4. Boundaries of Work
   The Contractor shall protect all structures, such as walks, pipelines, trees, shrubbery, and lawns during the progress of his work; shall remove from the site all cuttings, drillings, debris, and unused materials.

5. Water and Power
   The Contractor shall make all necessary arrangements for water and power for construction purposes. It is expected that the Owner will make water available to the Contractor for well construction purposes. There shall be no separate payment made to the Contractor for this item.

6. Completion Time
   Work on the Well shall be coordinated with the Owner to minimize or eliminate any interference with the existing operations of the site. Work on the Domestic Water Well shall start within ten (10) calendar days of receipt of the "Notice to Proceed" and all work under this Section shall be completed within sixty (60) calendar days of the date of such notice to proceed.

B. WELL REQUIREMENTS

The Contractor shall furnish all equipment and materials to install the new well pump and sanitize the well and pump. All work shall conform to the latest standards of the California Department of Water Resources Bulletins No. 74-81 and No. 74-90 "Water Well Standards, State of California". Well sealing, casing, developing, and disinfection shall be strictly in conformance with the recommendations of DWR Bulletin No. 74-90.

Following completion of his work, the Contractor shall remove from the premises all excess materials, tools, and equipment used in the execution of his work, and shall dispose of all debris resulting from his work.

Following completion of his work, the Contractor shall remove from the premises all excess materials, tools, and equipment used in the execution of his work, and shall dispose of all debris resulting from his work. The Contractor shall fill all sumps and/or excavations made by him and restore the surface of the site near the well to the satisfaction of the Engineer, and with the inspection and approval of the Owner.

C. TEST WELL CONSTRUCTION

a. Test Hole. A test hole shall be drilled at the site indicated on the Permit and staked in the field by the Engineer. It shall be at least eight (8) inches in diameter. It shall be drilled to the depth as shown indicated on the plans, utilizing an inorganic mud as a drilling fluid. Total containment and off-haul of all drilling spoils / mud shall be provided.

b. Driller's Log. An accurate driller's log of the materials penetrated shall be recorded by the driller who must be experienced at this work and have the skills to determine the depths and thickness of the various underlying strata encountered.

c. Core Samples. Formation samples from the test hole shall be collected and handled in a manner selected by the Contractor and approved by the Engineer. Core samples shall be collected at least every ten (10) feet, and whenever a different strata is encountered. Core sample tests shall provide sufficient particle size distribution data for determining well screen slot size. The location and number of particle size distribution tests shall be proposed by the Contractor and approved by the Engineer.

d. Electric Well Log. The Contractor shall coordinate the performance of an electric log of the open test hole. The electric log shall accurately log the complete depth of the test hole and shall have a spontaneous electrical potential curve and shall have a normal and a lateral resistivity curve. The electric log shall provide sufficient formation data for determining the water bearing and non-water bearing formation and similar data necessary for evaluating the proper completed depth of the well and the location of the well screen.

e. Well Log. The Contractor shall furnish the Engineer with an accurate and complete well log when the test hole is completed. Recommendations shall include locations for perforations, any special sealing considerations, and value of cathodic protection.

f. Abandoning/Destroying the Test Hole. The test hole shall be properly abandoned per County requirements and State Water Well standards. The volume of slurry added shall be measured, and the Local Governing Agency and Engineer must be notified to witness the well abandonment.

D. WELL CONSTRUCTION

a. Production Hole. The Well shall be drilled at the site indicated on the Permit and staked in the field by the Engineer. It shall be drilled to the minimum diameter and depth as indicated on the plans utilizing an inorganic mud as a drilling fluid. Total containment and off-haul of all drilling spoils / mud shall be provided.

b. Test Pumping. The location of the test pump reservoir and/or discharge shall be selected by the Contractor and approved by the Engineer.

c. Driller's Log. An accurate driller's log of the materials penetrated shall be recorded by the driller who must be experienced at this work and have the skills to determine the depths and thickness of the various underlying strata encountered.

d. Core Samples. Formation samples from the well hole shall be collected and handled in a manner selected by the Contractor and approved by the Engineer. Core samples shall be collected at depths recommended by the Contractor and approved by the Engineer as indicated from the Test Hole Construction and Electric Log Test. A contract shall include the collection and analysis of 10 core samples. Core sample tests shall provide sufficient particle size distribution data for determining well screen slot size.

e. Well Log. The Contractor shall furnish the Engineer with an accurate and complete well log when the well is completed.

f. Drilling to Accommodate Casing. The hole shall be drilled sufficiently straight so as to be used for the production well. The hole shall be constructed to the diameter and depth as indicated on the plans and as specified by the Engineer.

g. Pump Slab. A pump slab shall be provided as shown on the Plans. The pump slab shall be a minimum 30-inches square and meet the requirements of Bulletin 74-90, Section 1 0(A)(5). The pump slab shall be free of cracks, voids, or other significant defects likely to detract from its water tightness.

2. Annular Seal Cement Grout

Cement grout shall be placed in the 4 inch minimum annular space between the hole and the casing. The annular seal shall extend to the greatest depth as indicated on the plans, or required by the Owner, or a minimum depth of 50 feet or as called out on plans which ever is greater, and shall be landed at least 10 feet into a clay layer.

a. Grout Mixture. The cement grout shall consist of not more than two parts by weight of sand and one part of cement to five to seven gallons of clean water (per bag of cement). Quick setting cement, retardants to setting, or other additives, including hydrated lime to make the mix more fluid (up to 10 percent of the volume of cement) and bentonite (up to 5 percent to make the mix more fluid and to reduce shrinkage), may be used with the approval of the Engineer.

b. Method of Pouring. The grouting material shall be applied in one continuous operation from the bottom of the annular seal to the top by the use of a tremie pipe. The annular seal shall be a minimum of 4 inches in radial thickness. Freefall of sealant material and restricting groundwater flow during the placement of the sealant shall be prevented. The contractor shall provide verification that the volume of sealing material placed in the well during construction at least equals the volume to be sealed. No work shall be done until at least 48 hours have elapsed after the grouting operation.

3. Furnishing and Installing Well Screen and Casing

Casing and screening material shall conform to DWR Bulletin 74-90. A steel casing with 0.375 wall thickness and diameter as shown on the plans shall be installed using centering lugs to such depth as to be determined by the Engineer. The casing shall be resistant to corrosion and not have more than one longitudinal seam parallel to the axis. Casing material shall be selected by the Contractor and approved by the Engineer. The casing shall be applied in minimum lengths of 20 feet. All materials are to be new.

a. Machined Ends. All buff ends of the casing are to be machined to insure that the butt surface is at a true right angle with the longitudinal axis.

b. Method of Joining. All joints shall be made with 1/4" x 4" collar, the collar being attached to the section of the casing 2 inches on and 2 inches off each joint so that each succeeding joint of casing will slip into the collar and buff on the lower joint. All joints are to be continuously welded in accordance with the standards of the American Welding Society.

c. Spacer Lugs. An adequate number of spacing lugs are to be welded to the outer casing to insure that it is truly concentric with the hole, approximately every 30 feet. The casing is to be set plumb and to extend to a depth as required.

d. Well Screen. The well screen shall be of the continuous slot, wire-wound type; and shall conform to the diameter of the inner casing to which it is to be joined. The continuous slot, wire-wound type material shall be 304 Stainless Steel which includes both screen and fittings. The well screen aperture openings shall be determined to have sufficient open area to transmit the design flow, as indicated on the plans, at an aperture entrance velocity not to exceed 0.1 feet per second. The continuous slot, wire-wound type well screen is to be of flat wire construction conforming to that manufactured by U.O.P. Johnson Division of Universal Oil Products, Cook Well Stainer Co., or equal. The maximum screen slot size shall be 0.05 inches.

e. Joining Screen to Casing. Intermediate screen sections shall be joined by welding. Welding rod shall be of material suitable for joining corrosion resistant material. Well screens shall be furnished with collars for welding of at least 1/4-inch thickness. All welding shall be in conformance with the practices of the American Welding Society.

f. Bottom of Casing. The bottom of the casing shall be blanked off with a 5/16-inch welded steel plate.

g. Plumbness and Alignment. All casings and screens shall be truly round in shape, mounted concentrically and installed in the bore hole. Plumbness and alignment must be such that the intended pumping equipment can be lowered into the well to the full depth of the 16-inch diameter casing and removed without binding in any way. Non-alignment shall be corrected by the Contractor at his own expense.

h. Top of Casing. The top of the casing shall extend 24 inches above grade. Until the downhole items are ready for installation, the top of the casing shall be sealed with a 1/4-inch steel cover. The steel cover shall be tack-welded to the top of the casing.

i. Sounding Tube. A 3-inch diameter schedule 40 steel sounding tube with a watertight screw cap shall be provided. The sounding tube shall extend at least 3-inches above the pump slab. The sounding tube shall be sufficiently separated from the casing to allow the placement of a deep well turbine motor and pump head or a line shaft water lubed turbine pump, which ever is specified in the plans. A three-inch screened and inverted casing vent shall be provided on a fitting from the sounding tube, as shown on the plans.

4. Furnish and Install Gravel Pack
The gravel selected to fill the annular space between the well casing and the bore hole shall be clean water worn selected washed gravel. Grading of the gravel pack shall be determined from the sieve analysis of the test hole aquifer materials. The 70 percent retained size of the gravelpack is between four and nine times the 70 percent retained size of the finest member of the aquifer. The uniformity coefficient of the gravel pack shall not exceed 25. A sample of the gravel to be used shall be submitted with the sieve analysis to the Engineer for approval before any gravel is delivered to the well site.

a. Disinfection of Gravel. Prior to placing the gravel, a granular hypochlorite, or similar disinfectant shall be added to the gravel at the rate of one pound per cubic yard to the gravel based on 70 percent chlorine content. The method of adding the disinfectant shall suit field conditions and the method of the graveling used by the Contractor.

b. Placement of Gravel. The gravel shall be placed from the bottom of the casing to the bottom of the sanitary seal. Placement shall be made with suitable precautions to avoid the possibility of the gravel bridging or clogging at any point.

c. Gravel Feed Pipe. A 3 -inch diameter schedule 40 galvanized steel gravel feed pipe shall be installed to fill the annular space between the bore hole and the casing, as shown on the plans. The gravel feed pipe shall be capped with a threaded watertight cap and extend a minimum of three inches above the pump slab, sufficiently separated from the casing to allow the placement of a deep well submersible turbine motor and pump head or the line shaft water lubed turbine pump, which ever is specified.

5. Cleaning of the Well
After the well has been completely constructed, it shall be thoroughly swabbed, using alkalines, if necessary, to remove oil and grease. The well shall be bailed free of any heavy drilling mud and all sand deposits before the developing pump is installed.

6. Furnishing, Installing, and Removing of Test Pump
The Contractor shall supply and install a suitable test pump unit consisting of a deep well engine driven pump capable of pumping 33% to 133% of the design flow rate. The bowl setting shall be at least the anticipated pumping water level as indicated on the plans. Said equipment must be in good repair and capable of performing the pumping as required. For Discharge Rate Measurement, an orifice meter and control valve shall be installed on the pump discharge to determine discharge rate.

E. TESTING AND DEVELOPING THE WELL

The purpose of this operation is to cleanse the well of all driller's mud, chemicals, cuttings, sand and silt; and to produce at least the design flow of water free of discoloration and sediment, suitable for use in a domestic water supply system, and meeting the requirements of the U.S. Public Health Service Drinking Water Standards and of the State of California, California Administrative Code, Title 22, Division 4, Chapter 15.

1. Development Method and Minimum Sand Requirement
The Contractor shall surge the well frequently and operate the pump until it appears that there is no discoloration, sand, or sediment produced. This operation will continue until the Engineer is satisfied that the well is adequately developed. As a basis of final acceptance after the above conditions have been met, the well must not produce more than five parts per million of sand or sediment at a discharge of at least the design flow within 15 minutes after starting the pump. If this condition is not met within 24 hours of test pumping, the well shall be deemed not to have met specifications.

If the above conditions have been met, test pumping at a rate at least equal to the design flow shall be conducted for a period of twenty-four hours. During this twenty-four hour period water level measurements shall be made at the beginning of the test, every ten minutes for two hours, then every half hour for the remainder of the test period. After the twenty-four hour pump test, recovery water levels shall be made every ten minutes for two hours or until the well recovers to the original static water level. A graph of the water level measurements versus time shall be made for the entire 24 hour test pumping and recovery period.

2. Water Quality Testing

After the pump test a water sample shall be collected and analyzed. The water quality analysis shall include all constituents in the Water Quality Monitoring Regulations under the current State Permit; including General Mineral, General Physical, onorganic Chemical, Organic Chemical, and Radioactivity analyses, according to the State of California. California Administrative Code, Title 22, Division 4, Chapter 15, Articles 3 and 4. All water quality testing must be performed by a state accredited laboratory.

F. PERMANENT WELL PUMP AND DOWNHOLE ITEMS

1. Pump and Motor

The well pump shall be as described in the “Submersible Well Pump” section of these Specifications.

2. Pump Controls

Low level shut-off and re-start probes shall be supplied in the well to protect the pump. The level to set the probes will be determined by the Engineer, after review of the pump test data and selection of a pumping unit.

The turbine pump shall be controlled as described in the “Control Strategies” section of these Specifications.

3. Pump Testing

The pump shall be fully tested on water at the manufacturer's plant prior to shipment. If the pump manufacturer supplies the driving motor, pump and motor shall be assembled and tested as a unit. Testing shall consist of checking the unit at its rated speed, head capacity, efficiency and brake horsepower throughout the specified range of smooth operation; and at such other conditions of head and capacity to establish the performance curve.

A certified copy of the test curve shall be submitted to the Engineer. The Standards of the Hydraulic Institute shall govern the procedure and calculations for the testing.

G. WELL DISCHARGE PIPING

The well discharge piping shall be flanged ductile iron pipe and shall conform to Ductile Iron Pipe Specifications AWWA C151 and have a minimum pressure rating of 250 psi. The discharge piping shall be of equal diameter to the pump column and consist of a flex coupling, a screened and inverted air release vacuum breaker vent, a 3/8 inch copper sample tap with petcock, an tee with gate valve for pump to waste, an swing check valve, an isolation gate valve, and a chlorine injection tap. All pipe

fittings shall be manufactured in accordance with applicable AWWA standards for pipe type and application.

The well discharge piping shall be tested as described in the "Water Line, Valves" section of these Specifications.

H. DISINFECTING AND CAPPING THE WELL

The well shall be disinfected according to the requirements of California Administrative Code, Title 22, Division 4 and the California Well Standards, Bulletin 74-81, Appendix C, "Suggested Procedures for Disinfecting Wells". The disinfection shall be done after the placement of the permanent well pump. After disinfection, the Contractor shall take a bacteriological test sample, and have it analyzed by a State Certified Laboratory, according to Title 22. The test results must be acceptable before putting the well on line.

The top of the well shall be kept securely capped both day and night, in such a manner as to effectively prevent either tampering with the well or entrance of foreign matter.

A pipe or other effective means through which chlorine or other disinfecting agents may be introduced directly into the well shall be provided. The sounding tube may be used for this purpose. If an additional pipe is provided, it shall be installed at a height at least equal to the pump slab, shall be kept sealed, and shall be provided with a waterproof threaded cap or equivalently secure cap. An air relief vent shall be installed, as shown on the plans, and it shall terminate downward and be screened with 16 mesh screen to prevent contaminating material from entering the vent.

I. RECORDS

The Contractor shall furnish the Engineer copies of the driller's log, electric logs, test pumping data, and water quality data.

SECTION 15055
PIPING MATERIALS AND COMPONENTS

PART 1 - GENERAL

1.01 Summary

A. This section specifies the general requirements for piping materials and components and their installation and testing. Use this specification in conjunction with the Section 15060 and the Drawings.

1.02 References

A. This section references the following documents. They are a part of this section insofar as specified and modified herein. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI A13.1	Scheme for the Identification of Piping Systems
AWWA C651	Standard for Disinfecting Water Mains

1.03 Diagrammed Pipelines

A. Various pipelines are shown on the drawings in diagram form. These diagrammed pipelines shall be furnished, fabricated, erected and otherwise installed to lines, elevations, locations and dimensions as shown, specified or required for a complete installation. The Contractor shall verify all dimensions shown on the drawings and shall take such field dimensions as may be necessary to properly install all diagrammed pipelines.

B. The cost of furnishing, fabricating, locating, erecting and otherwise completely and properly installing all diagrammed pipelines shall be included in the lump sum Contract bid price and no separate payment will be made thereof.

PART 2 - PRODUCTS

2.01 Piping

A. Material

1. Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, lining and coating, shall be selected from those listed on the Section 15060.

B. Flange Assemblies

1. Flat faced flanges shall not be bolted to raised face flanges.
2. Gaskets for flat faced flanges shall be the full face type.
3. Gaskets for raised faced flanges shall match the raised face type.
4. Utilize only flat faced flanges when using flanges to mate dissimilar piping materials.

2.02 Pipe Identification

A. Plastic Coding Markers

1. Plastic markers for coding pipe shall conform to ANSI A13.1 as manufactured by W.H. Brady Company, Seton Name Plate Corporation, or equal.
2. Markers shall be the mechanically-attached type that are easily removable; they shall not be the adhesive applied type.
    a. Markers shall consist of pressure sensitive legends applied to plastic backing that is strapped or otherwise mechanically attached to the pipe.
    b. Legend and backing shall be resistant to petroleum based oils and grease and shall meet the criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL-STD-810C.
    c. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.
3. Markers bearing the legends on background colors selected by the Owner's Representative shall be provided in the heights required by ANSI A13.1.
4. Pipe markers shall include unidirectional and bidirectional arrows required by ANSI A13.1

B. Tracer Wire

1. Tracer wire shall be #12 insulated copper wire and included for piping as indicated herein.

C. Warning Tape

1. Warning tape shall be 3 inches wide and included for piping as indicated herein. Warning tape shall be made of inert plastic material suitable for direct burial and capable of stretching to twice its original length.
2. Warning tape shall be blue for potable water, purple for recycled water, and green for all other lines.
3. A warning message shall be printed on the tape.
    a. For Potable Water the message shall read "CAUTION: BURIED WATER PIPE BELOW."
    b. For Recycled Water the message shall read "CAUTION: BURIED RECYCLED WATER PIPE BELOW".
    c. For all other services the message shall read "CAUTION: BURIED PIPE BELOW". Letters shall be with black and the message shall be printed at maximum intervals of 2 feet.

PART 3 - EXECUTION

3.01 Installation

A. General:

1. Only proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be used. Manufacturer's written instructions must be on-site and available to Owner's Representative during construction.
2. The interior of all pipes shall be cleaned of all foreign matter before installing.
3. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
4. While pipe laying is NOT in progress, the open ends of the installed pipe shall be closed to prevent trench water from entering into the interior of the pipe.
    a. Adequate backfill shall be deposited on pipe to prevent floating of pipe.

b. Any pipe that has floated shall be removed from the trench, cleaned, and re-laid in an acceptable manner.

c. Temporary plugs shall be of the inflatable rubber type designed and supplied specifically for piping work. The use of burlap, wood, or other similar temporary plugs will not be permitted.

5. Cable, rope, or other devices used for lowering fittings into trench shall be attached around the exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fitting's interior for handling.

B. Diagrammed Pipe

1. Where such pipelines are shown only in diagram, they shall be arranged clear of other pipelines, equipment and walking areas, and shall be accessible for maintenance.

a. Such pipelines shall be fitted and installed in a neat and workmanlike manner in accordance with approved shop drawings.

b. An adequate number of unions shall be provided to facilitate dismantling or removal.

2. The final locations of appurtenances included as part of diagrammed pipelines shall be shown on the approved shop drawings or as determined in the field by the Owner's Representative.

C. Anchorage

1. All bends, plugs, caps and tees in pressure piping systems shall be anchored by mean of restrained joints unless otherwise specified or shown.

D. Structure to Buried Application Flexibility

1. Unless otherwise specified or shown, wherever piping 6 inches in diameter and larger passes from concrete to earth, 2 sleeve type flexible pipe couplings or flexible joints shall be provided with the first joint between 2 feet and 3 feet from the face of the structure.

a. The spacing between the two couplings shall be between 2 and 3 feet.

b. A single sleeve type flexible pipe coupling can be utilized if the concrete wall penetration employs a flexible pipe seal.

c. Where required for resistance to pressure, flexible couplings shall be restrained.

E. Vents and Drains

1. Manual air vents shall be provided at the high points of each reach of pipeline whether shown or not shown on drawings.

a. Manual air vents shall consist of a ¼" bronze cock and short copper tubing return.

b. Copper tubing shall be routed to the nearest floor.

c. Manual air vents in piping systems for fluids containing solids shall be 1-inch non-lubricated eccentric plug valves fitted with quick couplers.

2. Whether shown or not shown on drawings all pipelines shall be provided with a tap or welded nipple and valved drain on the bottom of the pipe.

a. Drains shall be piped to a sump, gutter, floor drain or other collection point.

b. Drain valves shall be 1" gate valves unless shown otherwise.

c. When drains cannot be run to collection points, they shall be rerouted to a point of easy access.

3.02 Cleaning and Flushing

A. General:

1. Piping systems shall be flushed and cleaned prior to testing. The Contractor may, in order to facilitate the cleaning of sections of buried or exposed piping between isolating valves, clean and test the system as specified in this section, prior to connection to the valving. Use of this procedure, however, will not waive the requirement for a full test of the completed system.
2. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system.
3. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.
4. The Contractor shall notify the Owner's Representative prior to cleaning and shall perform work in the presence of the Owner's Representative.

B. Air Systems:

1. Air or Foul Air system piping 6 inches in diameter and smaller shall be blown out, using air or the testing medium specified.
2. Air or Foul Air system piping larger than 6 inches shall be cleaned by having a swab or "pig" drawn through the entire length of the pipe. After connection to the equipment, it shall then be blown out using the equipment.

C. Liquid Systems:

1. After completion of cleaning, piping systems 12" and less shall be flushed with clean water for a minimum period of 15 minutes at the flow rate required to produce a minimum velocity of 6 feet per second.
   a. Contractor is responsible for all temporary piping and facilities required.
   b. Contractor shall comply with all State and Local regulations and requirements for disposal of flushing water.
2. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651. Post disinfection testing shall be done and paid for by the Contractor.

3.03 Testing

A. Upon completion of installation the Contractor shall test each piping system.

1. Pressures, media and test durations shall be as specified in the Section 15060.
2. Equipment that may be damaged by the specified test conditions shall be isolated.
3. Each test gauge shall be selected so that the specified test pressure falls within the upper half of the gauge's range.
4. The Contractor shall notify the Owner's Representative prior to each test and shall perform each test in the presence of the Owner's Representative.
5. Pipes shall not be encased in concrete until leakage test is completed and passed.
6. Pipes shall not be covered by concrete slabs or pavement until leakage test is completed and passed.
7. Flanges or flex couplings shall not be backfilled or buried until leakage test is completed and passed.

B. Pumped or Pressure Systems:

1. Preparatory to testing, the section of pipeline to be tested shall be filled with water and placed under a slight pressure for at least 24 hours.
2. The pipeline then shall be brought up to the test pressure specified.
3. Leakage from exposed and buried pumped systems shall be zero at the specified test pressure throughout the specified duration.

C. Gravity Systems

1. Gravity piping shall be tested by filling the section being tested with water until the level of water is at the maximum water level of the structure being drained.
2. Leakage shall not exceed 0.05 gallons per hour per inch of diameter per 100 feet for the test duration specified.

D. Air Systems

1. Air piping shall be tested by bringing the section being tested to the test pressure for the duration specified.
2. Leakage shall be zero for the duration specified.

E. Cross Connection Control

1. Cross connection testing between the potable water system and all other system shall be performed by a cross connection control specialist certified by the California-Nevada section of the American Water Works Association or an organization with equivalent certification requirements.
2. Contactor shall coordinate and pay for all expenses required to perform test.

3.04 Piping Identification

A. Pipe Coding

1. After application of the specified coating or painting and insulation systems, exposed piping, both interior and exterior, and all piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers.
2. Legend markers and directional arrows shall be located as required by ANSI A13.1.

B. Warning Tape and Tracer Wire

1. Warning tape shall be installed 12 inches above all potable water, recycled water, primary influent and foul air pipes. Tape shall be spread flat with message side up before backfilling.
2. Tracer wire shall be continuous and attached to all potable water and recycled water pipes. Tracer wire through valve boxes shall be placed outside of riser and inside of valve box.

****END OF SECTION****

SECTION 15060
PIPING SYSTEMS

PART 1 - DESCRIPTION

1.01 GENERAL

A. This Section specifies requirements for piping systems consisting of pipe, fittings and valves.

1.02 REFERENCES

A. This Section references the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.3	Malleable-Iron Threaded Fittings
ANSI B16.9	Factory-Made Wrought Steel Butt-Welding Fittings
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
ASTM A120	Pipe, Steel, Black and Hot Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinary Uses
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403	Wrought Austenitic Stainless Steel Pipe Fittings
ASTM D1784	Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
ASTM D1785	Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
ASTM D2751	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
ASTM D2466	Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
ASTM D2467	Specification for Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
ASTM D2564	Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
ASTM F439	Specification for Socket-Type Chlorinated Polyvinyl Chloride

Reference	Title
	(CPVC) Plastic Pipe Fittings, Schedule 80.
ASTM F441	Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
ASTM F493	Specification for Solvent Cements for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe and Fittings.
AWWA C106	Standard for Gray-Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids
AWWA C108	Standard for Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds for Water or Other Liquids
AWWA C110	Gray-Iron and Ductile Iron Fittings 3 Inch Through 48 Inch for Water and Other Liquids
AWWA C111	Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C151	Standard for Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 Inches and Larger - Shop Applied.
AWWA C208	Standard Dimensions for Steel Water Pipe
AWWA C210	Standard for Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C900	Standard for PVC Pressure Pipe
AWWA C905	Standard for Large Diameter PVC Pressure Pipe

1.03 PIPING SYSTEM SPECIFICATION SHEETS (PIPESPEC)

A. Each process piping system is specified in the following PIPESPEC sheets.

B. For plumbing piping, refer to Section 15420-PLUMBING PIPING SYSTEMS. The following piping systems refer to plumbing piping:

CW	Cold Water
D	Drain
HW	Hot Water
SS	Sanitary Sewer
V	Vent

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**DRAIN (D)**
Test Medium:	Water
Test Pressure:	In accordance with Section 712, Uniform Plumbing Code
Test Duration:	In accordance with Section 712, Uniform Plumbing Code
Flange Gaskets:	Neoprene Cloth Insert
Push On/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)
Exposed Piping	(none)

Buried and Encased Piping	(3-inches and smaller)
Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly
	(4-inches and larger)
Pipe:	PVC SDR 35 per Section 02644 pushes on joints.
Fittings:	PVC SDR 35, joints to match pipe, where shown on drawings.

Note:

1. All piping below slabs shall be encased in concrete.
2. All piping below tanks shall be encased in concrete.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**FOUL AIR (FA)**
Test Medium:	Air
Test Pressure:	5 psi
Test Duration:	4 hours
Flange Gaskets:	Neoprene Cloth Insert

Exposed Piping (2-inches and larger)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly

Buried and Encased Piping (3-inches and smaller)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly

Note:

1. Backfill all buried FA piping with 2-sack cement slurry.
2. Passivate stainless steel pipe and fittings following fabrication to remove heat tint, weld scale, free iron, and other impurities.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**MEMBRANE AIR (MA) / PROCESS AIR (PA)**
Test Medium:	Air
Test Pressure:	25 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping

(12" and smaller)

Pipe:	Stainless Steel, Schedule 10S, Type 304L, welded or flanged joints.
Fittings:	Steel to match pipe, Schedule 10S, Type 304L to match Pipe, welded or flanged joints, Victaulic (where shown).
Valves:	Butterfly

or

Pipe:	Type 304L Stainless Steel, ASTM A312, Schedule 10S, grooved couplings and welded or flanged joints, as shown.
Fittings:	Stainless Steel, ASTM A403.
Valves:	Butterfly

Buried Piping

(12" and smaller)

Pipe:	Steel, ASTM A53, unlined. Grooved couplings and welded or flanged joints. Tape coat.
Fittings:	Steel to match pipe. Welded joints. Tape coat.
Valves:	Butterfly

Note:

1. Piping in aeration tanks shall be Schedule 10S, Type 304L stainless steel below elevation 1425.70.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System:	**OVERFLOW (OF)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints, as shown.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged joints, as shown.
Valves:	None

Buried Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, restrained joints. AWWA C105 polyethylene encasement.
Fittings:	Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.
Valves:	None.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**PERMEATE (PRM)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe: Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket or flanged joints.

Fittings: Polyvinyl chloride (PVC), Schedule 80, normal impact.

Valves: Ball, Check, Butterfly

Buried Piping (4” and smaller)

Pipe: Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact, solvent welded socket joints.

Fittings: Polyvinyl chloride (PVC), Schedule 80, normal impact.

Valves: Ball, Check, Butterfly.

(4-inch through 12”)

Pipe: PVC C900 CL 150, restrained joints, at the contractor’s option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**Return Activated Sludge (RAS)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping

(4" and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, as shown.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints, as shown.

Valves: Plug.

Buried Piping (All sizes)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, restrained joints. AWWA C105 polyethylene encasement.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: None.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**RECYCLED WATER (RW)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (3" and smaller)

Pipe: Copper Type L with soldered joints.

Fittings: Wrought copper or cast bronze sweat fittings.

Valves: Gate, Ball

(4-inch and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints.

Valves: Check Valve, Gate Valve, Air Release.

Buried Piping (4-inch and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement motar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.

Fittings: Ductile Iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Butterfly Valve, Gate Valve.

Or

(4-inch and larger)

Pipe: PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

Note: Insulate all exposed piping 1 ½" dia or smaller.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**SAMPLE (SAM)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check, Needle.

Buried Piping (all sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact, solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check.

Tubing (all sizes)

Pipe:	Polyethylene tubing per ASTM D-1248 Type 1, Class A Category 4, Grade E5.
Fittings:	FAST and TITE polypropylene fittings with Noryl grab rings and Viton O-rings.
Valves:	PVC ball valves as shown on drawings.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**SODIUM HYPOCHLORITE (SCLS)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	N/A
Mechanical Joint/Coupling Gaskets:	N/A

Exposed Piping (All sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check

Tubing (all sizes)

Pipe:	Polyethylene tubing per ASTM D-1248 Type 1, Class A Category 4, Grade E5.
Fittings:	FAST and TITE polypropylene fittings with Noryl grab rings and Viton O-rings.
Valves:	PVC ball valves as shown on drawings.

Notes

1. Drill balls of valves per Section 15064.
2. Tubing shall be installed inside Schedule 80, PVC conduit; all bends shall be long radius. Provide pull boxes to facilitate pulling in tubing.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**SEWER FORCE MAIN (SFM)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged.
Valves:	None

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe. Grooved, flanged, or restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug
	or
Pipe:	PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.
Fittings:	Ductile or cast Iron, AWWA C110 or C153 fittings. Cement mortar lining. Restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**UNDER DRAIN (UD)**
Test Medium:	None
Test Pressure:	None
Test Duration:	None
Flange Gaskets:	None
Push On/Coupling Gaskets:	As required
Exposed Piping	(none)
Buried	(6” and larger)
Pipe:	HDPE perforated and non-perforated corrugated pipe, ADS N-12 ProLink Ultra pipe or approved equal. Perforations shall be circular or slotted with 3 slots at 120° and located in the outside valleys of the corrugations. Maximum slot length or diameter shall be 0.984 inches and a maximum slot width of 0.118 inches.
Fittings:	HDPE fittings to match pipe.
Valves:	None

Note:

All under drain corrugated piping shall be encased in 18” square crushed rock envelope wrapped with a woven geotextile fabric Amoco 2016 or approved equal.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**POTABLE WATER (W)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (2 1/2 -inch and less)

Pipe: Copper Type L with soldered joints.

Fittings: Wrought copper or cast bronze sweat fittings.

Valves: Gate, Reduced Pressure Principle Backflow Device

(3 –inch and greater)

Pipe: Steel, ASTM A53; AWWA C213 fusion epoxy coated and lined, grooved couplings and welded or flanged joints, as shown.

Fittings: Steel or ductile iron, lining and joints to match pipe.

Valves: Gate, check, control valve, pressure relief

Buried Piping (3 –inch and less)

Pipe: PVC SCH 80, normal impact, solvent welded joints.

Fittings: PVC SCH 80, normal impact.

Valves: Gate

(4-inch through 12”)

Pipe: PVC C900, Class 150, restrained joints, at the contractor’s option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

Note:

1. Disinfect pipe in accordance with AWWA C651.

Insulate all exposed piping 1 ½” dia or smaller.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**WASTE ACTIVATED SLUDGE (WAS)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints.
Valves:	Plug, Swing Check

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.
Fittings:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**WASTEWATER (WW)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged.
Valves:	None

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe. Grooved, flanged, or restrained joints. AWWA C105 polyethylene encasement.
Valves:	Gate
	or
Pipe:	PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.
Fittings:	Ductile or cast Iron, AWWA C110 or C153 fittings. Cement mortar lining. Restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

****END OF SECTION****

SECTION 15060
PIPING SYSTEMS

PART 1 - DESCRIPTION

1.01 GENERAL

A. This Section specifies requirements for piping systems consisting of pipe, fittings and valves.

1.02 REFERENCES

A. This Section references the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.3	Malleable-Iron Threaded Fittings
ANSI B16.9	Factory-Made Wrought Steel Butt-Welding Fittings
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
ASTM A120	Pipe, Steel, Black and Hot Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinary Uses
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403	Wrought Austenitic Stainless Steel Pipe Fittings
ASTM D1784	Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
ASTM D1785	Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
ASTM D2751	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
ASTM D2466	Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
ASTM D2467	Specification for Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
ASTM D2564	Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
ASTM F439	Specification for Socket-Type Chlorinated Polyvinyl Chloride

Reference	Title
	(CPVC) Plastic Pipe Fittings, Schedule 80.
ASTM F441	Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
ASTM F493	Specification for Solvent Cements for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe and Fittings.
AWWA C106	Standard for Gray-Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids
AWWA C108	Standard for Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds for Water or Other Liquids
AWWA C110	Gray-Iron and Ductile Iron Fittings 3 Inch Through 48 Inch for Water and Other Liquids
AWWA C111	Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C151	Standard for Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 Inches and Larger - Shop Applied.
AWWA C208	Standard Dimensions for Steel Water Pipe
AWWA C210	Standard for Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C900	Standard for PVC Pressure Pipe
AWWA C905	Standard for Large Diameter PVC Pressure Pipe

1.03 PIPING SYSTEM SPECIFICATION SHEETS (PIPESPEC)

A. Each process piping system is specified in the following PIPESPEC sheets.

B. For plumbing piping, refer to Section 15420-PLUMBING PIPING SYSTEMS. The following piping systems refer to plumbing piping:

CW	Cold Water
D	Drain
HW	Hot Water
SS	Sanitary Sewer
V	Vent

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**DRAIN (D)**
Test Medium:	Water
Test Pressure:	In accordance with Section 712, Uniform Plumbing Code
Test Duration:	In accordance with Section 712, Uniform Plumbing Code
Flange Gaskets:	Neoprene Cloth Insert
Push On/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)
Exposed Piping	(none)

Buried and Encased Piping	(3-inches and smaller)
Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly
	(4-inches and larger)
Pipe:	PVC SDR 35 per Section 02644 pushes on joints.
Fittings:	PVC SDR 35, joints to match pipe, where shown on drawings.

Note:

1. All piping below slabs shall be encased in concrete.
2. All piping below tanks shall be encased in concrete.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**FOUL AIR (FA)**
Test Medium:	Air
Test Pressure:	5 psi
Test Duration:	4 hours
Flange Gaskets:	Neoprene Cloth Insert

Exposed Piping (2-inches and larger)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly

Buried and Encased Piping (3-inches and smaller)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints
Fittings:	Polyvinyl chloride (PVC), Schedule 80.
Valves:	Butterfly

Note:

1. Backfill all buried FA piping with 2-sack cement slurry.
2. Passivate stainless steel pipe and fittings following fabrication to remove heat tint, weld scale, free iron, and other impurities.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**MEMBRANE AIR (MA) / PROCESS AIR (PA)**
Test Medium:	Air
Test Pressure:	25 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping

(12" and smaller)

Pipe:	Stainless Steel, Schedule 10S, Type 304L, welded or flanged joints.
Fittings:	Steel to match pipe, Schedule 10S, Type 304L to match Pipe, welded or flanged joints, Victaulic (where shown).
Valves:	Butterfly

or

Pipe:	Type 304L Stainless Steel, ASTM A312, Schedule 10S, grooved couplings and welded or flanged joints, as shown.
Fittings:	Stainless Steel, ASTM A403.
Valves:	Butterfly

Buried Piping

(12" and smaller)

Pipe:	Steel, ASTM A53, unlined. Grooved couplings and welded or flanged joints. Tape coat.
Fittings:	Steel to match pipe. Welded joints. Tape coat.
Valves:	Butterfly

Note:

1. Piping in aeration tanks shall be Schedule 10S, Type 304L stainless steel below elevation 1425.70.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System:	**OVERFLOW (OF)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints, as shown.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged joints, as shown.
Valves:	None

Buried Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, restrained joints. AWWA C105 polyethylene encasement.
Fittings:	Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.
Valves:	None.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**PERMEATE (PRM)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe: Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket or flanged joints.

Fittings: Polyvinyl chloride (PVC), Schedule 80, normal impact.

Valves: Ball, Check, Butterfly

Buried Piping (4” and smaller)

Pipe: Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact, solvent welded socket joints.

Fittings: Polyvinyl chloride (PVC), Schedule 80, normal impact.

Valves: Ball, Check, Butterfly.

(4-inch through 12”)

Pipe: PVC C900 CL 150, restrained joints, at the contractor’s option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**Return Activated Sludge (RAS)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping

(4" and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, as shown.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints, as shown.

Valves: Plug.

Buried Piping (All sizes)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, restrained joints. AWWA C105 polyethylene encasement.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: None.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**RECYCLED WATER (RW)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (3" and smaller)

Pipe: Copper Type L with soldered joints.

Fittings: Wrought copper or cast bronze sweat fittings.

Valves: Gate, Ball

(4-inch and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.

Fittings: Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints.

Valves: Check Valve, Gate Valve, Air Release.

Buried Piping (4-inch and larger)

Pipe: Ductile Iron, AWWA C151, AWWA C104 cement motar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.

Fittings: Ductile Iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Butterfly Valve, Gate Valve.

Or

(4-inch and larger)

Pipe: PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

Note: Insulate all exposed piping 1 ½" dia or smaller.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**SAMPLE (SAM)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check, Needle.

Buried Piping (all sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact, solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check.

Tubing (all sizes)

Pipe:	Polyethylene tubing per ASTM D-1248 Type 1, Class A Category 4, Grade E5.
Fittings:	FAST and TITE polypropylene fittings with Noryl grab rings and Viton O-rings.
Valves:	PVC ball valves as shown on drawings.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**SODIUM HYPOCHLORITE (SCLS)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	N/A
Mechanical Joint/Coupling Gaskets:	N/A

Exposed Piping (All sizes)

Pipe:	Polyvinyl chloride (PVC), NFS, Schedule 80, normal impact with solvent welded socket joints.
Fittings:	Polyvinyl chloride (PVC), Schedule 80, normal impact.
Valves:	Ball, Check

Tubing (all sizes)

Pipe:	Polyethylene tubing per ASTM D-1248 Type 1, Class A Category 4, Grade E5.
Fittings:	FAST and TITE polypropylene fittings with Noryl grab rings and Viton O-rings.
Valves:	PVC ball valves as shown on drawings.

Notes

1. Drill balls of valves per Section 15064.
2. Tubing shall be installed inside Schedule 80, PVC conduit; all bends shall be long radius. Provide pull boxes to facilitate pulling in tubing.

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**SEWER FORCE MAIN (SFM)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged.
Valves:	None

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe. Grooved, flanged, or restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug
	or
Pipe:	PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.
Fittings:	Ductile or cast Iron, AWWA C110 or C153 fittings. Cement mortar lining. Restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**UNDER DRAIN (UD)**
Test Medium:	None
Test Pressure:	None
Test Duration:	None
Flange Gaskets:	None
Push On/Coupling Gaskets:	As required
Exposed Piping	(none)
Buried	(6” and larger)
Pipe:	HDPE perforated and non-perforated corrugated pipe, ADS N-12 ProLink Ultra pipe or approved equal. Perforations shall be circular or slotted with 3 slots at 120° and located in the outside valleys of the corrugations. Maximum slot length or diameter shall be 0.984 inches and a maximum slot width of 0.118 inches.
Fittings:	HDPE fittings to match pipe.
Valves:	None

Note:

All under drain corrugated piping shall be encased in 18” square crushed rock envelope wrapped with a woven geotextile fabric Amoco 2016 or approved equal.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**POTABLE WATER (W)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (2 1/2 -inch and less)

Pipe: Copper Type L with soldered joints.

Fittings: Wrought copper or cast bronze sweat fittings.

Valves: Gate, Reduced Pressure Principle Backflow Device

(3 –inch and greater)

Pipe: Steel, ASTM A53; AWWA C213 fusion epoxy coated and lined, grooved couplings and welded or flanged joints, as shown.

Fittings: Steel or ductile iron, lining and joints to match pipe.

Valves: Gate, check, control valve, pressure relief

Buried Piping (3 –inch and less)

Pipe: PVC SCH 80, normal impact, solvent welded joints.

Fittings: PVC SCH 80, normal impact.

Valves: Gate

(4-inch through 12”)

Pipe: PVC C900, Class 150, restrained joints, at the contractor’s option, ductile iron piping with restrained joints will be allowed.

Fittings: Ductile iron, AWWA C110 or C153, Class 350, lining, thickness and coating to match pipe, restrained joints. AWWA C105 polyethylene encasement.

Valves: Gate

Note:

1. Disinfect pipe in accordance with AWWA C651.

Insulate all exposed piping 1 ½” dia or smaller.

PIPING SYSTEM SPECIFICATION SHEET—PIPESPEC

System	**WASTE ACTIVATED SLUDGE (WAS)**
Test Medium:	Water
Test Pressure:	150 psi
Test Duration:	120 Minutes with no detectable leakage
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining, thickness and coating to match pipe, grooved or flanged joints.
Valves:	Plug, Swing Check

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.
Fittings:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, flanged joints, restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

PIPING SYSTEM SPECIFICATION SHEET--PIPESPEC

System	**WASTEWATER (WW)**
Test Medium:	Water
Test Pressure:	125 psi
Test Duration:	120 Minutes
Flange Gaskets:	Neoprene Cloth Insert
Mechanical Joint/Coupling Gaskets:	Nitrile or Neoprene (oil resistant)

Exposed Piping (All sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe, grooved or flanged.
Valves:	None

Buried Piping (all sizes)

Pipe:	Ductile Iron, AWWA C151, AWWA C104 cement mortar lining, grooved or flanged joints, restrained joints.
Fittings:	Ductile iron, AWWA C110 or C153. Lining thickness and coating to match pipe. Grooved, flanged, or restrained joints. AWWA C105 polyethylene encasement.
Valves:	Gate
	or
Pipe:	PVC C900 CL 150, restrained joints, at the contractor's option, ductile iron piping with restrained joints will be allowed.
Fittings:	Ductile or cast Iron, AWWA C110 or C153 fittings. Cement mortar lining. Restrained joints. AWWA C105 polyethylene encasement.
Valves:	Plug

****END OF SECTION****

SECTION 15062
DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 Description

A. Scope: This section specifies ductile iron pipe, ductile or gray iron fittings and gaskets.

B. Definition: Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 References

A. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B2.1	Pipe Threads (Except Dryseal)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws
ANSI B31.1	Power Piping; Includes Summer 77, Winter 77, Summer 78, and Winger 78 Addenda
ASTM A716	Pipe Spec. for Ductile Iron Culvert
AWWA C101	Standard for Gray Iron and Ductile Iron Fittings
(ANSI C21-10)	2 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Standard for Rubber Gasket Joints for Ductile Iron
(ANSI C21-10)	and Gray iron Pressure Pipe and Fittings
AWWA C105	Standard for Polyethylene Encasement for Gray
(ANSI A21.5)	Ductile Cast Iron Piping for Water and Other Liquid
	Standard for Flanged Cast Iron and Ductile Iron
AWWA C115	Standard for Flanged Cast Iron and Ductile Iron
(ANSI A21.15)	Pipe with Threaded Flanges
AWWA C151	Standard for Ductile Iron Pipe, Centrifugally Cast, in
(ANSI 21.51)	Metal Molds or Sand Lined Molds for Water or Other Liquids
AWWA C153	Standard for Ductile Iron Compact Fittings for

(ANSI C21.53) Water Service

1.03 Submittals

A. The Contractor shall submit the following in accordance with Section 01300:

1. Shop drawings
2. Alignment drawings
3. Certification that such length of pipe has been tested physically for ductility and has satisfactorily passed such tests.
4. Certifications specified in the following documents:
   1) AWWA C151, paragraph 51-4.2
   2) ANSI 21.52, paragraph 52-4.2
   3) ASTM A716, paragraph 4.2
   4) AWWA C110, paragraph 10-4.3
   5) AWWA C111, paragraph 11-5.1
   6) AWWA C115, paragraph 15-3.2

PART 2 - PRODUCTS

2.01 General

A. Pipe design, materials, and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150, working pressure 250 psig, minimum
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI 21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	AWWA C110 or C153
Polyethylene encasement	AWWA C105

2.02 Gaskets

A. Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain not less than 50 percent by volume neoprene and shall be free from defects, reclaimed rubber and other deleterious substances.

2.03 Flange Assemblies

A. Flange assemblies shall be provided as specified in Section 15055-2.01 and herein.

B. Corrosion-resistant bolts and nuts for use with ductile iron joints are an acceptable substitute for alloyed bolts and nuts. Galvanized or cadmium steel bolts are not acceptable substitutes for stainless steel.

2.04 Joints

A. Push-on and Mechanical Joints: The plain ends of push-on pipe and mechanical joint pipe shall be marked with paint to show the required depth of penetration for making the joint.

B. Mechanically Restrained Joints: Mechanically restrained joints shall be designed to prevent separation of the joint by the pipe's internal thrust after installation. The design shall permit disassembling of the joint for repair and maintenance. Restraints shall be Field Lock 350 Gaskets (4 – 24 inch diameter), TR Flex, Fast-Grip Gaskets (4-24 inch), Mega Lug 1100 Series, Mega Lug Series 1700, or approved equal.

C. Grooved End Couplings: Where shown on the Drawings, grooved end couplings shall be Victaulic Style 31 for ductile iron pipe, or equal. Unless otherwise specified, bolts and nuts for submergence shall be 316 stainless steel regardless of any other protective coatings.

D. Sleeve-Type Couplings

1. Sleeve-Type Couplings, 30 inches and Smaller: Unless otherwise specified, couplings shall be ductile iron construction. Standard couplings shall be Powerseal 3501, or equal. Flanged coupling adapters shall be restrained type Romac Industries RFCA, or equal. Insulated couplings shall be fabricated steel, Powerseal 3539, Smith-Blair 416, or equal.

2. Sleeve-Type Couplings, Greater Than 30 inches: Unless otherwise specified, couplings shall be fabricated steel construction. Standard couplings shall be Powerseal 3538, Smith-Blair 411, or equal. Reducing couplings shall be Powerseal 3562, Smith-Blair 415, or equal. Flanged coupling adapters shall be Powerseal 3528, or equal.

2.05 Fittings

A. Ends shall be flanged, mechanical joint, as specified in the Pipespec or as shown in the Drawings. Elbows shall be the long radius style.

B. Service Saddles

1. Ductile iron, epoxy coated service saddle with double strap stainless steel strap

2. Smith-Blair 317; Romac Industries Style 202S; or equal

2.06 Polyethylene Encasement

A. Polyethylene encasement shall be used on all buried ductile iron pipe and fittings. Installation of polyethylene shall be as specified in ANSI A21.5, Section 5-4.2.1 and these specifications. Pipe, fittings, valves and couplings shall be wrapped. Fittings that require concrete backing shall be wrapped prior to placing the concrete.

B. The polyethylene encasement seams and overlaps shall be wrapped and held in place by means of a 2-inch wide plastic backed adhesive tape. The tape shall be Polyken No. 900 (polyethylene), Scotchwrap No. 50 (polyvinyl), or equal. The tape shall be such that the adhesive shall bond securely to both metal surfaces and polyethylene film.

C. The polyethylene encasement for recycled water pipe shall be color-coded purple.

2.07 Corrosion Control

A. Where indicated, all lines exceeding 100 feet in length shall be electrically continuous by means of an exothermic weld.

B. Corrosion test stations shall be provided at intervals specified.

2.08 Lining

A. Unless otherwise shown or specified, lining shall be cement mortar lining conforming to AWWA C104.

B. For all raw or screened wastewater service (sewer force main-SFM, or wastewater-WW) the pipe shall be lined with Protecto 401; 100% polyurethane - Madison Chemical Industries, Inc. CorroPipe II WasteLiner (use CorroPipe II WasteLiner (CM) for grit service) or approved equal. Apply lining thickness as recommended by the coatings manufacturer.

C. Where specified, glass lining shall consist of vitreous and inorganic material applied to the internal surfaces that have been prepared by sandblasting. The lining shall be applied in a minimum of two (2) coats, separately applied and coated. The entire coating shall be a minimum of 10 mils and a maximum of 25 mils dry film thickness. Lining shall have a hardness of 5-6 an the MOHS scale and a density of 2.5-3.0 grams per cubic centimeter as measured by ASTM D-792. Repair field cuts per manufacturer's recommendations.

2.09 Coating

A. Buried Service: Coating and mortar lining seal shall be asphaltic coating per AWWA C151 for pipe and AWWA C110 for fittings

B. Exposed Service except as noted: Supply bare pipe – no asphaltic coating. Field coat exterior per Section 09900-*COATING SYSTEMS*. Mortar lining seal shall be asphaltic coating per AWWA C151 for pipe and AWWA C110 for fittings.

C. Submerged Service: Coating and lining shall be 100% polyurethane - Madison Chemical Industries, Inc. CorroPipe II WasteLiner or approved equal. Apply coating thickness as recommended by the coatings manufacturer.

2.010 Restraints

A. Fittings unless otherwise shown or specified shall be restrained with Ebaa Iron 1100, series Mega lug mechanical joint restraint, or Sigma.

B. The ductile iron joints shall be restrained with Ebaa Iron 1700, series bell harness, or Sigma

PART 3 - EXECUTION

3.01 General

A. Piping runs shown on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01300-*SUBMITTALS*.

B. Pipe shall be installed in accordance with AWWA C600. Cuts on DIP pipe shall be coated with an acceptable bituminous material. Cut ends on Protecto 401 lined pipes shall be coated with Protecto 401 Joint Compound in accordance with the manufacturer's recommendations.

C. Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes,

including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

D. The Contractor shall conduct the tests in the presence of the Engineer.

3.02 Insulating Sections

A. Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section of rubber of plastic pipe shall be provided. Each insulating section shall have a length of 2 to 4 inches.

3.03 Anchorage

A. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted.

3.04 Restrained Joints

A. Provide restrained joints as indicated or as required to develop full joint restraint to withstand all working and test pressures. Joints encased in concrete below structures need not be restrained type providing Contractor can show that the concrete encasement will provide the necessary restraint for the piping system.

3.05 Acceptance Testing

A. Hydrostatic pressure tests shall be conducted and acceptability determined in accordance with AWWA C600 as modified by the Piping System Specification Sheets.

****END OF SECTION****

SECTION 15064
PVC PIPE

PART 1 - GENERAL

1.01 Summary

A. This section specifies polyvinylchloride (PVC) pipe for pressurized and non-pressurized systems.

1.02 Submittals

1. Descriptive literature showing pipe dimensions, joints, couplings and other details for each size of pipe indicated.
2. Manufacturer's standard installation instructions.

PART 2 - PRODUCTS

2.01 Material

A. PVC material for pipes and fitting shall complying with Cell Classification 12454-B or better, in accordance with ASTM D1784.

B. Pipe Color shall be based on application as follows:

1. Blue: potable water
2. Purple: recycled water
3. Green: drain pipe

C. The manufacturer shall mark the date of extrusion, nominal pipe diameter, PVC cell classification, ASTM designation, and SDR designation on the pipe.

2.02 Pipe and Fittings

A. <u>PVC Schedule 80</u>

1. Flat faced flanges shall be used for transitions between PVC pipe and pipe of different material.
2. Flange bolts shall be type 316 stainless steel per ASTM F593 and F594.

B. <u>PVC SDR 26</u>:

1. Pipe and fittings shall meet the requirements of:
   a. ASTM D 3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
   b. ASTM D 2321 Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
2. Pipe and fittings shall be suitable for joining by gasketed joints unless otherwise shown or indicated.

C. Flexible Couplings:

1. For pipes 12-inch and larger flexible couplings shall be Romtec Style 400 coupling with fusion bonded epoxy coating and lining and 316 SST bolts and nuts or equal.
2. For pipes less than 12-inch flexible couplings shall be Romtec Style 501 coupling with fusion bonded epoxy coating and lining and 316 SST bolts and nuts or equal. Provide restraint at flexible couplings in pressure pipes.

PART 3 - EXECUTION

3.01 Installation

A. Installation shall conform to the requirements of pipe manufacturer's standard printed installation instructions and to the supplementary requirements or modifications specified in this section. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.02 Testing

A. Field testing of pipe shall conform to the requirements of Section 15055.

****END OF SECTION****

SECTION 15064
PVC PIPE

PART 1 - GENERAL

1.01 Summary

A. This section specifies polyvinylchloride (PVC) pipe for pressurized and non-pressurized systems.

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1. Blue: potable water
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A. <u>PVC Schedule 80</u>

1. Flat faced flanges shall be used for transitions between PVC pipe and pipe of different material.
2. Flange bolts shall be type 316 stainless steel per ASTM F593 and F594.

B. <u>PVC SDR 26</u>:

1. Pipe and fittings shall meet the requirements of:
   a. ASTM D 3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
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PART 3 - EXECUTION

3.01 Installation

A. Installation shall conform to the requirements of pipe manufacturer's standard printed installation instructions and to the supplementary requirements or modifications specified in this section. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.02 Testing

A. Field testing of pipe shall conform to the requirements of Section 15055.

****END OF SECTION****

SECTION 15100
VALVES AND MISCELLANEOUS COMPONENTS

PART 1 - GENERAL

1.01 Summary

A. This Section includes valves and miscellaneous items to be installed in pipelines as follows:

1. Gate Valves (GV)
2. Swing Check Valves
3. Combination Electronic Control and High Level Shut-Off Valve
4. Mechanical Pipe Couplings

1.02 Related Sections

A. The City of Sunnyvale SSPWC and Standard Details apply to the work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this work.

Section	Title
Section 15060	Piping Systems

1.03 Submittals

A. Product Data, Shop Drawings, Samples: The following information shall be submitted in accordance with the requirements of the Supplemental General Provisions:

1. Gate Valves: Annotated Product Bulletins
2. Swing Check Valves: Annotated Product Bulletins
3. Combination Electronic Control and High Level Shut-Off Valve: Annotated Product Bulletins
4. Mechanical Pipe Couplings: Annotated Product Bulletins

B. Operation and Maintenance Data: Installation, operating, and maintenance data shall be in accordance with the Supplemental General Provisions.

1.04 Delivery, Storage, and Handling

A. All valves and miscellaneous items shall be packed, shipped, stored and handled in accordance with Section 01620.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.05 Project/Site Conditions

A. All items will be located in an exterior area. Temperature is expected to vary from 20 to 115 degrees F. Relative humidity is expected to vary from 20 to 100 percent.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Gate Valves: Mueller A-2361 series with EPDM disc and 316 stainless steel bolts per City of Sunnyvale SSPWC and Standard Details.

B. Combination Electronic Control and High Level Shut-Off Valve: Cla-Val Model 131-06/631-06 or approved equal that has been approved by City in writing.

2.02 Gate Valves

A. Refer to City of Sunnyvale SSPWC Sections 207 and 208 and Standard Details

B. Isolation valves shall be installed in compliance with AWWA Section 64577 and 64578 and requirements of AWWA C-509, manually operated.

2.03 Swing Check Valves

A. Swing check valves shall be lever and weight operated with adjustable position weight and lever arm attached to disk assembly for variable closure force. The valves shall have flange ends and be constructed of heavy cast iron body with a bronze seat ring. The body, cover and disk shall be cast iron, ASTM 126 Grade B.

2.04 Valve Operators

A. All valves, except check valves, shall be provided with manual operators unless otherwise specified. The direction of rotation of the handwheel or lever to open the valve shall be counterclockwise. Each valve body shall have cast thereon the word OPEN and an arrow indicating the direction to open.

2.05 Combination Electronic Control and High Level Shut-Off Valve

A. Combination electronic control and high level shut-off valves shall be hydraulically operated, pilot controlled, diaphragm valves. The solenoid pilot controls are actuated by electrical signals. The solenoid pilots either add or relieve line pressure from the cover chamber of the valve, causing it to open or close. The valve shall have flange ends and be constructed of ductile iron. The body and cover shall be ductile iron. The disc retainer & diaphragm washer shall be cast iron. The disc guide, seat, and cover bearing shall be bronze. The disc shall be Buna-N Rubber and the diaphragm shall be nylon reinforced Buna-N rubber. The stem, nut, and spring shall be stainless steel.

B. The solenoid valves shall be 24VDC with rubber parts of Buna-N rubber synthetic material. The solenoid control shall have a brass body, ASTM B283.

C. The combination electronic control and high level shut-off valve shall be equipped with an optional valve position transmitter, Cla-Val Model X117D or approved equal with City approval in writing. The valve position transmitter shall have a stainless

steel housing, steel brackets, brass adapter, stainless steel stem, and Buna-N synthetic rubber seals. The output signal shall be 4-20mA.

D. The combination electronic control and high level shut-off valve shall be equipped with an optional flow meter, Cla-Val Model X144 e-FlowMeter or approved equal with City approval in writing. The flow meter shall be stainless steel. The flow meter shall be 24VDC with an output signal of 4-20mA.

2.06 Mechanical Pipe Couplings

A. Sleeve-Type Couplings: Unless otherwise indicated, flexible type mechanical pipe couplings not intended to take tension shall be Rockwell Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Couplings for connecting steel pipe to ductile iron pipe shall be Rockwell Type 413, Dresser Style 62, or equal. Flanged coupling adapters shall be Rockwell Type 913, Dresser Style 128, or equal. Gaskets shall be EPDM synthetic rubber suitable for exposure to potable water.

PART 3 - EXECUTION

3.01 Installation

A. General: Valves shall be installed in accordance with the manufacturer's instructions. Valves shall be independently supported to prevent stresses on pipe.

B. Access: Valves shall be installed to provide easy access for operation, removal, and maintenance and to prevent interferences between the valve operators and structural members or other obstructions.

3.02 Coating

A. Coatings shall be as specified in the City of Sunnyvale SSPWC and standard details. Finish color shall be specified by the City Inspector.

**** END OF SECTION ****

SECTION 15200
DOMESTIC WATER WELL

A. SCOPE OF WORK

The work to be done hereunder includes the furnishing of all materials, transportation, tools, supplies, plant, equipment, and appurtenances necessary for the complete and satisfactory construction and development of a domestic water supply well in accordance with these Specifications and all Federal, State, and Local well construction standards.

1. Qualifications
   The Contractor shall be of established good reputation, regularly engaged in such works and licensed in accordance with the provisions of the Contractors License Law Chapter 9, Division 3, of the Business and Professions Code.

2. Permits, Laws, Ordinances and Insurance
   The Contractor shall, at his own expense, procure the well permit, and all certificates and licenses required of him by law for the execution of his work. He shall comply with all federal, state and local laws, ordinances or rules and regulations relating to the performance of the work, including the State General Permit for Storm Water Compliance During Construction. The Contractor must conform to State Prevailing Wage requirements and submit certified payroll to the State of California's Compliance Monitoring Unit using the eCPM system, at least monthly. Insurance and bonding requirements are outlined in the RFP document and General Conditions.

3. Location
   The well site is as shown on the plans included with these Specifications. This location will be staked in the field. Prior to drilling the well, this location shall be confirmed in the field by the Engineer and the Owner. The Owner shall arrange for access to the well site, and make suitable provisions for ingress and egress. The Contractor shall not enter on or occupy with crew, tools, equipment or material, any ground outside the property designated by the Owner without the written consent of the Owner of such ground.

4. Boundaries of Work
   The Contractor shall protect all structures, such as walks, pipelines, trees, shrubbery, and lawns during the progress of his work; shall remove from the site all cuttings, drillings, debris, and unused materials.

5. Water and Power
   The Contractor shall make all necessary arrangements for water and power for construction purposes. It is expected that the Owner will make water available to the Contractor for well construction purposes. There shall be no separate payment made to the Contractor for this item.

6. Completion Time
   Work on the Well shall be coordinated with the Owner to minimize or eliminate any interference with the existing operations of the site. Work on the Domestic Water Well shall start within ten (10) calendar days of receipt of the "Notice to Proceed" and all work under this Section shall be completed within sixty (60) calendar days of the date of such notice to proceed.

B. WELL REQUIREMENTS

The Contractor shall furnish all equipment and materials to install the new well pump and sanitize the well and pump. All work shall conform to the latest standards of the California Department of Water Resources Bulletins No. 74-81 and No. 74-90 "Water Well Standards, State of California". Well sealing, casing, developing, and disinfection shall be strictly in conformance with the recommendations of DWR Bulletin No. 74-90.

Following completion of his work, the Contractor shall remove from the premises all excess materials, tools, and equipment used in the execution of his work, and shall dispose of all debris resulting from his work.

Following completion of his work, the Contractor shall remove from the premises all excess materials, tools, and equipment used in the execution of his work, and shall dispose of all debris resulting from his work. The Contractor shall fill all sumps and/or excavations made by him and restore the surface of the site near the well to the satisfaction of the Engineer, and with the inspection and approval of the Owner.

C. TEST WELL CONSTRUCTION

a. Test Hole. A test hole shall be drilled at the site indicated on the Permit and staked in the field by the Engineer. It shall be at least eight (8) inches in diameter. It shall be drilled to the depth as shown indicated on the plans, utilizing an inorganic mud as a drilling fluid. Total containment and off-haul of all drilling spoils / mud shall be provided.

b. Driller's Log. An accurate driller's log of the materials penetrated shall be recorded by the driller who must be experienced at this work and have the skills to determine the depths and thickness of the various underlying strata encountered.

c. Core Samples. Formation samples from the test hole shall be collected and handled in a manner selected by the Contractor and approved by the Engineer. Core samples shall be collected at least every ten (10) feet, and whenever a different strata is encountered. Core sample tests shall provide sufficient particle size distribution data for determining well screen slot size. The location and number of particle size distribution tests shall be proposed by the Contractor and approved by the Engineer.

d. Electric Well Log. The Contractor shall coordinate the performance of an electric log of the open test hole. The electric log shall accurately log the complete depth of the test hole and shall have a spontaneous electrical potential curve and shall have a normal and a lateral resistivity curve. The electric log shall provide sufficient formation data for determining the water bearing and non-water bearing formation and similar data necessary for evaluating the proper completed depth of the well and the location of the well screen.

e. Well Log. The Contractor shall furnish the Engineer with an accurate and complete well log when the test hole is completed. Recommendations shall include locations for perforations, any special sealing considerations, and value of cathodic protection.

f. Abandoning/Destroying the Test Hole. The test hole shall be properly abandoned per County requirements and State Water Well standards. The volume of slurry added shall be measured, and the Local Governing Agency and Engineer must be notified to witness the well abandonment.

D. WELL CONSTRUCTION

a. Production Hole. The Well shall be drilled at the site indicated on the Permit and staked in the field by the Engineer. It shall be drilled to the minimum diameter and depth as indicated on the plans utilizing an inorganic mud as a drilling fluid. Total containment and off-haul of all drilling spoils / mud shall be provided.

b. Test Pumping. The location of the test pump reservoir and/or discharge shall be selected by the Contractor and approved by the Engineer.

c. Driller's Log. An accurate driller's log of the materials penetrated shall be recorded by the driller who must be experienced at this work and have the skills to determine the depths and thickness of the various underlying strata encountered.

d. Core Samples. Formation samples from the well hole shall be collected and handled in a manner selected by the Contractor and approved by the Engineer. Core samples shall be collected at depths recommended by the Contractor and approved by the Engineer as indicated from the Test Hole Construction and Electric Log Test. A contract shall include the collection and analysis of 10 core samples. Core sample tests shall provide sufficient particle size distribution data for determining well screen slot size.

e. Well Log. The Contractor shall furnish the Engineer with an accurate and complete well log when the well is completed.

f. Drilling to Accommodate Casing. The hole shall be drilled sufficiently straight so as to be used for the production well. The hole shall be constructed to the diameter and depth as indicated on the plans and as specified by the Engineer.

g. Pump Slab. A pump slab shall be provided as shown on the Plans. The pump slab shall be a minimum 30-inches square and meet the requirements of Bulletin 74-90, Section 1 0(A)(5). The pump slab shall be free of cracks, voids, or other significant defects likely to detract from its water tightness.

2. Annular Seal Cement Grout

Cement grout shall be placed in the 4 inch minimum annular space between the hole and the casing. The annular seal shall extend to the greatest depth as indicated on the plans, or required by the Owner, or a minimum depth of 50 feet or as called out on plans which ever is greater, and shall be landed at least 10 feet into a clay layer.

a. Grout Mixture. The cement grout shall consist of not more than two parts by weight of sand and one part of cement to five to seven gallons of clean water (per bag of cement). Quick setting cement, retardants to setting, or other additives, including hydrated lime to make the mix more fluid (up to 10 percent of the volume of cement) and bentonite (up to 5 percent to make the mix more fluid and to reduce shrinkage), may be used with the approval of the Engineer.

b. Method of Pouring. The grouting material shall be applied in one continuous operation from the bottom of the annular seal to the top by the use of a tremie pipe. The annular seal shall be a minimum of 4 inches in radial thickness. Freefall of sealant material and restricting groundwater flow during the placement of the sealant shall be prevented. The contractor shall provide verification that the volume of sealing material placed in the well during construction at least equals the volume to be sealed. No work shall be done until at least 48 hours have elapsed after the grouting operation.

3. Furnishing and Installing Well Screen and Casing

Casing and screening material shall conform to DWR Bulletin 74-90. A steel casing with 0.375 wall thickness and diameter as shown on the plans shall be installed using centering lugs to such depth as to be determined by the Engineer. The casing shall be resistant to corrosion and not have more than one longitudinal seam parallel to the axis. Casing material shall be selected by the Contractor and approved by the Engineer. The casing shall be applied in minimum lengths of 20 feet. All materials are to be new.

a. Machined Ends. All buff ends of the casing are to be machined to insure that the butt surface is at a true right angle with the longitudinal axis.

b. Method of Joining. All joints shall be made with 1/4" x 4" collar, the collar being attached to the section of the casing 2 inches on and 2 inches off each joint so that each succeeding joint of casing will slip into the collar and buff on the lower joint. All joints are to be continuously welded in accordance with the standards of the American Welding Society.

c. Spacer Lugs. An adequate number of spacing lugs are to be welded to the outer casing to insure that it is truly concentric with the hole, approximately every 30 feet. The casing is to be set plumb and to extend to a depth as required.

d. Well Screen. The well screen shall be of the continuous slot, wire-wound type; and shall conform to the diameter of the inner casing to which it is to be joined. The continuous slot, wire-wound type material shall be 304 Stainless Steel which includes both screen and fittings. The well screen aperture openings shall be determined to have sufficient open area to transmit the design flow, as indicated on the plans, at an aperture entrance velocity not to exceed 0.1 feet per second. The continuous slot, wire-wound type well screen is to be of flat wire construction conforming to that manufactured by U.O.P. Johnson Division of Universal Oil Products, Cook Well Stainer Co., or equal. The maximum screen slot size shall be 0.05 inches.

e. Joining Screen to Casing. Intermediate screen sections shall be joined by welding. Welding rod shall be of material suitable for joining corrosion resistant material. Well screens shall be furnished with collars for welding of at least 1/4-inch thickness. All welding shall be in conformance with the practices of the American Welding Society.

f. Bottom of Casing. The bottom of the casing shall be blanked off with a 5/16-inch welded steel plate.

g. Plumbness and Alignment. All casings and screens shall be truly round in shape, mounted concentrically and installed in the bore hole. Plumbness and alignment must be such that the intended pumping equipment can be lowered into the well to the full depth of the 16-inch diameter casing and removed without binding in any way. Non-alignment shall be corrected by the Contractor at his own expense.

h. Top of Casing. The top of the casing shall extend 24 inches above grade. Until the downhole items are ready for installation, the top of the casing shall be sealed with a 1/4-inch steel cover. The steel cover shall be tack-welded to the top of the casing.

i. Sounding Tube. A 3-inch diameter schedule 40 steel sounding tube with a watertight screw cap shall be provided. The sounding tube shall extend at least 3-inches above the pump slab. The sounding tube shall be sufficiently separated from the casing to allow the placement of a deep well turbine motor and pump head or a line shaft water lubed turbine pump, which ever is specified in the plans. A three-inch screened and inverted casing vent shall be provided on a fitting from the sounding tube, as shown on the plans.

4. Furnish and Install Gravel Pack
The gravel selected to fill the annular space between the well casing and the bore hole shall be clean water worn selected washed gravel. Grading of the gravel pack shall be determined from the sieve analysis of the test hole aquifer materials. The 70 percent retained size of the gravelpack is between four and nine times the 70 percent retained size of the finest member of the aquifer. The uniformity coefficient of the gravel pack shall not exceed 25. A sample of the gravel to be used shall be submitted with the sieve analysis to the Engineer for approval before any gravel is delivered to the well site.

a. Disinfection of Gravel. Prior to placing the gravel, a granular hypochlorite, or similar disinfectant shall be added to the gravel at the rate of one pound per cubic yard to the gravel based on 70 percent chlorine content. The method of adding the disinfectant shall suit field conditions and the method of the graveling used by the Contractor.

b. Placement of Gravel. The gravel shall be placed from the bottom of the casing to the bottom of the sanitary seal. Placement shall be made with suitable precautions to avoid the possibility of the gravel bridging or clogging at any point.

c. Gravel Feed Pipe. A 3 -inch diameter schedule 40 galvanized steel gravel feed pipe shall be installed to fill the annular space between the bore hole and the casing, as shown on the plans. The gravel feed pipe shall be capped with a threaded watertight cap and extend a minimum of three inches above the pump slab, sufficiently separated from the casing to allow the placement of a deep well submersible turbine motor and pump head or the line shaft water lubed turbine pump, which ever is specified.

5. Cleaning of the Well
After the well has been completely constructed, it shall be thoroughly swabbed, using alkalines, if necessary, to remove oil and grease. The well shall be bailed free of any heavy drilling mud and all sand deposits before the developing pump is installed.

6. Furnishing, Installing, and Removing of Test Pump
The Contractor shall supply and install a suitable test pump unit consisting of a deep well engine driven pump capable of pumping 33% to 133% of the design flow rate. The bowl setting shall be at least the anticipated pumping water level as indicated on the plans. Said equipment must be in good repair and capable of performing the pumping as required. For Discharge Rate Measurement, an orifice meter and control valve shall be installed on the pump discharge to determine discharge rate.

E. TESTING AND DEVELOPING THE WELL

The purpose of this operation is to cleanse the well of all driller's mud, chemicals, cuttings, sand and silt; and to produce at least the design flow of water free of discoloration and sediment, suitable for use in a domestic water supply system, and meeting the requirements of the U.S. Public Health Service Drinking Water Standards and of the State of California, California Administrative Code, Title 22, Division 4, Chapter 15.

1. Development Method and Minimum Sand Requirement
The Contractor shall surge the well frequently and operate the pump until it appears that there is no discoloration, sand, or sediment produced. This operation will continue until the Engineer is satisfied that the well is adequately developed. As a basis of final acceptance after the above conditions have been met, the well must not produce more than five parts per million of sand or sediment at a discharge of at least the design flow within 15 minutes after starting the pump. If this condition is not met within 24 hours of test pumping, the well shall be deemed not to have met specifications.

If the above conditions have been met, test pumping at a rate at least equal to the design flow shall be conducted for a period of twenty-four hours. During this twenty-four hour period water level measurements shall be made at the beginning of the test, every ten minutes for two hours, then every half hour for the remainder of the test period. After the twenty-four hour pump test, recovery water levels shall be made every ten minutes for two hours or until the well recovers to the original static water level. A graph of the water level measurements versus time shall be made for the entire 24 hour test pumping and recovery period.

2. Water Quality Testing

After the pump test a water sample shall be collected and analyzed. The water quality analysis shall include all constituents in the Water Quality Monitoring Regulations under the current State Permit; including General Mineral, General Physical, onorganic Chemical, Organic Chemical, and Radioactivity analyses, according to the State of California. California Administrative Code, Title 22, Division 4, Chapter 15, Articles 3 and 4. All water quality testing must be performed by a state accredited laboratory.

F. PERMANENT WELL PUMP AND DOWNHOLE ITEMS

1. Pump and Motor

The well pump shall be as described in the “Submersible Well Pump” section of these Specifications.

2. Pump Controls

Low level shut-off and re-start probes shall be supplied in the well to protect the pump. The level to set the probes will be determined by the Engineer, after review of the pump test data and selection of a pumping unit.

The turbine pump shall be controlled as described in the “Control Strategies” section of these Specifications.

3. Pump Testing

The pump shall be fully tested on water at the manufacturer's plant prior to shipment. If the pump manufacturer supplies the driving motor, pump and motor shall be assembled and tested as a unit. Testing shall consist of checking the unit at its rated speed, head capacity, efficiency and brake horsepower throughout the specified range of smooth operation; and at such other conditions of head and capacity to establish the performance curve.

A certified copy of the test curve shall be submitted to the Engineer. The Standards of the Hydraulic Institute shall govern the procedure and calculations for the testing.

G. WELL DISCHARGE PIPING

The well discharge piping shall be flanged ductile iron pipe and shall conform to Ductile Iron Pipe Specifications AWWA C151 and have a minimum pressure rating of 250 psi. The discharge piping shall be of equal diameter to the pump column and consist of a flex coupling, a screened and inverted air release vacuum breaker vent, a 3/8 inch copper sample tap with petcock, an tee with gate valve for pump to waste, an swing check valve, an isolation gate valve, and a chlorine injection tap. All pipe

fittings shall be manufactured in accordance with applicable AWWA standards for pipe type and application.

The well discharge piping shall be tested as described in the "Water Line, Valves" section of these Specifications.

H. DISINFECTING AND CAPPING THE WELL

The well shall be disinfected according to the requirements of California Administrative Code, Title 22, Division 4 and the California Well Standards, Bulletin 74-81, Appendix C, "Suggested Procedures for Disinfecting Wells". The disinfection shall be done after the placement of the permanent well pump. After disinfection, the Contractor shall take a bacteriological test sample, and have it analyzed by a State Certified Laboratory, according to Title 22. The test results must be acceptable before putting the well on line.

The top of the well shall be kept securely capped both day and night, in such a manner as to effectively prevent either tampering with the well or entrance of foreign matter.

A pipe or other effective means through which chlorine or other disinfecting agents may be introduced directly into the well shall be provided. The sounding tube may be used for this purpose. If an additional pipe is provided, it shall be installed at a height at least equal to the pump slab, shall be kept sealed, and shall be provided with a waterproof threaded cap or equivalently secure cap. An air relief vent shall be installed, as shown on the plans, and it shall terminate downward and be screened with 16 mesh screen to prevent contaminating material from entering the vent.

I. RECORDS

The Contractor shall furnish the Engineer copies of the driller's log, electric logs, test pumping data, and water quality data.

SECTION 16010
GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.01 Summary

A. This division includes the provisions for all material, labor, tools, equipment, testing and services necessary to provide a complete and operable electrical system.

B. The provisions of this Section shall apply to all electrical items specified in the various sections of Division 16, Division 17 and all other Divisions specifying electrical items of these Specifications, except where otherwise specified or shown on the Contract Documents.

C. Furnish all necessary labor, materials, equipment and incidentals required to install a complete and operational electrical system according to the intent of this specification and the accompanying drawings, whether itemized or not.

D. Examine the specification and drawings for mechanical equipment and provide all starters, circuit breakers, switches, pushbuttons and appurtenances, which are not specified to be with the mechanical equipment. Erect all electrical equipment not definitely stated to be erected by others, furnish and install conduit, wire and cable and make connections required to place all equipment in complete operation.

E. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the Contractor's convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction; ensure that adequate protection from these atmospheres is provided that is acceptable to the Owner’s Representative. Cap conduit runs during construction. Energize all space heaters furnished with equipment.

F. Interpretation of Drawings:

1. Any error or omissions of detail in either the drawings or the specifications shall not relieve the Contractor from correctly installing all materials necessary for complete and operating electrical system.

2. The Contractor shall inspect the site and verify all measurements and conditions and shall be responsible for the correctness of same. No extra compensation will be allowed because of differences between work shown on the drawings and measurements at the site.

3. The electrical drawings are diagrammatic, but shall be followed as closely as existing conditions and work of other contractors will permit. All deviations from the drawings required to make the work conform to structures as constructed, and to the work of others, shall be made at the Contractor's expense.

4. The Contractor shall examine the architectural, structural, mechanical and manufacturer's drawings for the various equipment in order to determine exact routing and final terminations for all conduits and cables. Conduits shall be stubbed up as near as possible to equipment enclosure.

5. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in location of outlets or equipment, prior to roughing in, without incurring any additional costs or charges.

6. Existing Conditions:

a. The electrical drawings were developed from past record drawings and information supplied by the Owner.

b. Carry out any work involving the shutdown of existing services to any piece of equipment now functioning or the tie-in of equipment to the existing system at such time as to provide the least amount of inconvenience to the Owner. Do such work when directed by the Engineer or the Inspector.

c. After award of Contract, confer with Engineer/Inspector to verify at each area of construction activity the location of existing underground utilities. Protect all existing underground utilities during construction.

d. NO work shall be started that involves the existing electrical system without first obtaining and completing all coordination forms required by the facility. All such coordination forms shall be submitted with drawings and procedures showing information about what, where, why and how the work will be done in accordance with the GENERAL REQUIREMENTS.

e. Prior to staring any underground work the Contractor shall obtain all the information of the underground utilities or obstructions from the Engineer and take proper precautions to locate the utilities by potholing or other approved means in accordance with **PROTECTION OF PERSONS AND PROPERTY AND RESTORATION OF EXISTING IMPROVEMENTS** of the GENERAL CONDITIONS, and **POTHOLING** of the GENERAL REQUIREMENTS.

G. Substitutions

1. The contract documents were developed using the first named manufacturer to determine physical space requirements, conduit and wiring requirements, capacities/ratings and implementation of the contract electrical and instrumentation control strategies. When indicated in the contract documents, the contractor may elect to use one of the other named manufacturers, or where allowed, provide equivalent previously unnamed manufacturers. Any deviations from the contract documents that result from using a manufacturer other that the first named manufacturer are the responsibility of the contractor.

2. Specific brand names and catalog numbers are used to describe materials in order to establish standards of performance and quality.

3. The decision of the Owner's Representative shall govern as to what is equal to the item specified. Equality will be judged on the basis of the following:

   a. Conformance with description or performance required.

   b. Equal in quality.

   c. Comparable in appearance and artistic effect where these are considerations.

   d. Comparable operation, maintenance and performance.

   e. Equal in longevity and service under conditions of climate and usage.

   f. Conformance with space allocations and requirements for operations from mechanical or electrical services provided without necessitating changes in details and construction or related work.

4. If the Owner's Representative considers it necessary, tests to determine the quality of the proposed materials shall be made, at the expense of the Contractor, by an unbiased laboratory, satisfactory to the Owner's Representative.

5. Any material, article, or method judged by the Owner's Representative equal to that specified will be approved, provided the Contractor submits a single written request, in triplicate, to the Owner's Representative, within 45 days after contract award, with the following information for each item:

a. Name of manufacturer or supplier.

b. Trade or brand name.

c. Type, model, style, and/or catalog number.

d. Size or capacity rating.

6. The Contractor assumes full responsibility for including complete, correct data in this one request and shall also attach completely referenced diagrams descriptive and technical data sheets for the Owner's Representative's determination of equality or suitability of appearance of any substitution item. Only one such request may be submitted. The Owner's Representative's rejection of any substitute shall automatically require the Contractor to furnish the specified item without further discussion or delay.

H. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	**Title**
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16130	Wiring Devices
Section 16140	Disconnects and Fused Switches
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment

Section 16310	Panelboards
Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 16325	Dry-Type Transformers
Section 16330	Variable Frequency Drives
Section 16400	Electric Service
Section 16450	Grounding
Section 16500	Lighting Fixtures and Accessories
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Secton 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System
Section 17924	Control Strategies

1.02 REFERENCES

A. Electrical work, including connection to electrical equipment integral with mechanical equipment described elsewhere in these specifications, shall be performed in accordance with the latest published regulations of the following codes and standards:

Reference	Title
	Federal Standards
	State Codes and Ordinances and Inspecting Authorities
	Local Codes and Ordinances and Inspecting Authorities
	The National Board of Fire Underwriters
NFPA	National Fire Protection Association
UL	Underwriters Laboratories
NEMA	National Electrical Manufacturers' Association
ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
OSHA	State Department of Industrial Safety
	State Public Utilities Commission
NEC	National Electrical Code (NEC) for all items not specifically covered the state and local ordinance.

Reference	Title
NFPA 79	Electrical Standard for Industrial Machinery

B. Nothing in these special provisions or on the drawings shall be interpreted as permission or direction to violate any governing code or ordinance.

C. Materials and equipment used in the performance of the electrical construction shall be fully UL approved for the class of service for which they are intended prior to submittal of shop drawings.

D. Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the applicable requirements of the National Electric Code (NEC); provided, that where a local code or ordinance is in conflict with the NEC, the provisions of said local code ordinance shall take precedence.

E. The construction and installation of all electrical equipment and materials shall comply with all applicable provisions of the Cal OSHA Safety orders (Title 8, CCR), State Building Standards, and applicable local codes and regulations

F. Related Sections

Section	Title
Section 11000	General Requirements for Equipment
Section 11004	Equipment Control Devices

1.03 System Description

A. The general extent of the electrical work includes, among others, the furnishing and installing of the following items:

1. Complete circuiting and connections for all motors, including their remote control and indicating devices.
2. Complete general lighting and small power installation, fixtures, receptacle outlets, switching and circuits.
3. All supports, bases, anchors, sleeves, hangers, conduit seals, and the like, all electrical work shown and/or specified, not particularly mentioned above.
4. Complete grounding systems.
5. Instruction, maintenance and overhaul manuals.
6. Control and alarm wiring.
7. Coordination for connection of power and telephone with utility companies.
8. Utility Company Metering.
9. Utility Services including all charges.
10. New Electrical Service Equipment.
11. Replace and abandon in place the existing electrical service equipment.
12. New Main Switchboard to replace the existing utility metering section, main breaker and automatic transfer switch sections of existing motor control center MCC P1.

13. Abandon in Place the existing utility metering section, main breaker and automatic transfer switch sections of the existing motor control center MCC P1.
14. New Motor Control Center
15. Modifications to the existing Motor Control Centers
16. Surge Protective Devices
17. New Panelboards
18. Modifications to the existing Panelboards
19. Transformers – Dry Type
20. Modifications to the existing Standby Generator Systems
21. Load Banks
22. New Automatic Transfer Switch
23. Replacement and demolition of the existing Automatic Transfer Switch.
24. New Control Panels
25. Modifications to the existing Control Panel.
26. Installation of vendor supplied panels.
27. Installation of conduit and conductors between vendor supplied field equipment and vendor supplied panels including termination of conductors within the vendor-supplied panels based on vendor-supplied documentation.
28. Conduit, wire, cable terminations, and equipment mounting associated with the Instrumentation System.
29. Interconnection wiring diagrams.
30. SCADA system hardware, software and programming.
31. Programmable controller and programming.
32. Conduit, wire, cable, terminations and equipment mounting associated with the telemetry and programming.
33. Power, control, alarm and instrumentation wiring for all equipment specified in specification Divisions 11, 15, 16, and 17.
34. Electrical connections to all Mechanical equipment and instruments.

B. Manufacturer’s Directions: Manufacturer's directions shall be followed in all cases where manufacturers furnish instructions covering points not shown on the drawings or herein specified.

C. Service for Electrical Power

1. Coordinate relocation of the existing incoming electrical service, 480 volt, three phase, three wire from the existing Main Switchboard to the new Main Switchboard as shown on drawings with the Owner and electrical utility company providing service. Refer to Section 16400.

1.04 Submittals

A. General: Submittals for all electrical equipment provided under this project manual shall be prepared and submitted within 60 days after notice to proceed.

B. Materials and Equipment Schedules: The Contractor shall deliver to the Engineer a complete list of all materials, equipment, apparatus, and fixtures which it proposes to use. The list shall include

sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

C. The submittal package for each individual equipment or groups of related equipment shall be complete and in accordance with this Section. As a condition precedent to the review of submittals and with the requirements of Section 01300, the Contractor shall furnish the manufacturer's statements accepting unit responsibility. The purpose of this provision is to ensure compatibility of all components specified under the specific technical specification and to provide sole source responsibility for system performance and maintenance. Not withstanding these provisions, however, the Contractor is not relieved of his responsibility for the indicated portions of the work. The following, as a minimum, shall be submitted:

1. Manufacturer and manufacturer's type and designation.
2. Manufacturer's catalog data indicating rated capacity, efficiency, rated output and other characteristics.
3. Any exception to these specifications along with justification for each exception shall be clearly stated on the first page of the submittal.
4. Shop drawings.
5. Parts list with material of construction.
6. Installation requirements, showing various clearances required.
7. Details of all appurtenances to be furnished with the specified item.

D. Shop drawings are required for materials and equipment listed in this and other sections. Shop drawings shall provide sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications. The following shall be included:

1. Front, side, and rear elevations, footprints and top views, with dimensions.
2. Location and size of conduit entrances and access plates.
3. Component data.
4. Connection diagrams, terminal diagrams, schematic wiring diagrams, conductor size, and type, etc.
5. Method of anchoring and embedded structural members; weight.
6. Finish.
7. Nameplates.
8. Temperature limitations, as applicable.
9. Rating of equipment as per specifications and drawings.
10. NEMA rating of enclosures.
11. Approved listing.

E. Catalog data shall be submitted to supplement all shop drawings. Catalog cuts, bulletins, brochures, or the like or photocopies of applicable pages thereof shall be submitted for mass produced, non-custom manufactured material. These catalog data sheets shall be stamped to indicate the project name, applicable Specification section and paragraph, model number, and options. This information shall be marked in spaces designated for such data in the stamp.

F. Record Drawings: In addition to the Record Drawings as a part of the record drawing requirements specified in the GENERAL REQUIREMENTS, the Contractor shall show depths and

routing of all concealed below-grade electrical installations. Said set of record drawings shall be available to the Engineer and the Inspector during construction. After final inspection, the Contractor shall transfer all record drawing information to a set of reproducible vellums which shall then be delivered to the Engineer. In addition, the Record Drawings shall show all variations between the work as actually constructed and as originally shown on the Drawings, based upon information supplied by the Contractor.

G. Manufacturer's Drawings: One set of equipment manufacturer's drawings shall be submitted to the Engineer for its records.

H. The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment according to the provisions of SPARE PARTS of the GENERAL REQUIREMENTS. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the Owner, only. Any spare parts which the Engineer permits the Contractor to use for startup activities shall be replaced by the Contractor prior to the Owner's acceptance of beneficial use of the equipment.

1. During the term of this Contract the Contractor shall notify the Engineer in writing about any manufacturer's modification of the approved spare parts, such as part number, interchangeability, model change or others. If the Engineer determines that the modified parts are no longer applicable to the supplied equipment, the Contractor at its expense shall provide applicable spare parts

1.05 Quality Assurance

A. Performance and Design Requirements

1. Manufacturer’s Qualifications: The equipment furnished under this division shall be the product of firms regularly engaged in the design and manufacture of the type of item specified, possessing the required technical competence, skill, resources and ability to complete the work specified herein with the requisite degree of quality in a timely and efficient manner. The Contractor shall be prepared to adequately document the qualifications of the manufacturers nominated to provide the equipment specified under this division. All documentation shall be submitted to the Owner’s Representative prior to design fabrication and shipment of any component specified herein. Nothing contained within these provisions shall be construed as relieving the Contractor of his responsibility for any portion of the work covered by this Section.

2. Arrangement: The drawings are generally diagrammatic and the location of outlets and equipment terminals are approximate unless detailed or dimensioned. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences and the location of electrical terminations on equipment.

3. The Contractor shall examine the structural and mechanical plans and shop drawings for the various equipment to determine exact routing and final terminations for all raceways and cables. Conduits shall be stubbed up as near as possible to equipment terminals and shall be within the concrete base for the equipment or a separate concrete curb.

4. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms, as shown. Where the Drawings do not indicate exact locations, the Contractor shall submit proposed locations to the Engineer for review. Where equipment is installed without instruction and must be moved, it shall be moved without additional cost to the Owner.

5. All work, including installation, connection, calibration, testing, and adjustment, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.
6. Allowance has been made in the design for the number of raceways, cables and conductors considered adequate for feeding the various drives and equipment. These circuits and diagrams are based on available data pertaining to the particular design of equipment and portray the systems, which the owner has chosen to effect the required operation and level of control. Equipment provided by the Contractor (even though of the make and model specified) may differ in detail, arrangement, or connections from that shown. If the Contractor uses equipment which differs from the equipment shown in major aspects and requires modifications to power, control or other electrical service, the Owner's acceptance of the equipment will be based upon the Contractor providing the modifications required, and they shall be of the same quality as shown and shall be provided at no additional cost to the Owner.
7. Protection of Equipment and Materials: The Contractor shall provide adequate means for and shall fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the work and until acceptable by the Engineer and the Inspector.
8. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.
9. The Contractor shall replace or have refinished by the manufacturer, all damaged materials or equipment, including face plates of panels and switchboard sections, at no expense to the Owner.
10. Tests: The Contractor shall make all tests required by the Engineer or the Inspector or other authorities having jurisdictions as per applicable standards.. All such tests shall be performed in the presence of the Engineer or the Inspector. The Contractor shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation. Operational testing shall be performed on all equipment furnished and/or connected in other Sections of Division 11, 16 and 17. Electrical and all other divisions specifying electrical items including furnishing of support labor for testing.
11. Standard test reports for mass-produced equipment shall be submitted along with the shop drawing for such equipment. Test reports on testing specifically required for individual pieces of equipment shall be submitted to the Engineer and the Inspector for review prior to final acceptance of the project.
12. Any test failure shall be corrected in a manner satisfactory to the Engineer and Inspector.
13. The Contractor shall furnish without extra charge any additional material and labor which may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications or shown on the drawings.
14. The Contractor shall apply and pay for all permits required by any of the legally constituted public authorities for the installation or construction of the work included under this Division including public utility charges for permits and connection fees. The Contractor shall arrange and pay for any inspections or examinations so required and deliver certificates of all such inspections to the Owner’s Representative. When these specifications call for materials or construction of a better quality or larger sizes than required by the above mentioned rules and regulations, the provisions of the specifications shall take precedence.

B. Operating Requirements:

1. Permits: The Contractor shall pay for permits, inspections and other costs incidental to providing electrical installations.
2. Contractor's Record Drawings: The Contractor shall maintain a neatly marked set of record drawings showing the installed location and routing of conduits, trays, cables, junction boxes, pull boxes, outlets, and interconnection circuits, etc., and the current status of control circuits as reflected on the control diagrams to the satisfaction of the Owner's Representative.
3. Inspection: The Contractor shall cooperate with the Owner's Representative and shall provide assistance at all times for the inspection of the electrical work performed under this contract. The Contractor shall remove covers, operate machinery, or perform any reasonable work which, in the opinion of the Owner's Representative, is necessary to determine the quality and adequacy of the work.

C. Quality of Materials.

1. All electrical materials used on this project shall be new and free from defects.
2. All electrical materials used on this project shall conform where applicable, to the following standards, unless otherwise noted:
   a. NEMA - National Electrical Manufacturers Association.
   b. ANSI - American National Standards Institute.
   c. UL - Underwriters Laboratories, Inc.
3. Each type of material shall be of the same manufacturer and quality throughout the work.

1.06 Delivery, Storage, and Handling

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturer's recommendations for storage. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as transformers, conductors, motors, and controls. Energize all space heaters furnished with equipment. Provide temporary heating, sufficient to prevent condensation, in transformers, switchgear, switchboards, motors, and motor control centers which do not bare space heaters.

B. Shipment: The major equipment items listed in this provision and furnished under this contract shall be shipped in sealed, weather-tight, enclosed conveyances in a manner designed to protect the equipment against damaging stresses during transport.

C. Inspection

1. The Contractor shall cooperate with the Owner's Representative and shall provide assistance at all times for the inspection of the electrical work. Remove covers, operate machinery, or perform any reasonable work which, in the opinion of the Owner's Representative, will be necessary to determine the quality or adequacy of the work.
2. If any material does not conform to these specifications the Contractor shall, within three days after being notified by the Owner's Representative, remove the materials from the premises.
3. Work shall not be closed in or covered before inspection and approval by the Owner's Representative. Cost of uncovering and making repairs where un-inspected work has been closed in shall be borne by the Contractor.

D. Supervision and Workmanship

1. The Contractor shall employ a competent electrical foreman on the job throughout the entire period of construction to see that his work is carried on without delay and completed as rapidly as possible.

E. Cooperative Work with Others

1. The Contractor shall cooperate with others, with due regard to their work, towards promotion of rapid completion of project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provision in time by Contractor, then he shall bear expense of such changes as necessary to be made in work of others.
2. Labor and materials, including templates, sleeves, anchors, concrete inserts and the like shall be furnished in ample quantities at such times as necessary to ensure uninterrupted progress of work.
3. Contractor shall cease work at any particular point temporarily and transfer his operations to such points or execute such portions of work as directed, when in the judgment of the Owner's Representative it is necessary to do so.

F. Cleanup

1. In addition to the requirements of **ENVIRONMENTAL CONTROL** of the GENERAL REQUIREMENTS, in all parts of the materials and equipment shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. All oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out.
2. During the progress of the work, the Contractor shall clean the premises and shall leave the premises and all portions of the site free of debris

1.07 Project / Site Conditions

A. General: For purposes of delineating electrical enclosure and electrical installation requirements of this project, certain areas have been classified in the Contract Documents as defined below. Electrical installations within these areas shall conform to the referenced code requirements for the area involved.

B. Seismic Consideration

1. All structures shall be designed in accordance with the requirements for Seismic Zone 4 of UBC and/or SEAC.
2. Equipment shall be anchored per CBC 2007, ASCE 7 and ACI 318 App D. Unmanned buildings shall be considered Occupancy Category 3 unless noted otherwise. Calculations shall be stamped by a California registered Civil Engineer.
3. Before any concrete pours associated with electrical equipment anchoring can begin, seismic calculations and submittals shall be approved by the Engineer and the Owner's Representative.
4. Each piece of equipment installed shall be anchored as required in the UBC for Seismic Zone 4. No equipment shall be anchored to vertical structural elements without written approval of the Owner's Representative.
5. Vibration isolated equipment shall be provided with snubbers capable of retaining the equipment in its designated location without any material failure or deformation of the snubbers when exposed to a vertical or horizontal force at the contact surface equal to 100 percent of the operating weight of the equipment. Air gaps between retainer and equipment base shall not exceed 1/4 inch.

6. All raceways, ductwork, accessories, and appurtenances, furnished with equipment shall be anchored to resist a lateral seismic force of 40 percent of its operating weight without excessive deflection. This force shall be considered acting at the center of gravity of the piece under consideration.

7. Calculations and shop drawings shall be submitted for all anchorage details. All calculations shall be made and signed by a registered engineer. In as much as all anchorage of equipment is to be made of cast-in-place concrete elements, it is imperative that types of anchorage be coordinated with the concrete contractor so that anchorage may be installed at the time of concrete placement. If calculations and anchorage details are not submitted prior to placement of the concrete, the Contractor shall be responsible for any strengthening of concrete elements because of superimposed seismic loading.

C. Unclassified Field Locations

1. Field equipment located in interior areas which have not been classified as hazardous locations as defined by the National Electrical Code, Article 500, may be subjected to ambient temperatures varying from 10 degrees F and 115 degrees F and relative humidity ranging from 10 to 90 percent. Incidental quantities of hydrogen sulfide gas and dust also may be present.

2. In exterior areas, ambient temperatures may vary from 10 degrees F and 115 degrees F with strong direct radiation from the sun. Relative humidity in all exterior field areas will vary from 10 to 100 percent with condensation and icing occurring. All areas may have trace quantities of hydrogen sulfide gas with wind blown dust, sand, hail, and rain occurring.

3. In exterior locations, exposed conduits shall be PVC coated Rigid Steel entrances shall be threaded; and fittings shall have gasketed covers. Provisions shall be made to drain the fitting or conduit system. Threaded fastening hardware shall be stainless steel. Mounting brackets shall be stainless steel. Attachments or welded assemblies shall be galvanized after fabrication. Instruments and control cabinets, panels, switchboards and motor control centers shall be "Weatherproof NEMA Type 4X." Enclosures shall be mounted 1/4-inch from walls to provide an air space, unless specifically shown otherwise.

D. Damp Location: Locations which are indoors and 2 feet below grade elevation or which are classified as damp locations on the Drawings shall have electrical installations which conform to the requirements for outdoor locations; except, that the air space from walls may be less than 1/4-inch and enclosures shall be NEMA Type 2. "Damp locations" shall include pipe galleries, tunnels, and basements. All rooms housing liquid handling equipment are also classified as damp locations regardless of grade elevation.

E. Splash Locations: Areas shown as splash-proof shall have electrical installations as described for "outdoor locations"; except, that NEMA Type 4X enclosures shall be provided for instruments and controls, panels, switchboards, and motor control centers.

F. Classified Field Locations

1. Field equipment located in hazardous areas shall comply with the National Electrical Code, Article 500.

2. Hazardous Locations: Areas shown as hazardous shall have electrical installations suitable for Class 1, Division 1, Group C and D locations as required under Cal/OSHA Safety orders (Title 8, CCR). Enclosures shall be NEMA type 7.

3. For this project, hazardous areas of the wastewater treatment plant are as follows:

   a. Influent Pump Station

G. Corrosive Locations

1. Field equipment located in areas subject to ammonia, corrosive fumes, or liquid chemical spills shall utilize materials and equipment specifically for corrosive areas.
2. Corrosive locations shall have stainless steel threaded hardware; all other electrical hardware, fittings, and raceway systems shall be PVC-coated. Enclosures shall be of fiberglass reinforced polyester or 316 stainless steel and meet NEMA Type 4X requirements.
3. For this project, the following areas are classified as corrosive:
   a. Screen Building

H. Electrical Equipment Enclosures

1. Remote electrical units located in electrical equipment enclosures will be subjected to environmental conditions where temperatures may vary from 10 degrees F and 115 degrees F; relative humidity may range from 10 to 100 percent; and dust and trace quantities of chlorine may be present.
2. In exterior areas, ambient temperatures may vary from 10 degrees F and 115 degrees F with strong direct radiation from the sun. Relative humidity in all exterior field areas will vary from 10 to 100 percent with condensation and icing occurring. All areas may have wind blown dust, sand, hail, and rain occurring.

1.08 Warranty

1.09 Maintenance

A. Information to be provided.

1. The Contractor shall also provide the following additional information for each item of equipment in the operation and maintenance manual required in Section 01730:
   a. Wiring and interconnection diagrams which show terminal blocks of all distribution and control assemblies; all power, control and signal raceways; junction and pull boxes; all devices; and all interconnecting wiring. Diagrams shall show conductor tag numbers, control wire color code as applicable and power wire and cable sizes.
   b. The outgoing power and control wires shall be run as single lines representing the raceways and shall show any junction boxes or ancillary control devices that may be located in the raceway system or tapped off the raceway along the route. All raceways shall be appropriately identified showing the proposed tag inscription. Wires are to be fanned out and labeled at each point showing the terminal number of the wire and typical wire tags. For factory wired equipment, both the factory terminal numbers as well as the terminal numbers shown on the contract control diagrams shall be shown. If additional space is required, more than one sheet may be used for the connection diagram.
   c. Operation and maintenance data.
   d. Maintenance manuals.
   e. Installation certificates

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. All material and equipment shall be new, free from defects, of current manufacture, and of the quality specified or shown, and shall be listed by the Underwriters Laboratories Inc. (UL) for the

purpose for which it is to be used where such listing has been applied by UL to similar products. Each type of material shall be of the same manufacture and quality throughout the work.

B. Where more than one unit of the same class of material or equipment are required, provide products of a single manufacture. Component parts of materials or equipment of the same manufacturer are preferred.

C. All electrical equipment shall be approved by a testing laboratory recognized by the Owner and shall conform to all applicable requirements of the latest edition of the California Building Code. In lieu of such approval, the Contractor must submit the equipment for approval to the independent NETA certified electrical testing laboratory. This shall include the plant preferred list of equipment and components specified in the plans and specifications. Contractor shall also include in his delivery schedule the approval time required by the independent NETA certified electrical testing laboratory for equipment without UL listing.

D. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

E. Equipment Finish: Provide materials and equipment with manufacturers' standard finish system, in accordance with Division 9 Finishes. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with Division 9 Finishes with ANSI No. 61, light gray color.

2.02 Fabrication

A. Corrosion Protection

1. Unless otherwise noted, all equipment and appurtenances provided under this section shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment, then primed and painted with a durable enamel finish. Minimum dry film thickness shall be 3 mils. The Contractor shall ensure that all panels or enclosures specified to be painted in this section shall match in color Plymouth Rock Gray on all exterior surfaces and flat white on all interior surfaces. Nonconforming panels shall be repainted.

2. Field painting of all equipment shall conform to the procedure or outline in applicable sections of the specifications that specify painting and finishing.

3. Galvanizing, where specified, shall conform to the applicable division of the specifications. Galvanized equipment and appurtenances shall not be shop primed or painted but shall be field painted and touched up as specified and directed by the Owner's Representative.

B. Special Tools: The Contractor shall provide all special tools required for operation and maintenance of the equipment. The tools shall be considered as part of the product and become the property of the Owner.

2.03 Source Quality Control

A. Hazardous Locations: Provide materials and equipment acceptable to the regulatory authority having jurisdiction for the Class, Division, and Group of hazardous area indicated.

PART 3 - EXECUTION

3.01 Preparation

A. Maintain continuity of electric service to all functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such

times and places as can be prearranged with Engineer and the electric utility company providing service to the facility. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer and notification of the Inspector. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work.

3.02 Installation

A. For all areas designed as hazardous areas, install all materials and equipment in a manner acceptable to the regulatory authority have jurisdiction for the Class, Division and Group of hazardous area indicated.

B. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between the manufacturers' instructions, codes and regulations, and these Contract Documents, follow Engineer's decision. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

C. Use appropriate conduit and conductor entry fittings with enclosures which maintain the specified enclosure environmental capability after proper installation.

D. Relocation or Removal of Materials and Equipment.

1. For existing materials and equipment that are to be relocated, remove all materials no longer used such as studs, straps, conduits and wire. Where not required for used in the relocation, remove or cut off concealed or embedded conduit, boxes or other materials and equipment to a point at least 3/4-inch below the final finished surface.

2. For existing materials and equipment that are to be remove, remove all materials no longer used such as studs, straps, conduits and wire. Remove or cut off concealed or embedded conduit, boxes or other materials and equipment to a point at least 3/4-inch below the final finished surface. Any equipment to be removed that is currently is working condition, shall be returned to the Owner unless otherwise noted in the Contract Documents.

3. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface in a neat and workmanlike manner. Follow any specific instructions given under Division 9, Finishes. Utilize skilled craftsmen of the trades involved.

E. Cutting and Patching

1. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer or the Inspector. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition. Utilize skilled craftsmen of the trades involved.

3.03 Field Quality Control

A. Each item of equipment provided as a part of this project shall be installed, aligned and tested by skilled workmen to the tolerances recommended by the equipment manufacturer. Provide work which has a neat and finished appearance. Carry out work in accordance with NECA Standard of Installation unless otherwise specified.

B. Allow materials, equipment, and workmanship to be inspected at any time by the Engineer or the Inspector. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer and the Inspector.

C. Testing and Start-Up

1. General
   a. The Contractor shall furnish all labor, materials, instruments and tools to make all connections for testing as described herein and Section 01660. All electric power, fuel, water, supplies, and utilities required for all tests shall be provided by the Contractor.
   b. During checkout and startup of the various plant systems, provide a crew of skilled craftsmen to be available for checkout and troubleshooting activities as required by the Engineer. Since coordination with other crafts and Contractors will often be required, the craftsmen assigned to checkout must be available outside normal working hours when necessary.
   c. All equipment shall be demonstrated as operating properly prior to the acceptance of the work.
   d. These tests shall be made in the presence of the Owner's Representative and the results will be recorded by the Owner's Representative. All deficiencies or unsatisfactory conditions, as determined by the Owner's Representative or inspecting authorities, shall be corrected by the Contractor in a satisfactory manner at the Contractor's expense.
2. Protective Devices: All protective devices shall be properly set and operative during the testing period. Before testing and energizing a system, all necessary precautions shall be taken to ensure the safety of personnel and equipment. All conductors and all electrical equipment shall be properly insulated and enclosed. All enclosures for conductors and equipment shall be properly grounded. Insulation resistance measurements must have been made and approved on all conductors and energized parts of electrical equipment.
3. Inspection of Joints: Joints and connections in conductors No. 6 AWG and larger shall be inspected by the Owner's Representative after the joints have been made and prior to application of any tape.
4. Preliminary Testing: After the visual inspection of joints and connections and the application of tape and other insulating materials, all sections of the complete system of wiring shall be thoroughly tested for shorts and grounds. The Contractor shall correct all defects.
5. Insulation Resistance Tests:
   a. Wire and Cable: All wires and cables to be used as feeders, branch circuit wiring, control circuits and other wiring shall be tested with an insulation resistance tester rated 500 volts D.C. and capable of measuring 100 megohms (Biddle Company Megger). Single-conductor wires and cable shall have a resistance to ground not less than 10 megohms, and conductors of multiple-conductor cables shall have a resistance to ground not less than 1 meg-ohm. Solid state device circuits shall not be meggered directly. Solid state devices shall be disconnected prior to resistance tests.
   b. Tests: The insulation resistance of each circuit phase-to-phase and phase-to-ground shall be measured for the following:
      1) Motor feeders shall be measured with the motor disconnected.
      2) Control circuits shall be measured with pushbuttons, interlocking relays, instruments, overcurrent devices, and the like connected.
      3) Lighting feeders to panelboards shall be measured with the branch circuit breakers open.
      4) The test shall be made with the branch breakers closed, and with receptacles and fixtures mounted, but before lamping.
      5) Power feeders shall be measured with switches and circuit breakers in place.

6. Equipment Tests
   a. Motor Control Centers/Switchboards -The following tests shall be performed
      1) The main bus and all power and control circuits shall be meggered.
      2) The wire terminals shall be checked and the connections shall be cleaned.
      3) All control switches, alarm devices, and indicating instruments shall be checked for proper operation under normal and simulated abnormal conditions.
      4) The thermal-overload heaters and the reset mechanism for each motor shall be checked.
      5) The motor nameplate full-load current shall be checked as the basis for checking the heater selection.
      6) The thermal-overload heaters shall be in accordance with the starter manufacturer's heater tables for motor enclosure and starter enclosure.
7. Phase Rotation: The connections of all equipment shall be checked for correct phase rotation. Coordinate motor phasing checks with the Engineer / Inspector and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that phasing has been checked and corrected.
8. Circuit Breakers: The following tests shall be performed:
   a. Inspect each circuit breaker.
   b. Check for loose connections.
   c. Operate each circuit breaker manually.
   d. Set the adjustable trips to the values specified.
9. Motor Insulation Testing. Each polyphase motor shall have its insulation resistance to ground measured with 1000 volt "Megger" prior to connection. Values of resistance of less than 10 megohms shall be cause for equipment rejection.
10. Thermal Overload Protective Devices
    a. For each motor, the Contractor shall compile the following data in neatly tabulated form. Data shall be obtained from the equipment provided on the job:
       1) Equipment driven
       2) Nameplate amperes
       3) Service factor
       4) Overload device catalog number. Overload device current range and setting.
11. Motor Tests:
    a. Record the amperage draw on all phases of each motor operating under full load. Ensure that these values do not exceed the motor nameplate full load amperage.
    b. Record the voltage between all phases of each motor operating under full load. If the voltage balance is not within plus or minus 5 percent of nominal, request the Utility power company or other responsible party to correct the issue.
    c. The Contractor shall compile, by visual inspection of equipment installed for each motor, the following data in neatly tabulated form and be placed in the O&M manual:
       1) Equipment Driven

2) Motor horsepower
3) Nameplate amperes
4) Service Factor
5) Temperature rating
6) Overload catalog number
7) Overload current range and setting
8) Circuit breaker rating
9) Circuit breaker trip setting, for magnetic only circuit breakers

d. The Contractor shall compile, by visual inspection and by use of the appropriate electric metering equipment the following data in neatly tabulated form and be placed in the O&M Manual:

1) Equipment Number
2) Equipment Name
3) Manufacturer
4) Model Number
5) Serial Number
6) Frame Number
7) Horsepower rating
8) RPM
9) FLA
10) Volts
11) Phase
12) Frequency
13) Power Factor
14) Service Factor
15) Code
16) Insulation
17) Duty
18) Design
19) Insulation Tests phase to ground in Meg-Ohms for phase A, B and C, individually recorded.
20) Motor Frame Grounding Test:
    a) Applied Volts
    b) Measured Amps
    c) Calculated Ohms
21) Motor Heater Measured Amps
22) Motor Thermal Trip Test

23) Motor Tests – Measured Values using a true RMS meter

a) Amperage for phase A, B, and C, individually recorded.

b) Voltage for AB, BC, and CA, individually recorded.

c) Power Factor

d) Wattage

3.04 Adjusting / Cleaning / Protection

A. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in location of outlets or equipment, prior to roughing in, without incurring any additional costs or charges.

B. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturers' recommendations for storage. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as transformers, conductors, motors, and controls. Provide temporary heating, sufficient to prevent condensation, in transformers, switchgear, switchboards, motors, and motor control centers which do not have space heaters.

C. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. When equipment intended for indoor installation is installed at the Contractors' convenience in areas where it is subject to dampness, moisture, dirt, or other adverse atmosphere until completion of construction, ensure that adequate protection from these atmospheres is provided that is acceptable to the Engineer and the Inspector. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction. Energize all space heaters furnished with equipment.

D. Cleaning and Touchup Painting: Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove all materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides a finish equal to or better than the factory finish, that meets the requirements of the Specifications, and that is acceptable to the Engineer and the Inspector.

****END OF SECTION****

SECTION 16011
PROTECTIVE DEVICE COORDINATION STUDY & ARC FLASH ANALYSIS

PART 1 - GENERAL

1.01 Summary

A. The System Integrator shall provide the following electrical power system studies for the project job:

1. Short Circuit study.
2. Protective device coordination study.
3. Arc Flash Hazard Analysis.

B. The Contractor shall be responsible for ensuring that all parties involved in the studies have the necessary information and data to carry out the studies. The System Integrator shall obtain and distribute the information and data from the Utility, the Owner and the manufacturers of the equipment and materials.

C. The Contractor shall be responsible for supplying the information and data in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

D. If during the studies, the System Integrator finds any inadequacies in the equipment or protective devices, he shall make recommendations for improvements as soon as they are identified.

E. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16140	Disconnects and Fused Switches
Section 16155	Motor Starters
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch

Section 16300	Electrical Service Equipment
Section 16310	Panelboards
Section 16320	Surge Protective Devices
Section 16325	Dry-Type Transformers
Section 16330	Variable Frequency Drives
Section 16400	Electric Service
Section 16450	Grounding

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
IEEE 241	Recommended Practice for Electric Power systems in Commercial Buildings
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE 399	Recommended Practice for Industrial and Commercial Power System Analysis
IEEE 1015	Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
IEEE 1584	Guide for Performing Arc Flash Hazard Calculations
ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ANSI C37.13	Standard Application Guide for AC High Voltage Circuit Breakers Used in Enclosures
ANSI C37.010	Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI C37.41	Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single Pole Air Switches, Fuse Disconnecting Switches and Accessories
NFPA 70	National Electrical Code, Latest Edition
NFPA 70E	Standard for Electrical Safety in the Workplace

1.03 System Description

A. The scope of the studies shall include all new distribution equipment supplied under this contact as well as all directly affected existing distribution equipment at the existing facility.

1.04 Submittals

A. Submit a draft of the final report for review by the Engineer. The report shall include the following as further described in Part 3.

1. Summary of the results of the short circuit and the protective device evaluation and coordination studies.
2. Description, purpose, basis and scope of the study.
3. Single line diagram generated by the selected computer program with node identification.
4. Tabulations of electrical capacities and characteristics of the equipment and protective devices.
5. Table comparing the calculated short circuit and the equipment ratings.
6. Coordination curves showing the proposed settings with the characteristics of the equipment and protective devices shown graphically on industry standard graph paper.

B. Submit a draft of the final report for review by the Engineer. The report shall include the following as further described in Part 3.

1. Engineer Comments from the preliminary submittal shall be incorporated in the following documents.
   a. Summary of the results of the short circuit and the protective device evaluation and coordination studies.
   b. Description, purpose, basis and scope of the study.
   c. Single line diagram generated by the selected computer program with node identification.
   d. Tabulations of electrical capacities and characteristics of the equipment and protective devices.
   e. Table comparing the calculated short circuit and the equipment ratings.
   f. Coordination curves showing the proposed settings with the characteristics of the equipment and protective devices shown graphically on industry standard graph paper.
2. Arc Flash Hazard Analysis to include computed incident energy levels and flash protection boundary distances.

C. Submit study within 30 days after acceptable shop drawings have been returned for devices listed in paragraph 16011.3.02, D.1.

D. The final version of the Arc Flash Hazard Study and Arc Flash Warning Labels shall be submitted at least 30 days prior to energizing the electrical equipment.

E. Provide three (3) copies of the final power system studies and one (1) set of warning labels

1.05 Quality Assurance

A. The Contractor shall have the study prepared by qualified engineers of an independent engineering firm or equipment manufacturer. The consultant shall be a California Registered Professional Electrical Engineer who has at least five (5) years of experience and specializes in performing power system studies.

B. The independent engineering firm or the equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash analysis it has performed in the last two years.

C. The studies shall be performed using computer software from a single software company, SKM PowerTools for Window or approved equal

PART 2 - PRODUCTS

2.01 This section not used.

PART 3 - EXECUTION

3.01 Examination

3.02 Preparation

A. The System Integrator to furnish short-circuit and protective device coordination studies as prepared by an approved engineering firm or equipment manufacturer.

B. The Contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E- Standard for Electrical Safety in the Workplace, reference Article 130.3, and Annex D

3.03 Installation

A. Data Collection

1. Contactor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
2. Source combination may include present and future motors and generators.
3. Load data utilized may include existing and proposed loads obtained from Contact Documents, provided by the Owner, or Contactor.
4. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

B. Short-Circuit Analysis

1. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
2. Transformer design impedances shall be used when test impedances are not available.
3. Calculation of the maximum rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a commercially available computer program.
4. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

5. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
6. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
7. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
8. The computer printout shall identify the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
9. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
    a. Evaluate equipment and protective devices and compare to short circuit ratings.
    b. Adequacy of switchgear, motor control centers and panelboard bus bars to withstand short-circuit stresses.
    c. Notify Engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

C. Protective Device Time-Current Coordination Analysis

1. Perform a protective device coordination study to select fuse ratings, ratios and characteristics of associated voltage and current transformers, breaker trip characteristics and settings. Include all voltage classes of equipment from the utilities incoming line protective device down to and including all Main Switchboard feeder breakers, main breakers for all motor control centers, main breakers for all control panels, and, at each motor control center provide the motor circuit breaker for each motor size that is greater than 20 HP. Include a description, purpose, basis, and scope of the study and a single line diagram of the portion of the power system which is included within the study. Note inadequacies found during the study.
2. The time-current coordination analysis shall be performed with the aid of a commercially available computer program. It shall include the determination of settings, ratings, or types for the protective devices supplied. It shall also include any proposed adjustments to existing protective devices to which the supplied devices must coordinate.
3. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.
4. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
5. Provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full size log-log forms. Include with each curve sheet a complete title and one line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Include the following on the curve sheets:

a. Power company relay and fuse characteristics

b. Low-voltage equipment circuit breaker trip device characteristics.

c. Low-voltage fuse characteristics.

d. Pertinent transformer characteristics.

e. Pertinent motor and generator characteristics.

f. Characteristics of other system load protective devices.

g. Show transformer full load and 150%, 400%, or 600% currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and symmetrical and asymmetrical fault currents at each switchgear and panelboard.

h. Motor overload characteristics.

i. Conductor damage curves.

6. Include with the report the manufacturer's time-current curves for all protective devices.

7. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

8. The study shall include a separate, tabular computer printout containing the suggested device settings of all overcurrent protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

9. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

10. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for increasing system protection or device coordination.

11. Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified. Report shall also include suggestions to:

    a. Improve coordination between upstream and downstream devices.

    b. Reduce fault current clearing times of upstream devices.

    c. Identify equipment protection boundary and inrush current conflicts.

D. Arc Flash Hazard Analysis

1. Per NEC 110.16, perform an arc-flash analysis according to IEEE Standard 1584, "IEEE Guide for Performing Arc Flash Hazard Calculations," based upon results from the short circuit current analysis and optimized overcurrent protective device settings provided in the overcurrent protective device coordination study. Determine the following:

    a. Flash Hazard Protection Boundary

    b. Limited Approach Boundary.

    c. Restricted Boundary.

    d. Prohibited Boundary

    e. Incident Energy Level.

f. Required Personal Protective Equipment Class.

g. Type of Fire Rated Clothing.

2. The arc flash hazard study shall include the electrical distribution system equipment shown on the single line diagrams of the contract documents. The arc flash hazard study shall be used in conjunction with the approved short circuit and protective device coordination studies. The results of the power system studies shall be present in a report format that includes the following sections:

   a. Introduction, executive summary and recommendations, assumptions, reduced copy of the single line diagram.

   b. Arc Flash Evaluations Summary Spreadsheet.

   c. Bus Details Sheets.

   d. Arc Flash Warning Labels printed in color on adhesive backed labels.

3. A detailed arc-flash hazard analysis report with computed incident energy levels (Calories per square inches) and flash protection boundary distances at equipment indicated above to insure adequate protection and safety of personnel working in the vicinity of electrical equipment.

4. Arc Flash Hazard warning stickers, sized a minimum of 3.5” x 5” with the seven items listed in paragraph A above shall be located so as to be clearly visible to qualified persons on the existing and new electrical equipment including switchboards, motor control centers, power distribution panels, and panelboards. The labels shall include the bus name; upstream Protective Device Name, Type and Settings; bus line to line voltage and printed in color on adhesive backed Avery Labels.

   a. For each 600, 480, 240, and applicable 208 volt panelboard, one arc flash label shall be provided.

   b. For each low voltage switchboard, one arc flash label shall be provided.

   c. For each switchgear, one flash label shall be provided.

3.04 Material and Equipment Schedules

A. General: Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels Proposed major corrective modification will be taken under advisement by the Engineer, and the Contractor will be given further instructions.

B. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer.

C. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

D. Notify Engineer in writing of any required major equipment modifications.

E. Arc Flash Training: The contractor of the Arc Flash Hazard Analysis shall train the owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

END OF SECTION

SECTION 16030
ELECTRICAL TESTS

PART 1 - GENERAL

1.01 Summary

A. This Section specifies the work necessary to test, commission and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The work of this Section includes furnishing the labor, equipment and power required to support the testing specified in other Divisions of these Specifications. Electrical testing specified herein, and functional testing of all power and controls not tested under Division 17, Instrumentation and Control shall be completed before commencement of plant start-up. This scope may require the Contractor-+ to activate circuits, shutdown circuits, and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.

C. Related Sections:

Section	Title
Section 01660	Installation, Testing, and Commissioning
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16130	Wiring Devices
Section 16140	Disconnects and Fused Switches
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16330	Variable Frequency Drives
Section 16400	Electric Service
Section 16428	Quick-Connect Safety Switch
Section 16450	Grounding
Section 16500	Lighting Fixtures and Accessories
Section 17010	General Requirements, Instrumentation

Section	Title
Section 17201	Control Panels
Section 17512	Site Acceptance Tests
Section 17902	SCADA System
Section 17924	Control Strategies

D. Other Technical Section which include requirements for factory testing, test standards, and test report submittal when requirements are applicable.

1.02 References

A. NETA Latest Edition

1.03 Submittals

A. Test Reports and Procedures

1.04 Quality Assurance

A. The following test requirements are intended to supplement test and acceptance criteria that may be stated elsewhere.

1. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.
2. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known, and reasonable, current in the ground current sensor circuit. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.
3. Cable Testing:
   a. 480-volt circuits shall be tested for insulation resistance with a 1000-volt megohm meter.
   b. Testing shall be done after the 480-volt equipment is terminated.
   c. Phase-to-phase A-B, B-C, A-C and phase-to-ground insulation resistance tests shall be performed on each cable prior to 5-kV and 25-kV cable termination at equipment but subsequent to stress cone makeup.
   d. Test results shall be submitted for review 30 days prior to plant operation and any system testing. Equipment which may be damaged during this test shall be disconnected.
   e. Perform tests with all other equipment connected to the circuit. In order to be acceptable, the cable must withstand the test high voltage without breakdown, have steady or decreasing leakage current during the high potential test, and have satisfactory comparable megger readings in each megger test.
   f. Test results shall be submitted to the engineer and shall state equipment used and time of test
   g. Cable operating at more than 2,000 volts shall be tested in accordance with ICEA publications S-68-61, S-61-402, S-19-81, and S-68-516
   h. Cable testing and report submittal shall be performed by an organization sanctioned by the Manufacturer of the cable to be tested.
   i. Testing shall verify the quality of cable terminations

j. Test results for medium and high voltage cable shall be submitted to the Engineer 30 days prior to the time schedule for equipment energization

4. Test ground fault interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle Manufacturer.

5. A functional test and check of all electrical components is required prior to performing subsystem testing and commissioning. Components and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:

   a. Visual and physical check of cables, buss work, circuit breakers, transformers, and connections associated with all new and modified equipment.

   b. Circuit breakers which are specified with adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or longtime overcurrent, shall be field adjusted by a representative of the circuit breaker Manufacturer. Time and pickup setting shall correspond to the recommendations of the Protective Devices Coordination Study. Setting shall be tabulated and proven for each circuit breaker in its installed position; test results shall be certified by the tester and transmitted to the Engineer (7 copies).

6. Complete ground testing of all grounding electrodes and grid prior to testing the equipment.

B. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

PART 2 - (NOT USED)

PART 3 - EXECUTION

3.01 Field Quality Control

A. Conductors, Conductors Rated 600 Volts or Less:

1. Field Test

   a. Perform insulation resistance testing of all power and control circuits 600 volts and less with a 500-volt megger.

   b. Prepare a written test report of the results and submit to the Engineer prior to final inspection.

   c. Minimum acceptable value for insulation resistance is 1 megohm**.**

   d. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.

B. Conductors, Instrumentation Cables

1. Field Test

   a. After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests witnessed by the Engineer to ensure that

instrumentation cable shields are isolated from ground, except at the grounding point. Remove all improper grounds.

C. Grounding

1. Field Tests:

   a. Test in the Engineer's presence the ground resistance of the grounding system. Ground resistance shall not exceed 5 ohms.

   b. Test all ground fault interrupter (GFI) receptacles and circuit breakers for proper connection and operation with methods and instruments prescribed by the manufacturer.

   c. Provide copies of reports of all grounding system tests for inclusion in Technical Manuals and for review by the Engineer.

   d. Provide ground resistance tests in the presence of the Engineer and submit results. Utilize a ground resistance megger "Earth" tester with a minimum resistance capacity range of 0-5000 megohms at 2000 VDC. Utilize the full potential method or the three terminal method as described by Biddle or NETA national electrical test association

2. Field Tests:

   a. Functional Test: Prior to plant startup, all equipment shall be inspected for proper alignment, proper connection, proper operation of control and instrumentation, proper rotation, and satisfactory starting operation of the indicated motor.

      1) Test all starters for proper contactor action, proper interlocks and permissives operation, and proper indication prior to applying power to motor.

      2) Approval of Engineer prior to energizing motors is required;

   b. All functional and field tests are required to be performed in the presence of the Engineer or Owner's Representative.

D. Electrical Motors

1. Tests shall be performed as per ANSI/IEEE standard 112-1978 "IEEE Standard Test Procedure for poly phase Instruction Motors and Generates".

   a. A 1,000 volt megger test shall be performed on 460 volt motors. A 500 volt megger test shall be performed on 200 volt and 120 volt motors. Test

2. Factory Testing:

   a. Prior to shipment, provide a megger report on the motor that indicates that each motor winding to ground has a value greater than 999 megohms and record the megger values between motor legs A and B, A and C, B and C.

3. On Site Testing - Delivery

   a. Once the motor is delivered on site, the motor shall be meggered to confirm that no damage to the motor occurred during shipping and handling. The megger readings shall match the values contained in the factory megger report. If the recorded values differ by 10% the motor may be rejected by the engineer. Provide a copy of the delivery megger report within 10 days from delivery to project site

4. On Site Testing – Long Term Storage

   a. If the motor is in storage for more than 3 months prior to installation then a megger report shall be prepared and submitted to Engineer for approval. If the recorded values differ by 10% the motor may be rejected by the engineer. Provide a copy of the long term storage report 10 days prior to schedule installation.

5. On-Site Testing – Post Installation
    a. Once motor is installed perform meter tests on completion of installation and confirmation of proper phase rotation. If the recorded values differ by 10% the motor may be rejected by the engineer. Provide a copy of the post installation megger report 10 days after installation.

****END OF SECTION****

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SECTION 16110
RACEWAYS, FITTINGS, AND SUPPORTS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all raceways, wire ways, raceway supports, cable trays and concrete encased ducts.

B. Type: All raceways shall be polyvinyl chloride (PVC) coated rigid galvanized steel, Robroy Plasti-Bond II or equal, conduit unless otherwise noted

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01330	Submittals
Section 01600	Product Requirements
Section 01750	Starting and Adjusting
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
ANSI C80.1	Electrical Rigid Steel Conduit
UL 1	Flexible Metal Conduit
UL 5	Surface Metal Raceway and Fittings

Reference	Title
UL 6	Electrical Rigid Metal Conduit – Steel
UL 514B	Conduit, Tubing and Cable Fittings
UL 651	Schedule 40 and 80 Rigid PVC Conduit and Fittings
NEMA RNI-2005	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC-2-2003	Electrical PVC Tubing and Conduit
NEMA TC-3-2004	PVC Fittings for Use With Rigid PVC Conduit and Tubing
ANSI/UL 467	Grounding and Bonding Equipment
NEC	National Electric Code, latest edition

1.03 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01330 and 16010. Submittals shall include the following data, drawings, and description of materials.

1. Manufacturer and manufacturer's type and designations for each equipment item
2. List of construction material for all conduits, fittings, supports and accessories
3. The Contractor shall furnish copies of the manufacturer's certified test reports for the material being supplied to establish compliance with NEMA RN-1

1.04 Quality Assurance

A. Performance and Design Requirements: The conduits and fittings shall be premium quality and suitable for installation in water facilities. The PVC used for Schedule 80 conduits and the PVC coating on rigid galvanized steel conduit shall be made from virgin material.

B. Inspection: All ducts shall be inspected by the Engineer prior to backfill. The Engineer shall inspect for drainage slope, spacers, conduit condition, and joints.

C. All equipment furnished by the Contactor shall be listed by and bear the label of Underwriters' Laboratories, (UL) or of an independent testing laboratory acceptable to the Owner.

1.05 Delivery, Storage, and Handling

A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location as agreeable with Site Engineer, and secure from weather or accidental damage.

1.06 Project / Site Conditions

A. The raceways, fittings, and supports will be installed either exposed, concealed, or in duct banks in a water facility and may be subjected to dust and moisture. Ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity should range from 10 percent to 100 percent. The raceways, fittings, and supports may be subject to dust and moisture.

PART 2 - PRODUCTS

2.01 Manufacturers

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with Section 01600 – Material and Equipment Substitution.

2.02 Equipment and Materials

A. All raceways shall be PVC coated rigid galvanized steel conduit unless otherwise indicated on the drawings or in these specifications. With the exception of raceways with non-linear loads, underground raceways shall be polyvinyl chloride (PVC) Schedule 40, within duct banks without concrete caps. Underground raceways with non-linear loads shall be PVC coat rigid steel conduits. Raceways installed in stud walls or above suspended ceilings shall be electrical metallic tubing (EMT). All raceways installed in exposed locations shall be rigid galvanized steel conduit with a PVC bonded coating and lining. Flexible metal conduit shall be employed for connections to lighting fixtures. Final raceway runs to electrical equipment on machinery requiring flexibility or that is subject to vibration shall be liquid-tight flexible metal conduit. All fittings and supports installed in exposed locations shall be PVC coated. Minimum size of all conduits shall be 3/4-inch.

B. Rigid Steel Conduit

1. Comply to Underwriter's Laboratories UL-6 specification, ANSI C80.1-77 and Federal specification WW-C-581E (77 APR 04) or latest revisions. Rigid steel conduit shall be zinc coated both inside and outside after fabrication by hot-dip galvanizing. The threads shall also be hot-dip galvanized.

2. Use rigid steel conduit, including bushings, couplings, elbows, nipples, and other fittings, galvanized by hot-dipping, and meeting the requirements of ANSI C80.1 and ANSI C80.4, UL.

3. Do not use setscrew type couplings, bushings, bends, nipples, and other fittings, unless approved by the ENGINEER or the INSPECTOR. Factory bends are not permitted unless approved by the ENGINEER or the INSPECTOR. Conduit bending radius shall not be less than the minimum cable bending radius of the cable to be installed.

C. Electrical Metallic Tubing (EMT):

1. Comply to Underwriter's Laboratories UL 797, ANSI C80.3-77 and Federal Specification WW-C-563 (73 DEC 04) or latest revisions. EMT shall be galvanized.

D. PVC Conduit:

1. Nonmetallic conduit shall be high impact polyvinyl chloride (PVC), Schedule 40 unless otherwise noted in this Specification Section or where shown otherwise on the contact drawings. The nonmetallic conduit shall be corrosion resistant. Minimum tensile strength shall be 6000 psi, and minimum compressive strength shall be 9000 psi. The material shall have a smoke emission rate of not more than 5.1 grams/100 grams by the Arapahoe smoke chamber test.

2. Use rigid PVC Schedule 40 conduit, UL listed for concrete-encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use.

E. PVC Coated Rigid Steel

1. PVC coated conduit shall be hot-dip galvanized including the threads. The interior and exterior surfaces shall be coated with 2 mils thick urethane. The exterior of the conduit shall be PVC coated to a minimum 40-mil thickness. The PVC coating shall be permanently bonded to the conduit. The coating shall have a minimum tensile strength of 3500 psi. The interior shall be coated with a urethane coating no more than 7 mils thick.
2. A PVC coated coupling shall be furnished with each length of conduit. The PVC sleeve of the coupling shall equal the outside diameter of the coated conduit and shall extend 1-1/2 inches from each end of the coupling.
3. Prior to coating, the galvanized conduits and fittings shall be UL listed. Use PVC coated fittings with the same interior and exterior coating requirements. PVC coated fittings and sleeves shall be completely watertight to prevent moisture from penetrating the interior of the conduits and fittings.
4. The PVC coating shall be resistant to ultra-violet rays when installed outdoors. The conduit and fittings shall meet all the requirements of NEMA RN-1 1989.

F. Flexible Metal Conduit

1. Flexible metal conduit shall be formed from spirally wound galvanized steel strip with successive convolutions that are securely interlocked. Minimum size of the flexible metal conduit shall be 3/4 inch. Fittings shall be of the compression type. Lengths shall not exceed 60 inches. Flexible metal tubing shall include a code size insulated green ground conductor.

G. Flexible Metal Conduit, Liquid-Tight

1. Use UL listed liquid-tight flexible metal conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.
2. Provide external grounding connector and appropriately sized grounding conductor to assure ground continuity.
3. Minimum size shall be 2 inch.

H. Wireways

1. All wireways and auxiliary gutters shall be JIC sectional flange oil-tight type with hinged covers. Minimum size shall be 8 inches by 8 inches unless otherwise noted. All wireways shall be painted.
2. Provide outdoor, rain-tight steel-enclosed wireway and auxiliary gutter where indicated. Utilize wireways and fittings that are UL listed, and have a cover that can easily be removed. Manufacturers and types: Square D Square-Duct; General Electric Type HS; or equal.

2.03 Components and Accessories

A. Use cable sealing fittings forming a watertight nonslip connection to pass cords and cables into conduit. Size cable sealing fitting for the conductor OD. For conductors with OD's of ½-inch or less, provide a neoprene bushing where the conductor enters the connector. Use Crouse-Hinds CGBS, Appleton CG Series, or equal, cable sealing fittings.

B. Fittings for Rigid Steel

1. Fittings used with rigid galvanized steel conduit shall be hot-dip galvanized. Locknuts shall be extra heavy galvanized steel for sizes through 2 inches. Locknuts larger than 2 inches shall be galvanized malleable iron. Bushings shall be galvanized malleable iron with insulating collar. Grounding bushings shall be of the locking type and shall be provided with feed-through compression lugs for securing the ground cable. Unions shall be galvanized ferrous

alloy types UNF or UNY. Thread-less fittings shall not be utilized with rigid galvanized steel conduits.

2. Expansion fittings in embedded runs shall be of the watertight type and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
3. Use insulated throat bushings of metal with integral plastic bushings rated for 105 degrees C.
4. For insulated throat bushings for rigid steel conduit, use Thomas & Betts Nylon Insulated Metallic Bushings, or O.Z. Gedney Type B, or equal.
5. Use Myers Scru-Tite, or equal hubs for rigid steel conduit.
6. Use conduit bodies for rigid steel conduit of metal and sized as required by the NEC (NFPA 70-2008). Use Appleton Form 35 threaded Unilets; Crouse-Hinds Mark 9 or Form 7 threaded condulets; Killark Series O Electrolets; or equal, for normal conduit bodies for rigid steel conduit. Where conduit bodies for rigid steel conduit are required to be approved for hazardous (classified) locations, use conduit bodies manufactured by Appleton, Crouse-Hinds, or Killark, or equal.
7. Use only couplings for rigid steel conduit supplied by the conduit manufacturer.
8. Use Appleton Type EYF, EYM, or ESU; Crouse-Hinds Type EYS or EZS; Killark Type EY or EYS; or equal, sealing fittings for rigid steel conduit. Where condensate may collect on top of a seal, provide a drain by using Appleton Type SF Crouse-Hinds Type EYD or EZD, or equal Drain Seal.
9. Use Appleton Type ECDB, Crouse-Hinds ECD, or equal drain fittings for rigid steel conduit.

C. Fittings for PVC Conduit

1. Fittings used with PVC conduits shall be of the PVC solvent-weld type and shall be of the same material as the conduit.
2. Expansion fittings shall be provided as recommended by the manufacturer.

D. Fittings for PVC Coated Rigid Steel Conduit

1. Fittings with PVC coated rigid steel conduit shall be PVC coated in a manner similar to the conduit. The exterior of the fittings shall be coated with 2-mil thick urethane prior to the application of the 40-mil exterior PVC coat. Interior of the fittings shall have a 2-mil urethane finish. The fittings shall have ribbed finish to assist in the installation of fittings.
2. Thread-less fittings shall not be used with PVC coated rigid steel conduit.
3. Bushings and ground bushings shall be as specified for rigid galvanized steel conduits.

E. Fittings for Flexible Metal Conduit

1. Fittings used with flexible metal conduit shall be compression type, cadmium-plated malleable iron body with locknut and bushing
2. Where applicable, 45- and 90-degree fittings shall be used

F. Fittings for Liquid-Tight Flexible Conduit

1. Fittings used with liquid-tight conduit shall have cadmium-plated malleable iron body and gland-nut, brass grounding ferrule threaded to engage conduit. These fittings shall also use spiral and "O" ring seals around the conduit, the box connection and insulated throat. The insulated throat connectors for liquid-tight flexible metal conduit of metal will have an integral plastic bushing rated for 105 degrees C, and of the long design type extending outside of the box or other device at least 2-inches.

2. Use Thomas & Betts Super-Tite Nylon Insulated Connectors or equal
3. Where applicable, 45- and 90-degree fittings shall be used

G. Raceway Supports

1. General: Raceway support systems shall be designed to provide a factor of safety of no less than five.
2. Conduit Supports: Conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. When used with PVC coated rigid steel conduit, the conduit supports shall be 40 mils thick PVC coated.
3. Ceiling Hangers: Ceiling hangers shall be adjustable galvanized carbon steel, PVC coated 40 mils thick, pipe hangers. Straps or hangers of plumber's perforated type will not be acceptable. Hanger rods shall be 2-inch minimum galvanized all-thread rod and shall meet or exceed ASTM A193-B7 and ASME Boiler and Pressure Vessel Code specifications. Trapeze, rod type hangers shall not be loaded in excess of 700 pounds per rod. Where loading exceeds this value, rigid frames shall be provided.
4. Racks: Racks shall be constructed from framing channel. Channels and all associated hardware shall be steel, hot-dip galvanized after fabrication of the channel. Field cuts shall be painted with zinc-rich paint. Channels attached directly to building surfaces shall be 14-gage minimum material 1-5/8 inches wide by 13/16 inch deep. All other channels shall be 12-gage minimum material 1-5/8 inch wide by 1-5/8 inch minimum depth. Racks shall be designed to limit defection to 1/360 of span. All exposed ends of framing channel shall be covered with manufacturer's standard plastic inserts. The racks shall be PVC coated to 40 mil thickness.

H. Raceway Tags

1. Provide permanent, nonferrous metal markers with raceway designations pressure stamped, embossed, or engraved onto the tag.
2. Tags relying on adhesives or taped-on markers are not acceptable.
3. Attach tags to raceways with noncorrosive wire.

I. Warning Tape:

1. Provide heavy-gauge, yellow plastic tape of 6 -inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT or RT; Griffolyn Co. Terra-Tape; or equal

PART 3 - EXECUTION

3.01 Preparation

A. In addition to the provisions of the Division 1 – General Requirements, and Section 16010 "Electrical General Provisions," prior to installation, store all products specified in this section in a dry location.

B. Minimum Raceway Size: Use no circular raceway less than 3/4-inch.

C. Preparation for pulling in conductors:

1. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or

replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

2. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

3.02 Installation

A. All conduits containing conductors connected to the input or output of a non-linear load, such as a variable frequency drive, shall be rigid steel, PVC coated.

B. Unless otherwise indicated, all underground conduits shall PVC coated rigid steel.

C. Each conduit shall be identified at each end with a permanent non-corrosive metal marker. Designation shall be pressure stamped into the tag. The conduit identification shall be the designated conduit number as shown.

D. Location and Installation, Required Raceway Type

1. Exterior, Exposed Locations:
   a. PVC coated rigid steel
2. Interior, Exposed Locations:
   a. EMT, only for above-ceiling applications
   b. PVC coated rigid steel conduit [except for communication, instrumentation, and VFD output power conduits.
3. Interior, Concealed (Not Embedded in Concrete):
   a. Rigid steel conduit
   b. PVC Schedule 40 conduit except for communication, instrumentation, and VFD output power conduits.
4. Aboveground, Embedded in Concrete Walls or Floors:
   a. Rigid steel conduit
   b. PVC schedule 40 conduit
5. Underground, Direct Earth Burial:
   a. PVC coated rigid steel conduit
   b. PVC schedule 40 conduit except for communication, instrumentation, and VFD output power conduits.
6. Underground, Below Concrete Floor Slabs
   a. PVC Schedule 40 conduit except for communication, instrumentation, and VFD output power conduits.
   b. PVC coated rigid steel conduit
   c. Rigid steel conduit
7. Final Connection to Certain Equipment
   a. Make final connection to motors, wall or ceiling mounted fans and unit heaters, dry type transformers, valves, local instrumentation, and other equipment where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, with 36-inch maximum length liquid-tight, PVC-jacketed, flexible steel conduit.

b. The flexible conduit shall be long enough to allow the item to which it is connected to be withdrawn or moved off its base. Use liquid-tight flexible metal conduit in outside areas, process areas exposed to moisture, and areas required to be oil free and dust-tight.

8. Special Locations:

   a. Use rigid steel conduit:

      1) Where conduit changes from underground and/or concrete embedded to exposed

      2) Under equipment mounting pads

      3) In exterior light pole foundations

9. Communication and Instrumentation Conduits:

   a. Rigid steel conduit

   b. PVC coated rigid steel conduit

E. Location, Routing, and Grouping:

1. All exposed conduits shall be PVC coated rigid galvanized steel conduits.

2. Conceal or expose raceways as indicated. Group raceways in same area together. Locate raceways at least 12-inches away from parallel runs of heated piping for other utility systems.

3. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible. Conduit supports spaced not more than 8 feet apart.

4. No conduit shall approach closer than 6 inches to any object operating above the rated temperature of its cable temperature.

5. Conduit supported directly from the concrete structure shall be spaced out at least 1/4 inch using one-hole hot-dip galvanized malleable iron straps with nesting backs or, if three or more conduits are located in a parallel run, they shall be spaced out from the wall approximately 5/8 inch to 1 inch by means of framing channel. Runs of individual conduit suspended from the ceiling shall be supported with galvanized wrought steel pipe hangers. Where three or more conduits are suspended from the ceiling, suitable steel racks shall be constructed subject to submittal to the Engineer for review.

6. Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors in accordance with the structural section of these specifications. Individual conduit supports may be similar to cast-in-place anchors, die-cast, rustproof alloy expansion shields or cast flush anchors. Wooden plugs, plastic inserts or gunpowder-driven inserts shall not be used as a base to secure conduit supports.

7. All conduit entering sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the device and shall have an insulating bushing constructed over the conduit end. All conduit entering NEMA 12 boxes shall be terminated with a rain-tight hub having an insulated liner. All surface mounted cast boxes and plastic enclosures shall have threaded hubs. All joints shall be made with standard threaded couplings or specified unions. Metal parts of plastic control stations and coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of all conduit shall be cut square, reamed and threaded with straight threads. Rigid steel conduit shall be made up tight and without thread compound. Male threads on rigid steel conduit shall be coated with electrically conductive zinc rich paint. Threading shall be done with dies, with the guide sleeve bored out to allow for increased diameter or the PVC coated conduit. Conduit shall be made with the next larger bend or next larger shoe bushed for proper fit.

8. Avoid obstruction of passageways. Run concealed raceways with a minimum of bends in the shortest practical distance considering the building construction and other systems.
9. In block walls, do not run raceways in the same horizontal course with reinforcing steel.
10. In outdoor, underground, or wet locations, use watertight couplings and connections in raceways. Install and equip boxes and fittings so as to prevent water from entering the raceway.
11. Paint all threads of galvanized conduits with UL approved zinc-rich paint or liquid galvanizing compound before assembling. Touch up after assembly to cover nicks or scars.
12. Do not notch or penetrate structural members for passage of raceways except with prior approval of the Engineer or the Inspector.
13. Do not run raceways in equipment base foundations.
14. Locate above ground raceways concealed in poured concrete so that the minimum concrete covering is not less than 1-1/2-inches.
15. Except at raceway crossings, separate raceways in slabs not less than six times the raceway outside diameter
16. Raceways installed under slab floors shall lie completely under the slab with no part of the horizontal run of the raceway embedded within the slab.
17. Install concealed, embedded, and buried raceways so that they emerge at right angles to the surface. Provide support during pouring of concrete to ensure that raceways remain in position.
18. Allow a minimum of 7 feet headroom for conduit passing over walkways.
19. Communication and instrumentation conduits crossing power circuits shall be separated from such circuits by the minimum distance stipulated by the IEEE standards.
20. Welding, brazing or otherwise heating of the conduit is not allowed. Plumber's perforated tape shall not be used for any purpose.
21. Where required for ease of pulling and as necessary to meet code, the Contractor shall provide cast junction or pullboxes even though not shown on the drawings. The Contractor shall limit the number of equivalent 90-degree bends to three in any run between pull boxes. Runs shall be limited to 400 feet, less 100 feet for each equivalent 90-degree bend in the run. Bends and offsets shall be avoided where possible, but where necessary, shall be made with an approved hickey or conduit bending machine, or shall be factory preformed bends.
22. All conduit entering sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the device and shall have an insulating bushing constructed over the conduit end. All conduit entering NEMA 12 boxes shall be terminated with a rain-tight hub having an insulated liner. All surface mounted cast boxes and plastic enclosures shall have threaded hubs. All joints shall be made with standard threaded couplings or specified unions. Metal parts of plastic control stations and coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of all conduit shall be cut square, reamed and threaded with straight threads. Rigid steel conduit shall be made up tight and without thread compound. Male threads on rigid steel conduit shall be coated with electrically conductive zinc rich paint. Threading shall be done with dies, with the guide sleeve bored out to allow for increased diameter or the PVC coated conduit. Conduit shall be made with the next larger bend or next larger shoe bushed for proper fit.

23. Conduit constructed in concrete slabs or walls shall be placed in the middle third of the slab or wall. Conduit rising through a slab shall be protected by a formed concrete pad approximately 6 inches in diameter and 4 inches above the finished floor, or the conduit shall come up through the equipment pad. Clearances equal to the conduit trade diameter, but not less than 1-1/2 inches, shall be maintained between conduits encased in slabs. Clearances of less than 1-1/2 inches at conduit crossing and terminating locations may be allowed at the discretion of the Engineer.
24. Flexible conduit shall not be used as a general purpose raceway but shall be provided in locations requiring flexibility with the approval of the Engineer.
25. Liquid-tight conduit shall be used for all motor connections as detailed. Where flexibility is required for electrical raceways on equipment, liquid-tight conduit shall be used in accordance with JIC standards, these specifications, and the local codes. The maximum length of flexible, liquid tight conduit shall be 36-inches. The terminating fitting and sealing shall be as shown in the motor details.
26. The Contractor shall exercise the necessary precautions to prevent the lodging of dirt, concrete or trash in the conduit, fittings and boxes during the course of construction.

F. Support:

1. Support raceways at intervals not exceeding NEC requirements unless otherwise indicated. Support multiple raceways adjacent to each other by ceiling trapeze. Support individual raceways by wall brackets, strap hangers, or ceiling trapeze, fastened by toggle bolts on hollow masonry units, expansion shields on concrete or brick, and machine screws or welded thread studs on steelwork.
2. Threaded studs driven in by a powder charge shall not be accepted.
3. Support all raceways from building structural members only.
4. Do not use nails anywhere or wooden plugs inserted in concrete or masonry as a base for raceway or box fastenings. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

G. Bends:

1. Make changes in direction of runs with symmetrical bends. Make bends and offsets of the longest practical radius. Do not heat metal raceways to facilitate bending.
2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel and of neat appearance. Make field bends in parallel runs.
3. For PVC conduits, use factory made elbows for all bends 30 degrees or larger. Use acceptable heating methods for forming smaller bends.
4. Make no bends in flexible conduit that exceed 90 degrees or allowable bending radius of the cable to be installed or that significantly restricts the conduits flexibility.

H. Bushing and Insulating Sleeves:

1. Where metallic conduit enters metal equipment enclosures through conduit openings, install a bonding bushing on the end of each conduit. Install a bonding jumper from the bushing to any equipment ground bus or ground pad.
2. If neither exists, connect the jumper to a threaded bolt connection to the metallic enclosure.
3. Use manufacturer's standard insulating sleeves in all metallic conduits or insulated bushings terminating at an enclosure.

I. Expansion Joints:

1. Provide suitable expansion fittings for raceways crossing expansion joints in structures or concrete slabs, or provide other suitable means to compensate for expansion and contraction.
2. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by the manufacturer and as required.

J. PVC Conduit:

1. Solvent weld PVC conduit joints with solvent recommended by the conduit manufacturer. Follow manufacturer's solvent welding instructions and provide watertight joints.
2. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings.
3. Use acceptable PVC female adapters when joining PVC conduit to rigid metal conduit.

K. PVC Coated Rigid Steel Conduit:

1. Install in strict accordance with the manufacturer's Instructions.
2. Touch up any damage to the coating with conduit manufacturer acceptable patching compound.
3. PVC boot shall cover all threads.
4. Where belled conduits are used, bevel the un-belled end of the joint before joining. Leave no metallic threads uncovered.
5. PVC coated conduit shall be tightened, with strap wrenches, and the plastic overlap shall be coated and sealed in accordance with the manufacturer's recommendations. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. All damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Joints in multiple conduit runs shall be staggered.
6. Threading:
   a. Plasti-Bond can be threaded with any standard threading tool. Larger model power threaders with open die heads require no modification beyond optional grip inserts for PVC coated conduit.
   b. If a threader with a tight-fitting die head is to be used, like many hand-held models, it is necessary to machine out the interior diameter of the stationary guide approximately 12/100ths of an inch to allow for clearance of the PVC coating. Prior to machining the pipe guide take note of the sequence in which the dies are removed; then replace dies in the proper sequence.
   c. If conduit is to be threaded manually it must be pencil cut before threading to enable the die teeth on the threader to engage the conduit. In the same manner as sharpening a pencil with a knife, cut away 1/4" of the exterior coating from the end to be threaded. This allows the pipe guide to ride up and over the PVC coating enabling the removal of the coating and threading in one operation.
   d. Before threading, by any method, a series of cuts should be made in the PVC coating along the longitudinal axis of the conduit. The thread protector attached to one end of the conduit can be used to gauge the length of the cuts. Make a slit up one side of the thread protector with a knife and remove it from the conduit. Push the thread protector over the cut end of the conduit to be threaded and place a mark on the PVC coating at the end of the protector. With a knife, cut around the circumference of the conduit at the mark, through the PVC coating, to the metal. This cut will indicate the starting point for the longitudinal cuts and it will give an even ending to the PVC coating removed during

threading. The longitudinal cuts will allow the PVC coating to be removed in small pieces instead of long strips that can foul the die head causing the conduit to collapse.

e. Use a good quality thread cutting oil to flush away the metal and PVC chips. After threading use a degreasing spray to thoroughly clean the threads and the interior of the pipe. Use care not to contaminate the cutting oil with the degreasing spray. Degreasing is important in order to insure that the touch up compound will adhere to the unprotected steel. Bare steel is the most vulnerable area to corrosion in any conduit system, therefore, touch up compound must be used on all field cut threads and internal reams. These specially formulated interior and thread touch-up compounds are available in 4 ounce and quart cans. When an access fitting or coupling is attached to the newly threaded conduit a colored band red for Plasti-Bond), will form at the end of the sleeve. This indicates proper installation procedures have been followed

L. Penetrations:

1. Seal the interior of all raceways entering structures at the first box or outlet with oakum or suitable plastic expandable compound to prevent the entrance into the structure of gases, liquids, or rodents.
2. Dry pack with non-shrink grout around raceways that penetrate concrete walls, floors, or ceilings aboveground, or use one of the methods specified for underground penetrations.
3. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide an acceptable, malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement specified or indicated, provide such a device having a gland type sealing assembly at each end with pressure bushings which may be tightened at any time. When there is raceway concrete encasement specified or indicated, provide such a device with a gland type sealing assembly on the accessible side. Securely anchor all such devices into the masonry construction with one or more integral flanges. Secure membrane waterproofing to such devices in a permanently watertight manner.
4. Wherever conduits penetrate concrete wall panels to outdoors or as shown, the Contractor shall detail the required mountings. He shall locate and use a galvanized pipe sleeve for passage of the conduit. A compression type seal shall be used to form a complete watertight installation. The installation design shall be submitted to the Engineer.
5. Where an underground raceway without concrete encasement enters a structure through a non-waterproofed wall or floor, install a sleeve made of Schedule 40 galvanized pipe. Fill the space between the conduit and sleeve with a suitable plastic expandable compound, or an oakum and lead joint, on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device as specified may be used in lieu of the sleeve.
6. Where raceways penetrate fire-rated walls, floors, or ceilings, fire stop openings around electrical penetrations to maintain the fire-resistance rating
7. Raceways passing through roofs shall be flashed.
8. Provide conduit seals where required by Article 500 of the NEC.

M. Underground Conduits, Direct Burial raceways:

1. Unless otherwise indicated, all underground conduits shall PVC coated rigid steel.
2. Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation unless otherwise authorized by the Engineer.

3. Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.
4. Do not use union type fittings underground.
5. Provide a minimum cover of 2-feet over all underground raceways unless otherwise indicated. Warning tape as specified in Article 2.11A shall be placed no less than 12 inches above conduit and duct bank.
6. Do not backfill underground direct burial raceways until they have been inspected by the Engineer.
7. Warning Tapes: Bury warning tapes approximately 8-inches below grade and above all underground conduit runs or duct banks. Align parallel to and within 12-inches of the centerline of runs.
8. When the contract drawings indicate underground PVC conduits then a transition shall be provided. The transition shall be made from PVC Schedule 80 conduit to PVC coated rigid galvanized steel conduit at all stub-ups and when entering equipment. The transition shall consist of a PVC coated rigid galvanized conduit. Conduits shall be laid with a minimum grade of 2 inches per 100 feet from structure to manhole or from high point to manholes.
9. Ducts shall be of the dimensions and materials and with reinforcing as shown. They shall have a uniform continuous slope with no low points to entrap water. All duct runs shall be placed on an undisturbed excavated soil base wherever possible. Where duct runs pass through backfilled areas, the soil base shall be a backfill of loam, placed in layers. Each layer shall be solidly tamped or rolled, as required, to obtain complete compaction to the elevation and pitch of the bottom of the duct run shown. The compaction shall be as specified in the structural section of these specifications.
10. Plastic spacers shall be manufactured by the conduit supplier and shall be located 5 feet on centers. Wire ties shall be made at each spacer location and shall be securely anchored. Duct runs shall be watertight. When the termination of duct is not detailed on the duct run drawing, a coupling shall be installed.
11. The ends of all conduits shall be suitably plugged, capped and protected from damage during construction. Ends of conduits which are not to be used for long periods shall be protected from dirt, rodents, etc., by plugging at the ends with wooden or manufactured plugs. A non-setting compound may be used on the plug to make it adhere to the conduit end. A 1/4-inch hole shall be drilled in the lower portion of the plug to provide drainage of the plugged conduit.
12. A No. 9 galvanized wire shall be pulled through each high voltage and 480-volt power feeder conduit and a No. 12 wire shall be pulled through branch feeder conduits as the conduit sections are laid and the wire shall be securely fastened at each end of the finished duct run. When ducts are reserved for future use, the galvanized wire shall be replaced with a 5/8-inch nylon cord.
13. A galvanized wire shall always be attached to the rear end of the swab or mandrel to replace the wire being pulled out. When not in use, this wire shall be securely fastened at both ends of the duct.
14. Each conduit in a manhole, handhole, or pull box shall be identified with a stamped aluminum or brass tag bearing the conduit number. The tags shall be permanently attached to conduits by means of 316 stainless steel or nylon tie wrap. Install conduit couplings and cap ends of all spare underground conduits at each handhole/manhole.
15. Each conduit shall be identified at each end with a permanent non-corrosive metal marker. Designation shall be pressure stamped into the tag. The conduit identification shall be the designated conduit number as shown.

16. Separation and Support:

    a. Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type raceways used, and in no case greater than 10-feet.

    b. Support raceways installed in fill areas to prevent accidental bending until backfilling is complete. Tie raceways to supports, and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.

17. Arrangement and Routing:

    a. Arrange multiple conduit runs substantially in accordance with any details shown on the Drawings. Locate underground conduits where indicated on the Drawings.

    b. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Engineer for instructions before further work is done.

    c. Where other utility piping systems are encountered or being installed along a raceway route, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems. Refer conflicts with these requirements to the Engineer for instructions before further work is done.

    d. Provide insulated grounding bushings on all metallic raceways entering manholes. Provide bell-ends flush with manhole walls on all nonmetallic raceways entering manholes.

    e. In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.

    f. Provide markers at grade to indicate the direction of underground conduits provided under this Contract. Provide markers consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction. Provide markers at all bends and at intervals not exceeding 100-feet in straight runs. Use markers made of sheet bronze not less than 1/4-inch thick embedded in and secured to the top of concrete posts. Use markers not less than 10-inches long and 3/4-inch wide and marked ELECTRIC CABLES in letters 1/4-inch high incised into the bronze to a depth of 3/32-inch.

    g. All conduits shall enter maintenance holes and structures at right angles.

18. Raceway Coating:

    a. At couplings and joints, coat metallic underground direct-burial conduits with Koppers Bitumastic No. 505 or equal, or wrap with Scotchwrap No. 51, or equal plastic tape with 1/2-inch overlap.

19. Direct Earth Burial Conduit Zone Backfill Installation:

    a. Backfill material for the conduit zone of direct burial conduit trenches may be selected from the excavated material if it is free from roots, foreign material, and oversized particles.

    b. Use material with 3/4-inch maximum particle size and suitable gradation for satisfactory compaction. Remove material if necessary to meet these requirements.

    c. Imported 3/4-inch minus gravel or sand may be used in lieu of material from the excavation.

d. After conduits have been properly installed, backfill the trench with specified material placed around the conduits and carefully tamped around and over them with hand tampers. Final, tamped conduit cover shall be 4-inches minimum.

20. Backfill Installation Above Conduit Zone of Direct Burial Conduit:

a. Unless otherwise required in Section 0200 “Earthwork”, Backfill material above the conduit zone of direct burial conduit may be selected from the excavated material, if it contains no particles larger than 3-inches in diameter and is free from roots or debris. Imported material meeting these same requirements may be used in lieu of material from the excavation. Compact backfill in maximum 12-inch layers to at least 95 percent of the maximum density at optimum moisture content as determined by ASTM D 1557.

N. Wireways:

1. Mount wireways securely in accordance with the LAEC and manufacturer's instructions. Locate removable cover or hinged cover on accessible vertical face of wireway unless otherwise indicated.

O. Empty Raceways

1. Certain raceways will have no conductors pulled in as part of this Contract. Identify with tags at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Raceway Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Mandrel and provide a nylon pull cord in each empty raceway.

P. Firestops:

1. The Contractor shall furnish adequate firestops and seals for cables, conduits, trays, and wireways, etc., passing through building floors or wall openings.

2. Products which utilize intumescent compounds capable of being leached out by water shall not be used.

3. Flamenastic 71A, Vimasco No. 1-A, or equal, shall be used for this purpose and shall be applied in accordance with manufacturer's recommendations.

Q. Painting

1. Paint raceway systems in accordance with and as specified in Section 09900 - Protective Coating Systems.

3.03 Field Quality Control

A. Provide raceway systems meeting or exceeding the requirements of the NEC.

3.04 Adjusting / Cleaning / Protection

A. Following installation, protect products from the effects of moisture, corrosion, and physical damage during construction. Keep openings in conduit and tubing capped with manufactured seals during construction.

****END OF SECTION****

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SECTION 16115
JUNCTION AND DEVICE BOXES AND FITTINGS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all electrical junction boxes, device boxes, fixture support boxes, floor boxes, terminal cabinets and fittings.

B. Type: Unless otherwise listed, all junction boxes, device boxes, fittings, etc., shall be hot-dip galvanized cast ferrous alloy type. All exposed boxes and fittings shall be PVC coated.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16450	Grounding

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
ANSI C80.1	Electrical Rigid Steel Conduit
UL 1	Flexible Metal Conduit
UL 5	Surface Metal Raceway and Fittings
UL 6	Electrical Rigid Metal Conduit – Steel

Reference	Title
UL 514B	Conduit, Tubing and Cable Fittings
UL 651	Schedule 40 and 80 Rigid PVC Conduit and Fittings
NEMA RNI-2005	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC-2-2003	Electrical PVC Tubing and Conduit
NEMA TC-3-2004	PVC Fittings for Use With Rigid PVC Conduit and Tubing

1.03 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 and 16010.

1.04 Quality Assurance

A. The boxes and fittings shall be premium quality suitable for installation in a Wastewater Facility.

1.05 Project / Site Conditions

A. The boxes and fittings will be installed in a Wastewater Facility. Ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity may be expected to fluctuate between 10 percent and 100 percent. In some installations, the boxes and fittings may be subjected to hydrogen sulfide gas, dust, moisture, and methane gas.

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. Junction boxes; device boxes; fixture support boxes; and oblong, round and rectangular conduit fittings shall be hot-dip galvanized cast ferrous alloy. Integrally cast threaded hubs or bosses shall be provided for all conduit entrances and shall provide for full 5-thread contact on tightening. Drilling and threading shall be done before galvanizing. The cover plate shall be of similar hot-dip galvanized cast ferrous alloy material. A full body neoprene gasket and Type 316 stainless steel screws shall be provided for all covers. Hubs for connection of conduit to sheet steel junction, device or terminal boxes shall be made of cast ferrous alloy, electroplated with zinc, and shall have insulating bushings. The hubs shall utilize a neoprene "O"-ring and shall provide a watertight connection.

B. Outlet and Switch Boxes: Outlet and switch boxes shall be FS or FD boxes as manufactured by Crouse-Hinds, Appleton, or equal. Boxes shall be provided with blank covers for all unused openings.

C. Ganged Boxes: Outlet and device boxes shall be ganged where two or more devices are located together. Device covers shall be ganged for gang boxes and shall be gasketed with suitable neoprene gaskets to fit the devices and box used.

D. Sheet Steel Boxes: Boxes larger than FD boxes shall be fabricated from code gage steel, finished inside and out as specified for terminal cabinets. Before finish is applied, a grounding pad drilled for two bolted grounding lugs or a grounding stud shall be welded to the inside of the box. All hardware shall be Type 316 stainless steel. Boxes shall, as a minimum, meet NEMA 12 and JIC requirements and shall be NEMA 4 where exposed to the weather or dripping water.

E. Explosion-Proof Boxes and Fittings: In all Class I, Divisions 1 and 2, hazardous areas, boxes and fittings shall be explosion-proof and shall comply with Article 500 of the NEC. Seals for conduit systems in hazardous atmosphere locations shall be of hot-dip galvanized cast ferrous alloy, and each seal shall be of a suitable configuration for the individual circumstance. Sealing compound shall be UL listed for explosion-proof sealing fittings and shall be of the same manufacture as the fittings.

F. Boxes in Corrosive Areas: Boxes and fittings located in corrosive areas shall be NEMA 4X. This material shall be fiberglass reinforced polyester with minimum properties as follows:

1. Compressive strength: 28,000 psi.
2. Flexural strength: 15,000 psi per ASTM D790 and D675.
3. Tensile strength: 12,000 psi per ASTM D638.
4. Flame-resistant and self-extinguishing per ASTM D635.

G. All conduit entries shall use ferrous alloy hubs with 40 mil epoxy coating. All conduit entering plastic boxes and any exposed metal on plastic boxes which is not isolated from the interior of the box shall be bonded together with a suitable grounding conductor. Corrosive areas shall be as noted in Section 16010 and/or as shown on the drawings.

PART 3 - EXECUTION

3.01 Examination

3.02 Preparation

3.03 Installation

A. Outlet and switch boxes shall be located to provide ample clearance between fixtures and pipes, beams and ducts. The location shall be verified on the job to avoid conflict with other work. Boxes shall be accurately placed and shall be independently and securely supported. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes nor shall welding or brazing be used for attachment. Boxes shall be secured by galvanized brackets, expansion bolts, toggle bolts, or machine or wooden screws depending on the type of construction. Unless otherwise indicated, receptacle boxes shall be mounted 12 inches above the floor in offices and similar areas and 48 inches above the floor in all other areas. Switch boxes shall be mounted 48 inches above the floor.

B. Boxes in corrosive atmospheres or wet locations shall be PVC or PVC coated cast steel with threaded hubs.

****END OF SECTION****

SECTION 16120
WIRE AND CABLES, 600 VOLTS AND BELOW

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all raceways, wire ways, raceway supports, cable trays and concrete encased ducts.

B. Type: All raceways shall be polyvinyl chloride (PVC) coated rigid galvanized steel, Robroy Plasti-Bond II or equal, conduit unless otherwise noted

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Secton 17506	Extended Warranty and Maintenance
Section 17512	Site Acceptance Tests

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
ICEA S-61-402/NEMA WC-5	Thermoplastic - Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-19/NEMA WC-3	Rubber - Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
S-68-524/NEMA WC-7	Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
S-68-516/NEMA WC-8	Ethylene Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NFPA	National Fire Protection Association
UL 62	Flexible Cord and Fixture Wire
UL 83	Insulated Wires and Cables
UL 486A	Wire Connectors and Soldering Lugs for use with Copper Conductors
UL 486B	Wire Connectors for use with Aluminum Conductors
UL 510	Insulating Tape
UL 1277	Electric Power and Control Tray Cables with Optical Fiber Members
UL 1449	Safety Transient Voltage Surge Suppressors
NEMA WC-55	Instrumentation Cables and Thermocouple Wire
NEMA WC-57	Control Cables
ASTM B8	Standard Specifications from Concentric Lay Standard Copper Conductors, Hard, Medium-Hard or Soft
Title 8	Industrial Relations, Subchapter 5, Electrical Safety Orders, California Code of Regulations

1.03 Definitions

A. Cable: Multi-conductor, insulated, with outer sheath.

   1. May contain either building wire or instrumentation wire.

B. Instrumentation Cable: Multiple conductors, insulated, twisted with outer sheath, intended for transmission and distribution of low current (4-20 mA DC) or low voltage (0-10 V DC) analog signals, No. 16 AWG and smaller. Commonly used types are defined in the following:

   1. TWP: Twisted pair without shield.
   2. TWSP: Twisted shielded pair.
   3. TWST: Twisted-shielded triad.

C. Wire: Single conductor, insulated, with or without outer jacket depending upon type

1.04 Submittals

A. The submittals shall comply with the provisions set forth in Sections 01300 and 16010.

B. Shop Drawings shall include:

1. Product technical data including:
   a. Acknowledgement that submitted products meet requirements of standards.
   b. Catalog cuts and other brochures depicting conductor characteristics.
   c. Manufacturer's recommended splicing, testing, and installation procedures and practices and Manufacturer's installation instructions.
2. Manufacturer's certified test records, factory test procedures and test Reports.
3. Samples

C. Field testing using attached Cable Test Data Form, HI-POT and Megger tests including certified test reports. Also, include splicing personnel qualifications.

1.05 Quality Assurance

A. The wire and cable shall be of premium quality suitable for installation in Wastewater facilities.

B. All Conductors furnished by the CONTRACTOR shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL).

C. The construction and installation of all electrical equipment and materials shall comply with all provisions of the CAL OSHA Safety Orders Title 8 CCR, as applicable), State Building Standards, and applicable local codes and regulations

1.06 Delivery, Storage, and Handling

A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location as agreeable with Site Engineer, secure from weather or accidental damage.

1.07 Project / Site Conditions

A. The wire and cable will be installed in raceways in a wastewater facility. Ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent. In some installations, the wire and cable will be subjected to hydrogen sulfide gas, dust, moisture, and methane gas.

PART 2 - PRODUCTS

2.01 Manufacturers

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the GENERAL REQUIREMENTS.

B. Building wire, power and control cable.

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

a. Alpha Wire Corporation.

b. American Insulated Wire Corporation.

c. Belden Wire and Cable.

d. Carol Cable Company.

e. General Cable.

2. Conform to UL 444, Communications Cable, NEC type CMP, tinned copper conductors, 100 percent shield coverage, single TSP, Teflon insulated with Teflon jacket in all applications except small diameter.

3. Multiple conductor, small diameter instrumentation cable shall be used where existing conduits limit conduit space as called out on drawings.

   a. Plenum type single or multi paired, twisted pairs, overall shield with drain wire.

   b. FEP or FPR insulation and jacket.

   c. Moisture and flame resistance.

   d. Jacket thickness 0.015 IN minimum.

   e. Maximum outside diameter:

      1) 1 PR – 0.125 IN.

      2) 2 PR – 0.180 IN.

4. Telephone cable.

   a. Solid conductors, tinned copper, No. 24 AWG.

   b. 150 volt, vinyl insulated.

   c. UL listed 2576

2.02 Equipment and Materials

A. Unless otherwise indicated, provide stranded conductors, except provide solid conductors where No. 10 AWG and No. 12 AWG are designated for branch circuit power wiring in lighting and receptacle circuits.

B. For all direct burial and aerial conductors and cables, provide conductors with UL labeling "TYPE USE" and RHW insulation with heavy-duty, black, neoprene sheath meeting the physical requirements and minimum thickness requirements of ICEA S-19-81 and NEMA WC 3.

C. Where flexible cords and cables are specified, provide Type SO, 600-volt, with the number and size of copper conductors indicated.

D. Insulation

1. All conductors shall be rated at 600 Volts unless noted otherwise within this specification section.

2. All wiring shall be type THWN unless otherwise noted within this specification section.

3. All conductors shall be sized for operation at 75 degrees C maximum operating temperature.

4. For power conductors, provide all single conductors and individual conductors of multi-conductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding by applying a heat shrink tube of the appropriate color.

E. Conductors

1. Unless specifically noted otherwise herein, all conductors for general wiring shall be a minimum of 98% conductivity, stranded, soft drawn copper. Aluminum or aluminum alloys are not acceptable.
2. 120 Volt control, indicator, signal and metering conductors may be #14 AWG, and shall be stranded.

F. Instrumentation Signal Cables

1. Instrumentation signal cables shall be of the type used for process control with twisted shielded pairs or triads with polyvinyl jacket an overall shield over the multiple pairs or triads.
2. The instrumentation cable shall be rated 600 Volts at 90 degrees C or better.
3. The size of the instrumentation cable shall be AWG No. 16 with seven strands minimum.
4. All instrumentation cables shall be UL listed. Belden 8719 (Pairs), Belden 8618 (Triads) or equal.

G. PLC Communications Cables

1. Communication cables for remote I/O connections and for PLC high speed data communications shall be as recommended by the manufacturer of the PLC equipment.

H. Ethernet Communications Cables

1. Ethernet communication cables shall be Cat 5, Unshielded Twisted Pair (UTWP) for building interiors.
2. Ethernet communication cables shall be gel filled outdoor rated Cat 5, Unshielded Twisted Pairs for site and building exteriors and no more than 50 feet into building interiors.

I. Portable Cable:

1. Cord shall be NEMA Type SOW-A flexible cord rated at -50 deg C to 105 deg C. All cords shall contain an equipment grounding conductor. Cord shall be rated for use as a fully submersible cable.
2. Conductors: Bunch or rope stranded, uncoated annealed copper conforming to UL and CSA requirements. A suitable separator is applied over the conductor.
3. Insulation: Ethylene Propylene (EPDM) conforming to UL Standard 1581 and CSA requirements. Minimum average wall thickness is 45 mils for 14 AWG, 12AWG, and 10 AWG; and 50 mils for sizes 8 AWG through 2 AWG.
4. Color code: Insulation colored as follows:
   a. 2 Conductors - Black, White
   b. 3 Conductors - Black, White, Green
   c. 4 Conductors - Black, White, Red, Green
   d. 5 Conductors - Black, White, Red, Green and Orange
5. Cable assembly: The applicable number of insulated conductors are cable together with elastomeric fillers, as necessary, and with a suitable lay.
6. Jacket: Black or Yellow special thermosetting compound conforming to UL and CSA requirements.
7. Marking: Jacket surface is printed in accordance with requirements of UL, CSA and MSHA.

8. Portable cord for supply to permanent installations, such as pumps, cranes, hoists and portable equipment shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Weatherproof strain relief fittings shall be used for all connections. To prevent unnecessary strain on cords, 45-degree and 90-degree connectors shall be used where applicable. Flexible cords feeding submersible non-wicking neoprene construction.
9. Manufacturer shall be American Mustang, York Wire & Cable or equal.

J. VFD Cable:

1. The cable shall be 600V/1000V rated, with stranded tinned copper conductors, shielded, suitable for use with Variable Frequency Drives.
2. The insulation shall be rated 90 degrees Celsius Wet/Dry operating temperature.
3. Terminations shall have rating that are at least equal to those of the cable.
4. The conductor shall be annealed stranded tinned copper per ASTM B3, B8 and B33.
5. The insulation shall have a minimum average wall thickness of 30 mils with the insulation mater XLPE with a XHHW-2 listing per UL 44. The insulated conductors shall be cabled together with a minimum of one ground wire with a minimum circular mil area equivalent to one circuit conductor. Fillers shall be included as necessary to make the cable round.
6. The cabled assembly shall be shielded with helically two 2-mil copper tapes that provide 100% coverage over the assembly or with a a 80% minimum coverage tinned copper braid shield used in conjunction with an Aluminum foil shield tape.
7. All cables shall have a continuous overall outer sheath of polyvinyl chloride suitable for 90 degree Celsius use.
8. Manufacturer shall be Belden VFD cable, Lapp Group Olfex or equal.

K. Control Cable:

1. Control cable shall be Type SO extra flexible and shall consist of No. 16 copper conductors insulated for 600 volt service. The overall jacket shall consist of 7/64-inch neoprene minimum. The number of conductors shall be as shown on the drawings.

L. Grounding Wire

1. Ground wires, no. 1/0 AWG or larger tinned stranded bare copper cable. All smaller ground wires shall be insulated with green color insulation.

2.03 Components and Accessories

A. Connections

1. Wire nuts for joints, splices and taps for conductors #8 and smaller shall consist of a cone shaped expandable coil spring insert, insulated with a teflon or plastic shell. Threaded or crimp types will not be accepted. Use "Skotchlock", "Hydent", or equal.
2. Terminals for stranded conductors #8 and smaller shall be a pre-insulated crimp type.
3. Lugs and connectors for conductors #6 and larger shall be compression types of one piece tubular construction with flat rectangular tongues. Two hole lugs shall be used for sizes 4/0 and larger. Fittings for copper conductors shall be tin-plated copper.

B. Wire and Cabling Termination and Splicing

1. Subject to compliance with Contract Documents, the following manufacturers are acceptable.

a. Burndy Corporation

b. Ideal

c. Minnesota Mining and Manufacturing Co

d. Penn Union

e. Thomas and Betts

f. Or Equal

2. Splicing of cables and wires in the manholes and handholes shall be kept at a minimum. Where it is possible to pull cables or wires directly through the manholes or handholes, splicing shall be moisture-proof and encapsulated using insulating sealing compound. Splicing kits similar to 3M Company 82A or 8500 Series shall be utilized.

C. Labeling

1. Provide complete power and control conductor identification system so that after installation, circuits can be easily traced from origin to final destination.

2. Conductor labels shall be white PVC tubing with machine printed black marking. Tubing shall be sized to fit conductor insulation. Adhesive strips are not acceptable. Machine printed markings, directly on conductors, will be accepted. Panduit, Thomas & Betts, or equal.

3. Tag conductors using a three-segment conductor numbering scheme which defines the origin of the conductor, the function of the conductor, and the destination of the conductor.

a. Example: MCCA-P-MCCB where MCCA is the origin, P is the function identification (P = power, C = control, S = signal, etc.), and MCCB is the destination.

b. For conductors with one point of origin and two or more destinations, expand the function identification number, e.g., PA, PB, etc.

c. Make the origin and destination identification the specific names for the equipment used in the Contract Documents. Make the instrumentation and control identification names exactly as designated, i.e., FT-S-121.

4. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation, with machine printed black marking capable of accepting 24 machine printed character per sleeve label. Adhesive strips are not acceptable.

D. Pulling Lubricant

1. All cables shall be properly coated with pulling compound recommended by the cable manufacturer before being pulled into conduits so as to prevent mechanical damage to the cables during installation.

2. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

E. Electrical Tape

1. Pressure sensitive vinyl.

2. Premium grade.

3. Heat, cold, moisture, and sunlight resistant.

4. UL listed.

5. Thickness, depending on use conditions: 7, 8.5. or 10 mil.

6. For cold weather or outdoor location, tape must also be all-weather rated.

7. Comply with UL 510

2.04 Fabrication

A. Electrical conductors shall be delivered to the job site plainly marked or tagged on 24 inch centers as follows:

1. Underwriters' Label.
2. Gauge.
3. Voltage.
4. Kind of Insulation.
5. Name of Manufacturer.
6. Trade Name

2.05 Source Quality Control

A. Phase A, B, C implies the direction of positive phase rotation.

PART 3 - EXECUTION

3.01 Preparation

A. Color Coding and Labeling. Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

DESCRIPTION	PHASE/CODE LETTER	WIRE OR TAPE COLOR
480 V, 3 PHASE	A	BROWN
	B	YELLOW
	C	ORANGE
208/120 V, 3 PHASE, 4 WIRE	A	BLACK
	B	RED
	C	BLUE
240/120V, 3 PHASE. 4 Wire	A	BLACK
	B	ORANGE (if High Leg)
	C	BLUE
240 / 120 V, 1 PHASE	L1	BLACK
	L2	RED
120 VAC UPS POWER	L1	ORANGE
DC CONTROL		LIGHT BLUE
NEUTRAL	N	WHITE
GROUND	G	GREEN
SHIELDED PAIR	+	BLACK
	-	CLEAR
PLC DI AND DO, 120 VAC		BLUE (NOTE 1)
LOW VOLTAGE CONTROL		VIOLET (NOTE 2)

Note 1 - Low voltage control electrically direct connected to PLC DI or DO points. Only the wire between the PLC DI or DO and its first landing point shall be BLUE. Wire between this point and other terminations or field devices shall be VIOLET.

Note 2 - Low voltage control not electrically direct connected to PLC DI or DO points. Low voltage includes 120 volts AC or DC and below. Control wiring includes wires, which follow control devices such as switches, or relays and which are not directly connected to power sources, fuses or circuit breakers.

1. In addition to color coding, all power, control, and alarm wiring shall be numbered and identified by means of wire markers at all service pedestals, motor control centers, panelboards, auxiliary gutters, junction boxes, pull boxes, receptacle outlets, light outlets, manholes, disconnect switches, and circuit breakers. These markers shall correspond to numbers on shop drawings, wiring diagrams and interconnection wiring diagrams. Wire markers shall consist of machine engraved numbers applied by an approved marking device.

B. Care shall be exercised in pulling wire and cable into conduit or trays so as to avoid kinking, putting undue stress on the cables, or otherwise abrading them. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. No grease will be permitted in pulling wire or cable. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved. contractor shall perform and submit pulling calculation per manufacturers recommendation to ascertain that there is no overstrain to the cable. The raceway construction shall be complete and protected from the weather before cable is pulled into it.

C. Single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations shall be wrapped together by arc and fireproofing tapes, and shall be bundled throughout their exposed length with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on centers.

D. Incoming wire in service pedestals, panels, and motor control centers, No. 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, and neatly spread into tees and connected to their respective terminals. Sufficient slack shall be allowed in cables for alterations in terminal connections. Lacing shall be done with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for wire runs, lacing is not necessary when the wire is properly installed in the ducts. Slack shall be provided in junction and pull boxes and in handholes and manholes. Amount of slack shall be equal to the largest perimeter dimension of the box.

E. Wires crossing hinges shall be made up into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

F. Electrical Tape Usage:

1. For insulating connections of #8 AWG wire and smaller: 7 mil vinyl tape.
2. For insulating splices and taps of #6 AWG wire or larger: 10 mil vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

G. Pulling:

1. No oil, grease or similar substances shall be used to facilitate the pulling in of conductors. Use a specifically approved wire pulling compound.
2. No wire or cable shall be pulled in until all construction which might damage insulation or fill conduit with foreign material is completed.
3. Wire shall be pulled into conduits with care to prevent damage to insulation, using basket pulling grips to avoid slipping of insulation on conductors. Nylon rope or other "soft" surfaced cable must be used for pulling in conduits other than steel.

H. Connections:

1. Stranded conductors #8 and smaller shall be terminated with terminals of appropriate size where connected to screw type lugs.
2. Joints, splices and taps in dry locations for conductors #8 and smaller shall be made with twist-on connectors suitably sized for the number and gauge of the conductors.
3. Furnish and install proper lugs in all service pedestals, panelboards, motor control centers and gutters as required to properly terminate every cable. Where paralleled conductors, or conductors of large size are to terminate on a breaker, a short length of copper cable (of capacity of the breaker) shall be connected to the breaker, and the proper compression type lug installed to connect this cable to the feeder cable. The cutting of cable strands to fit the breaker will not be permitted.
4. Only crimping tools approved by the manufacturer of the terminals or lugs shall be used.
5. Uninsulated lugs and wire ends shall be insulated with layers of plastic tape equal to insulation of wire and switchboards, with all irregular surfaces properly padded with insulating putty prior to application of tape. Wire in service pedestals, panels, cabinets, pullboxes and wiring gutters shall be neatly grouped together and laced with #12 standard lacing twine, or cable ties.
6. In underground location, joints, splices and taps shall be insulated by the "Skotchcast" epoxy-resin method. In-line splices may be insulated by approved waterproof "shrink tube" method.
7. In service pedestals, panels, pull boxes, gutter, etc. conductor shall be neatly fanned out and tagged with wire markers.
8. At outlets, junction boxes, pull-boxes, fittings, etc., conductors shall be looped or pigtailed to extend at least six inches without splice beyond such wiring enclosures, and where used, pigtails added to loops for connection to fixtures or devices shall be at least six inches long.
9. Conduit shall be capped during construction by means of manufactured conduit seals or caps to prevent entrance of water or debris, and shall remain closed until ready for use.

3.02 Installation

A. Install all wiring in raceway unless otherwise indicated on the drawings.

B. Power Feeder, power branch, control and instrumentation circuits shall be not combined in conduit, wireway, junction or pull boxes; except as permitted in the following:

1. Where specifically indicated on the drawings or field conditions dictate and written permission is obtained from the Engineer.
    a. Feeder and branch circuits shall be isolated from each other and from all control and instrumentation circuits.
    b. Control circuits shall be isolated from feeder, branch and instrumentation circuits.
    c. 12 VDC, 24 VDC and 48 VDC may utilize a common raceway.
    d. 125 VDC shall be isolated from all other AC and DC circuits.
    e. AC control circuits shall be isolated from all DC circuits.

C. Instrumentation circuits shall be isolated from feeder, branch and control circuits.

D. Ground the drain wire of shielded cables at one end only.

E. Maintain electrical continuity of the shield when splicing twisted shielded conductors.

F. Make splices and taps only at pull or junction boxes.

G. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. Contractor shall supply terminal boards as required.
2. Do not field wire directly to devices.
3. Ground both ends of spare wires.

H. All conduits containing conductors shall be sealed as the conduit enters pull boxes and electrical vaults and manholes. Power conductor, control conductors, and instrumentation conductors shall be bundled and supported separately and independently in pullboxes, vaults and manholes.

I. Cables:

1. Do not splice without permission of the ENGINEER or the INSPECTOR. Locate splices, when permitted, only in readily accessible cabinets or junction boxes using terminal strips. Splices will not be permitted unless deemed necessary by approved pulling tension calculations.
2. Where connections of cables installed under this section are to be made under Division Instrumentation and Controls, leave pigtails of adequate length for neat bundled type connections.
3. Instrumentation, computer, and control cables run under infinite access floors in control rooms may be installed under the floor without protection. Run individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least ½ inch in diameter.
4. Maintaining the integrity of shielding of instrumentation cables is essential to the operation of the control systems. Take special care in cable installation to ensure that grounds do not occur because of damage to the jacket over the shield.
5. Cables entering manholes, handholes or vaults shall be sealed using an expanding foam product approved for the purpose.

J. Conductor Arc and Fireproofing Tapes

1. Use arc and fireproofing tapes on all 600-volt single conductors and cables except those rated Type TC at splices in all maintenance holes, handholes, vaults, cable trays, and other indicated locations. Wrap together as a single cable all conductors entering from each conduit.
2. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.
3. Wrap together as far as possible, conductors carrying phases A, B, and C of the same feeder. Do not wrap together conductors carrying only two of the three phases.
4. The cables shall be trained as closely as possible to their final positions.
5. The cables shall be cleaned of all oil, grease, and cable pulling compounds using suitable solvents and cleaners non-injurious to cable and then wiped completely dry.
6. Any projecting surfaces such as fittings, ground connectors or bonding connections shall be covered with an insulating compound to present a smooth continuous surface for taping.
7. Fireproofing tapes shall be submitted as shop drawings for approval. Tapes shall be 3-inch width half-lapped and extend a minimum of 6-inches into the raceway. Use ¾” glass tape at three foot intervals to hold tape in place.

K. Labeling.

1. Each power and control circuit conductor shall be identified as shown at each terminal to which it is connected with a legible permanent coded marking sleeve. This includes all wring

terminations whether field terminations or interior wiring within switchboards, motor control centers, control panels, equipment, junction panels and boxes.

2. In each manhole, handhole and pull box, each conductor shall be similarly marked with a split sleeve, machine marked so the identification can be made using groups of letters and numbers.
3. Each wire and conductor shall be labeled with a wire label that corresponds and matches the wire labels shown on the approved interconnect drawings, loop drawings or elementary wiring diagrams.
4. For neutral wires such as jumpers between adjacent relay coil neutral terminal that are less than 7 inches in length, the wire label may be omitted if there isn't sufficient space for the labels.
5. Wire numbering shall be compatible and consistent with existing system and shall be approved by the engineer.
6. For general lighting and 120 volt powered receptacles, the wire labels shall be installed at each device with a label that consists of the panelboard name and the circuit number. For example, the Circuit Breaker located in the number 1 position of Panelboard "OPL2 would have its associated wiring labeled as "PNLOPL2-L1 (line power) and "PNLOPL2-N1 (Neutral).

L. Wire and Cabling Termination and Splicing

1. Power and control conductors shall be terminated in terminal blocks with solderless box lugs. Signal leads shall be terminated in terminal blocks with saddle-type pressure connectors capable of receiving two No. 16 AWG or smaller conductors on each point.
2. Splices in power wiring shall be made with two compression lugs bolted together. Splices in stranded control wiring or lighting circuits may be made with compression connectors. Splices in signal wiring shall be soldered. Splicing shall not be considered as a normal method of construction. Splicing shall be used only when no practical alternative exists to using terminals or point-to-point wiring. When utilized, splicing of 600 V or less insulated wire shall be made only in junction boxes. No splicing shall be permitted in conduit fittings.
3. Solid wire shall not be lugged nor shall electrical spring connectors be used on any wiring. Lugs and connectors shall be installed with a compression tool recommended by the lug manufacturer for the particular lug used. Pulling tensions shall not exceed the cable manufacturer's recommendations.
4. All conductors shall be tagged at each end in motor control centers, control panels, service pedestals and control stations with a legible permanent coded wire-marking sleeve. All conductors shall be identified in each manhole, handhole or pull box. Field conductors shall be similarly tagged at each end, except that each conductor termination shall have its marking sleeve imprinted with terminal identification for both ends of the conductor. A schedule shall be provided with the record drawings correlating these wire markings.
5. All splices and terminations for No. 1/0 AWG cable, and larger, shall be inspected by the Engineer prior to and after insulation is applied. Terminations at polyphase motors shall be made by bolt connecting the lugged conductors and then applying rubber filler tape and two 2-lapped layers of vinyl tape to equal or exceed the thickness of conductor insulation.

M. Grounding

1. A grounding system shall be installed in accordance with the National Electrical Code and specification section 16450. All grounding surfaces shall be thoroughly cleaned before connecting the grounding electrodes. All conduit shall be grounded directly or through equipment frames and ground buses to the grounding system.

2. In addition to the conduit system, all equipment having 480 volt, 120/208 volt or 120/240 volt supply shall be grounded to the supply source ground bus by a green insulated code sized ground conductor installed in the conduit with the phase cables. Ground conductors for small panels and equipment shall be of same size as associated conductors.

3.03 Adjusting / Cleaning / Protection

A. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

B. All debris and moisture shall be removed from both new and existing raceways, boxes, and cabinets before installing wire or cable

****END OF SECTION****

SECTION 16120
WIRE AND CABLES, 600 VOLTS AND BELOW

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all raceways, wire ways, raceway supports, cable trays and concrete encased ducts.

B. Type: All raceways shall be polyvinyl chloride (PVC) coated rigid galvanized steel, Robroy Plasti-Bond II or equal, conduit unless otherwise noted

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Secton 17506	Extended Warranty and Maintenance
Section 17512	Site Acceptance Tests

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

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Title 8	Industrial Relations, Subchapter 5, Electrical Safety Orders, California Code of Regulations

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   1. May contain either building wire or instrumentation wire.

B. Instrumentation Cable: Multiple conductors, insulated, twisted with outer sheath, intended for transmission and distribution of low current (4-20 mA DC) or low voltage (0-10 V DC) analog signals, No. 16 AWG and smaller. Commonly used types are defined in the following:

   1. TWP: Twisted pair without shield.
   2. TWSP: Twisted shielded pair.
   3. TWST: Twisted-shielded triad.

C. Wire: Single conductor, insulated, with or without outer jacket depending upon type

1.04 Submittals

A. The submittals shall comply with the provisions set forth in Sections 01300 and 16010.

B. Shop Drawings shall include:

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   a. Acknowledgement that submitted products meet requirements of standards.
   b. Catalog cuts and other brochures depicting conductor characteristics.
   c. Manufacturer's recommended splicing, testing, and installation procedures and practices and Manufacturer's installation instructions.
2. Manufacturer's certified test records, factory test procedures and test Reports.
3. Samples

C. Field testing using attached Cable Test Data Form, HI-POT and Megger tests including certified test reports. Also, include splicing personnel qualifications.

1.05 Quality Assurance

A. The wire and cable shall be of premium quality suitable for installation in Wastewater facilities.

B. All Conductors furnished by the CONTRACTOR shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL).

C. The construction and installation of all electrical equipment and materials shall comply with all provisions of the CAL OSHA Safety Orders Title 8 CCR, as applicable), State Building Standards, and applicable local codes and regulations

1.06 Delivery, Storage, and Handling

A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location as agreeable with Site Engineer, secure from weather or accidental damage.

1.07 Project / Site Conditions

A. The wire and cable will be installed in raceways in a wastewater facility. Ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent. In some installations, the wire and cable will be subjected to hydrogen sulfide gas, dust, moisture, and methane gas.

PART 2 - PRODUCTS

2.01 Manufacturers

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the GENERAL REQUIREMENTS.

B. Building wire, power and control cable.

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

a. Alpha Wire Corporation.

b. American Insulated Wire Corporation.

c. Belden Wire and Cable.

d. Carol Cable Company.

e. General Cable.

2. Conform to UL 444, Communications Cable, NEC type CMP, tinned copper conductors, 100 percent shield coverage, single TSP, Teflon insulated with Teflon jacket in all applications except small diameter.

3. Multiple conductor, small diameter instrumentation cable shall be used where existing conduits limit conduit space as called out on drawings.

   a. Plenum type single or multi paired, twisted pairs, overall shield with drain wire.

   b. FEP or FPR insulation and jacket.

   c. Moisture and flame resistance.

   d. Jacket thickness 0.015 IN minimum.

   e. Maximum outside diameter:

      1) 1 PR – 0.125 IN.

      2) 2 PR – 0.180 IN.

4. Telephone cable.

   a. Solid conductors, tinned copper, No. 24 AWG.

   b. 150 volt, vinyl insulated.

   c. UL listed 2576

2.02 Equipment and Materials

A. Unless otherwise indicated, provide stranded conductors, except provide solid conductors where No. 10 AWG and No. 12 AWG are designated for branch circuit power wiring in lighting and receptacle circuits.

B. For all direct burial and aerial conductors and cables, provide conductors with UL labeling "TYPE USE" and RHW insulation with heavy-duty, black, neoprene sheath meeting the physical requirements and minimum thickness requirements of ICEA S-19-81 and NEMA WC 3.

C. Where flexible cords and cables are specified, provide Type SO, 600-volt, with the number and size of copper conductors indicated.

D. Insulation

1. All conductors shall be rated at 600 Volts unless noted otherwise within this specification section.

2. All wiring shall be type THWN unless otherwise noted within this specification section.

3. All conductors shall be sized for operation at 75 degrees C maximum operating temperature.

4. For power conductors, provide all single conductors and individual conductors of multi-conductor power cables with integral insulation pigmentation of the designated colors, except conductors larger than No. 6 AWG may be provided with color coding by applying a heat shrink tube of the appropriate color.

E. Conductors

1. Unless specifically noted otherwise herein, all conductors for general wiring shall be a minimum of 98% conductivity, stranded, soft drawn copper. Aluminum or aluminum alloys are not acceptable.
2. 120 Volt control, indicator, signal and metering conductors may be #14 AWG, and shall be stranded.

F. Instrumentation Signal Cables

1. Instrumentation signal cables shall be of the type used for process control with twisted shielded pairs or triads with polyvinyl jacket an overall shield over the multiple pairs or triads.
2. The instrumentation cable shall be rated 600 Volts at 90 degrees C or better.
3. The size of the instrumentation cable shall be AWG No. 16 with seven strands minimum.
4. All instrumentation cables shall be UL listed. Belden 8719 (Pairs), Belden 8618 (Triads) or equal.

G. PLC Communications Cables

1. Communication cables for remote I/O connections and for PLC high speed data communications shall be as recommended by the manufacturer of the PLC equipment.

H. Ethernet Communications Cables

1. Ethernet communication cables shall be Cat 5, Unshielded Twisted Pair (UTWP) for building interiors.
2. Ethernet communication cables shall be gel filled outdoor rated Cat 5, Unshielded Twisted Pairs for site and building exteriors and no more than 50 feet into building interiors.

I. Portable Cable:

1. Cord shall be NEMA Type SOW-A flexible cord rated at -50 deg C to 105 deg C. All cords shall contain an equipment grounding conductor. Cord shall be rated for use as a fully submersible cable.
2. Conductors: Bunch or rope stranded, uncoated annealed copper conforming to UL and CSA requirements. A suitable separator is applied over the conductor.
3. Insulation: Ethylene Propylene (EPDM) conforming to UL Standard 1581 and CSA requirements. Minimum average wall thickness is 45 mils for 14 AWG, 12AWG, and 10 AWG; and 50 mils for sizes 8 AWG through 2 AWG.
4. Color code: Insulation colored as follows:
   a. 2 Conductors - Black, White
   b. 3 Conductors - Black, White, Green
   c. 4 Conductors - Black, White, Red, Green
   d. 5 Conductors - Black, White, Red, Green and Orange
5. Cable assembly: The applicable number of insulated conductors are cable together with elastomeric fillers, as necessary, and with a suitable lay.
6. Jacket: Black or Yellow special thermosetting compound conforming to UL and CSA requirements.
7. Marking: Jacket surface is printed in accordance with requirements of UL, CSA and MSHA.

8. Portable cord for supply to permanent installations, such as pumps, cranes, hoists and portable equipment shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Weatherproof strain relief fittings shall be used for all connections. To prevent unnecessary strain on cords, 45-degree and 90-degree connectors shall be used where applicable. Flexible cords feeding submersible non-wicking neoprene construction.
9. Manufacturer shall be American Mustang, York Wire & Cable or equal.

J. VFD Cable:

1. The cable shall be 600V/1000V rated, with stranded tinned copper conductors, shielded, suitable for use with Variable Frequency Drives.
2. The insulation shall be rated 90 degrees Celsius Wet/Dry operating temperature.
3. Terminations shall have rating that are at least equal to those of the cable.
4. The conductor shall be annealed stranded tinned copper per ASTM B3, B8 and B33.
5. The insulation shall have a minimum average wall thickness of 30 mils with the insulation mater XLPE with a XHHW-2 listing per UL 44. The insulated conductors shall be cabled together with a minimum of one ground wire with a minimum circular mil area equivalent to one circuit conductor. Fillers shall be included as necessary to make the cable round.
6. The cabled assembly shall be shielded with helically two 2-mil copper tapes that provide 100% coverage over the assembly or with a a 80% minimum coverage tinned copper braid shield used in conjunction with an Aluminum foil shield tape.
7. All cables shall have a continuous overall outer sheath of polyvinyl chloride suitable for 90 degree Celsius use.
8. Manufacturer shall be Belden VFD cable, Lapp Group Olfex or equal.

K. Control Cable:

1. Control cable shall be Type SO extra flexible and shall consist of No. 16 copper conductors insulated for 600 volt service. The overall jacket shall consist of 7/64-inch neoprene minimum. The number of conductors shall be as shown on the drawings.

L. Grounding Wire

1. Ground wires, no. 1/0 AWG or larger tinned stranded bare copper cable. All smaller ground wires shall be insulated with green color insulation.

2.03 Components and Accessories

A. Connections

1. Wire nuts for joints, splices and taps for conductors #8 and smaller shall consist of a cone shaped expandable coil spring insert, insulated with a teflon or plastic shell. Threaded or crimp types will not be accepted. Use "Skotchlock", "Hydent", or equal.
2. Terminals for stranded conductors #8 and smaller shall be a pre-insulated crimp type.
3. Lugs and connectors for conductors #6 and larger shall be compression types of one piece tubular construction with flat rectangular tongues. Two hole lugs shall be used for sizes 4/0 and larger. Fittings for copper conductors shall be tin-plated copper.

B. Wire and Cabling Termination and Splicing

1. Subject to compliance with Contract Documents, the following manufacturers are acceptable.

a. Burndy Corporation

b. Ideal

c. Minnesota Mining and Manufacturing Co

d. Penn Union

e. Thomas and Betts

f. Or Equal

2. Splicing of cables and wires in the manholes and handholes shall be kept at a minimum. Where it is possible to pull cables or wires directly through the manholes or handholes, splicing shall be moisture-proof and encapsulated using insulating sealing compound. Splicing kits similar to 3M Company 82A or 8500 Series shall be utilized.

C. Labeling

1. Provide complete power and control conductor identification system so that after installation, circuits can be easily traced from origin to final destination.

2. Conductor labels shall be white PVC tubing with machine printed black marking. Tubing shall be sized to fit conductor insulation. Adhesive strips are not acceptable. Machine printed markings, directly on conductors, will be accepted. Panduit, Thomas & Betts, or equal.

3. Tag conductors using a three-segment conductor numbering scheme which defines the origin of the conductor, the function of the conductor, and the destination of the conductor.

a. Example: MCCA-P-MCCB where MCCA is the origin, P is the function identification (P = power, C = control, S = signal, etc.), and MCCB is the destination.

b. For conductors with one point of origin and two or more destinations, expand the function identification number, e.g., PA, PB, etc.

c. Make the origin and destination identification the specific names for the equipment used in the Contract Documents. Make the instrumentation and control identification names exactly as designated, i.e., FT-S-121.

4. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation, with machine printed black marking capable of accepting 24 machine printed character per sleeve label. Adhesive strips are not acceptable.

D. Pulling Lubricant

1. All cables shall be properly coated with pulling compound recommended by the cable manufacturer before being pulled into conduits so as to prevent mechanical damage to the cables during installation.

2. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

E. Electrical Tape

1. Pressure sensitive vinyl.

2. Premium grade.

3. Heat, cold, moisture, and sunlight resistant.

4. UL listed.

5. Thickness, depending on use conditions: 7, 8.5. or 10 mil.

6. For cold weather or outdoor location, tape must also be all-weather rated.

7. Comply with UL 510

2.04 Fabrication

A. Electrical conductors shall be delivered to the job site plainly marked or tagged on 24 inch centers as follows:

1. Underwriters' Label.
2. Gauge.
3. Voltage.
4. Kind of Insulation.
5. Name of Manufacturer.
6. Trade Name

2.05 Source Quality Control

A. Phase A, B, C implies the direction of positive phase rotation.

PART 3 - EXECUTION

3.01 Preparation

A. Color Coding and Labeling. Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

DESCRIPTION	PHASE/CODE LETTER	WIRE OR TAPE COLOR
480 V, 3 PHASE	A	BROWN
	B	YELLOW
	C	ORANGE
208/120 V, 3 PHASE, 4 WIRE	A	BLACK
	B	RED
	C	BLUE
240/120V, 3 PHASE. 4 Wire	A	BLACK
	B	ORANGE (if High Leg)
	C	BLUE
240 / 120 V, 1 PHASE	L1	BLACK
	L2	RED
120 VAC UPS POWER	L1	ORANGE
DC CONTROL		LIGHT BLUE
NEUTRAL	N	WHITE
GROUND	G	GREEN
SHIELDED PAIR	+	BLACK
	-	CLEAR
PLC DI AND DO, 120 VAC		BLUE (NOTE 1)
LOW VOLTAGE CONTROL		VIOLET (NOTE 2)

Note 1 - Low voltage control electrically direct connected to PLC DI or DO points. Only the wire between the PLC DI or DO and its first landing point shall be BLUE. Wire between this point and other terminations or field devices shall be VIOLET.

Note 2 - Low voltage control not electrically direct connected to PLC DI or DO points. Low voltage includes 120 volts AC or DC and below. Control wiring includes wires, which follow control devices such as switches, or relays and which are not directly connected to power sources, fuses or circuit breakers.

1. In addition to color coding, all power, control, and alarm wiring shall be numbered and identified by means of wire markers at all service pedestals, motor control centers, panelboards, auxiliary gutters, junction boxes, pull boxes, receptacle outlets, light outlets, manholes, disconnect switches, and circuit breakers. These markers shall correspond to numbers on shop drawings, wiring diagrams and interconnection wiring diagrams. Wire markers shall consist of machine engraved numbers applied by an approved marking device.

B. Care shall be exercised in pulling wire and cable into conduit or trays so as to avoid kinking, putting undue stress on the cables, or otherwise abrading them. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. No grease will be permitted in pulling wire or cable. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved. contractor shall perform and submit pulling calculation per manufacturers recommendation to ascertain that there is no overstrain to the cable. The raceway construction shall be complete and protected from the weather before cable is pulled into it.

C. Single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations shall be wrapped together by arc and fireproofing tapes, and shall be bundled throughout their exposed length with nylon, self-locking, releasable, cable ties placed at intervals not exceeding 12 inches on centers.

D. Incoming wire in service pedestals, panels, and motor control centers, No. 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, and neatly spread into tees and connected to their respective terminals. Sufficient slack shall be allowed in cables for alterations in terminal connections. Lacing shall be done with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for wire runs, lacing is not necessary when the wire is properly installed in the ducts. Slack shall be provided in junction and pull boxes and in handholes and manholes. Amount of slack shall be equal to the largest perimeter dimension of the box.

E. Wires crossing hinges shall be made up into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

F. Electrical Tape Usage:

1. For insulating connections of #8 AWG wire and smaller: 7 mil vinyl tape.
2. For insulating splices and taps of #6 AWG wire or larger: 10 mil vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

G. Pulling:

1. No oil, grease or similar substances shall be used to facilitate the pulling in of conductors. Use a specifically approved wire pulling compound.
2. No wire or cable shall be pulled in until all construction which might damage insulation or fill conduit with foreign material is completed.
3. Wire shall be pulled into conduits with care to prevent damage to insulation, using basket pulling grips to avoid slipping of insulation on conductors. Nylon rope or other "soft" surfaced cable must be used for pulling in conduits other than steel.

H. Connections:

1. Stranded conductors #8 and smaller shall be terminated with terminals of appropriate size where connected to screw type lugs.
2. Joints, splices and taps in dry locations for conductors #8 and smaller shall be made with twist-on connectors suitably sized for the number and gauge of the conductors.
3. Furnish and install proper lugs in all service pedestals, panelboards, motor control centers and gutters as required to properly terminate every cable. Where paralleled conductors, or conductors of large size are to terminate on a breaker, a short length of copper cable (of capacity of the breaker) shall be connected to the breaker, and the proper compression type lug installed to connect this cable to the feeder cable. The cutting of cable strands to fit the breaker will not be permitted.
4. Only crimping tools approved by the manufacturer of the terminals or lugs shall be used.
5. Uninsulated lugs and wire ends shall be insulated with layers of plastic tape equal to insulation of wire and switchboards, with all irregular surfaces properly padded with insulating putty prior to application of tape. Wire in service pedestals, panels, cabinets, pullboxes and wiring gutters shall be neatly grouped together and laced with #12 standard lacing twine, or cable ties.
6. In underground location, joints, splices and taps shall be insulated by the "Skotchcast" epoxy-resin method. In-line splices may be insulated by approved waterproof "shrink tube" method.
7. In service pedestals, panels, pull boxes, gutter, etc. conductor shall be neatly fanned out and tagged with wire markers.
8. At outlets, junction boxes, pull-boxes, fittings, etc., conductors shall be looped or pigtailed to extend at least six inches without splice beyond such wiring enclosures, and where used, pigtails added to loops for connection to fixtures or devices shall be at least six inches long.
9. Conduit shall be capped during construction by means of manufactured conduit seals or caps to prevent entrance of water or debris, and shall remain closed until ready for use.

3.02 Installation

A. Install all wiring in raceway unless otherwise indicated on the drawings.

B. Power Feeder, power branch, control and instrumentation circuits shall be not combined in conduit, wireway, junction or pull boxes; except as permitted in the following:

1. Where specifically indicated on the drawings or field conditions dictate and written permission is obtained from the Engineer.
    a. Feeder and branch circuits shall be isolated from each other and from all control and instrumentation circuits.
    b. Control circuits shall be isolated from feeder, branch and instrumentation circuits.
    c. 12 VDC, 24 VDC and 48 VDC may utilize a common raceway.
    d. 125 VDC shall be isolated from all other AC and DC circuits.
    e. AC control circuits shall be isolated from all DC circuits.

C. Instrumentation circuits shall be isolated from feeder, branch and control circuits.

D. Ground the drain wire of shielded cables at one end only.

E. Maintain electrical continuity of the shield when splicing twisted shielded conductors.

F. Make splices and taps only at pull or junction boxes.

G. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. Contractor shall supply terminal boards as required.
2. Do not field wire directly to devices.
3. Ground both ends of spare wires.

H. All conduits containing conductors shall be sealed as the conduit enters pull boxes and electrical vaults and manholes. Power conductor, control conductors, and instrumentation conductors shall be bundled and supported separately and independently in pullboxes, vaults and manholes.

I. Cables:

1. Do not splice without permission of the ENGINEER or the INSPECTOR. Locate splices, when permitted, only in readily accessible cabinets or junction boxes using terminal strips. Splices will not be permitted unless deemed necessary by approved pulling tension calculations.
2. Where connections of cables installed under this section are to be made under Division Instrumentation and Controls, leave pigtails of adequate length for neat bundled type connections.
3. Instrumentation, computer, and control cables run under infinite access floors in control rooms may be installed under the floor without protection. Run individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least ½ inch in diameter.
4. Maintaining the integrity of shielding of instrumentation cables is essential to the operation of the control systems. Take special care in cable installation to ensure that grounds do not occur because of damage to the jacket over the shield.
5. Cables entering manholes, handholes or vaults shall be sealed using an expanding foam product approved for the purpose.

J. Conductor Arc and Fireproofing Tapes

1. Use arc and fireproofing tapes on all 600-volt single conductors and cables except those rated Type TC at splices in all maintenance holes, handholes, vaults, cable trays, and other indicated locations. Wrap together as a single cable all conductors entering from each conduit.
2. Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape. Make each band of at least two wraps of tape directly over each other.
3. Wrap together as far as possible, conductors carrying phases A, B, and C of the same feeder. Do not wrap together conductors carrying only two of the three phases.
4. The cables shall be trained as closely as possible to their final positions.
5. The cables shall be cleaned of all oil, grease, and cable pulling compounds using suitable solvents and cleaners non-injurious to cable and then wiped completely dry.
6. Any projecting surfaces such as fittings, ground connectors or bonding connections shall be covered with an insulating compound to present a smooth continuous surface for taping.
7. Fireproofing tapes shall be submitted as shop drawings for approval. Tapes shall be 3-inch width half-lapped and extend a minimum of 6-inches into the raceway. Use ¾” glass tape at three foot intervals to hold tape in place.

K. Labeling.

1. Each power and control circuit conductor shall be identified as shown at each terminal to which it is connected with a legible permanent coded marking sleeve. This includes all wring

terminations whether field terminations or interior wiring within switchboards, motor control centers, control panels, equipment, junction panels and boxes.

2. In each manhole, handhole and pull box, each conductor shall be similarly marked with a split sleeve, machine marked so the identification can be made using groups of letters and numbers.
3. Each wire and conductor shall be labeled with a wire label that corresponds and matches the wire labels shown on the approved interconnect drawings, loop drawings or elementary wiring diagrams.
4. For neutral wires such as jumpers between adjacent relay coil neutral terminal that are less than 7 inches in length, the wire label may be omitted if there isn't sufficient space for the labels.
5. Wire numbering shall be compatible and consistent with existing system and shall be approved by the engineer.
6. For general lighting and 120 volt powered receptacles, the wire labels shall be installed at each device with a label that consists of the panelboard name and the circuit number. For example, the Circuit Breaker located in the number 1 position of Panelboard "OPL2 would have its associated wiring labeled as "PNLOPL2-L1 (line power) and "PNLOPL2-N1 (Neutral).

L. Wire and Cabling Termination and Splicing

1. Power and control conductors shall be terminated in terminal blocks with solderless box lugs. Signal leads shall be terminated in terminal blocks with saddle-type pressure connectors capable of receiving two No. 16 AWG or smaller conductors on each point.
2. Splices in power wiring shall be made with two compression lugs bolted together. Splices in stranded control wiring or lighting circuits may be made with compression connectors. Splices in signal wiring shall be soldered. Splicing shall not be considered as a normal method of construction. Splicing shall be used only when no practical alternative exists to using terminals or point-to-point wiring. When utilized, splicing of 600 V or less insulated wire shall be made only in junction boxes. No splicing shall be permitted in conduit fittings.
3. Solid wire shall not be lugged nor shall electrical spring connectors be used on any wiring. Lugs and connectors shall be installed with a compression tool recommended by the lug manufacturer for the particular lug used. Pulling tensions shall not exceed the cable manufacturer's recommendations.
4. All conductors shall be tagged at each end in motor control centers, control panels, service pedestals and control stations with a legible permanent coded wire-marking sleeve. All conductors shall be identified in each manhole, handhole or pull box. Field conductors shall be similarly tagged at each end, except that each conductor termination shall have its marking sleeve imprinted with terminal identification for both ends of the conductor. A schedule shall be provided with the record drawings correlating these wire markings.
5. All splices and terminations for No. 1/0 AWG cable, and larger, shall be inspected by the Engineer prior to and after insulation is applied. Terminations at polyphase motors shall be made by bolt connecting the lugged conductors and then applying rubber filler tape and two 2-lapped layers of vinyl tape to equal or exceed the thickness of conductor insulation.

M. Grounding

1. A grounding system shall be installed in accordance with the National Electrical Code and specification section 16450. All grounding surfaces shall be thoroughly cleaned before connecting the grounding electrodes. All conduit shall be grounded directly or through equipment frames and ground buses to the grounding system.

2. In addition to the conduit system, all equipment having 480 volt, 120/208 volt or 120/240 volt supply shall be grounded to the supply source ground bus by a green insulated code sized ground conductor installed in the conduit with the phase cables. Ground conductors for small panels and equipment shall be of same size as associated conductors.

3.03 Adjusting / Cleaning / Protection

A. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

B. All debris and moisture shall be removed from both new and existing raceways, boxes, and cabinets before installing wire or cable

****END OF SECTION****

SECTION 16130
WIRING DEVICES

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all electrical receptacles, plugs, plug strips, switches, device plates and surface covers.

B. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16160	Pilot Devices
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17512	Site Acceptance Tests

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
NEC	National Electrical Code, Latest Edition
NEMA WD1	General Wiring Devices
NEMA WD6	Wiring Devices Dimensional Requirements
UL 498	Attachment Plugs and Receptacles

Reference	Title
UL 943	Ground-Fault Circuit-Interrupters
UL 1449	Safety for Surge Protective Devices
Federal Specification WC596	Connector, Electrical, Power
Federal Specification WC-896	Switches, Toggle (Toggle and Lock), Flush Mounted
NEMA TC-3-2004	PVC Fittings for Use With Rigid PVC Conduit and Tubing

1.03 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 and 16000.

1.04 Quality Assurance

A. All wiring devices shall be premium quality suitable for installation in water facilities and may be subjected to dust and moisture. All wiring devices shall be of the heavy-duty type with ratings as shown on the drawings or as specified.

B. All wiring devices shall be listed by UL or other testing firms that are recognized by the Owner.

C. All wiring devices shall comply with Federal Specification WS896 and WC 596 for switches and receptacles respectively.

D. All wiring devices shall comply with NEMA configurations and standards for general and special purpose wiring devices.

1.05 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.06 Project / Site Conditions

A. The receptacles; plugs, together with all plug strips; switches and device plates will be installed in water facilities and reservoirs where temperature is expected to range from 10 degrees F and 115 degrees F. Relative humidity is expected to range between 10 and 100 percent.

1.07 Warranty

A. Refer to Section 17506 for requirements.

1.08 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Make like items of equipment the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacture's service. Wiring devices shall be of the manufacturer and model numbers described in this specification section.

2.02 Equipment and Materials

A. General: All wiring devices shall be industrial extra heavy duty specification grade with provisions for back wiring and side wiring with captive-held binding screws. All receptacles shall be of the grounding type.

1. Devices located in areas with suspended ceilings or stud walls shall be ivory finish.
2. Devices located outdoors shall be black.
3. Devices located corrosive environments shall be yellow.

B. Single Phase Receptacles and Plugs:

1. 120V RECEPTACLES: 120V receptacles shall be NEMA 5-20R and shall accept NEMA 5-15p or 5-20p plug caps. These shall be Cooper 5362 Series, Hubbell 5362 Series, Leviton 5362 Series or equal.
2. 120V GFCI Receptacles: 120V GFCI receptacles shall be UL listed and shall have provisions for trip indication, testing and resetting. 120V GFCI receptacles shall meet or exceed UL 943 (Class A GFCI), UL 498. These shall be Copper VGF20V Series, Hubbell GFR5362SG Series, Leviton 7899-SG Series or equal.
3. Locking 250 volt, 3 phase receptacles shall be NEMA L15-20 or L15-30 as applicable.
   a. Receptacles rated for 20 amps shall be Cooper CRL152OR Series, Hubbell HBL2425SW Series or equal.
   b. Receptacles rated for 30 amps shall be Cooper CWL153OR Series, Hubbell HBL2725SW Series or equal.
4. Corrosion-Resistant Receptacles: Receptacles called out "corrosion-resistant" shall be of yellow nylon construction with all metal parts of monel or cupro-nickel complying with Federal Specification W-C-596d. Corrosion resistant receptacles shall be Cooper 5362GR Series, Hubbell HBL53CM62 Series, or equal.
5. Weatherproof UL listed While-In-Use Covers: Weatherproof While-In-Use Covers will be provide with corrosion-resistance receptacles shall be designed so that the watertight integrity of the plug-receptacle is maintained when the units are plugged together and the live parts are equally protected when the plug is removed and when the cover is in place. The units shall consist of oil-resistant metal cover assemblies with a corrosion-resistant polycarbonate receptacle bodies. Plug caps shall match the receptacle and shall be of the same manufacturer. Metal Cover closed cell neoprene form gasket. These shall be Copper WIUMV-1, Hubbell WP8MH or equal.
6. Plug Caps: Except for Corrosive Environments, Plug caps shall be industrial grade, of the cord grip type with black and white nylon housing, Hubbell HBL5266C, Leviton 5266C or equal. For Corrosion Environments, plug caps shall be corrosion resistant yellow nylon housing, Hubbell HBL52CM66C, Leviton 52CM-66C or equal and shall be of the same configuration and manufacture as the receptacle. One plug shall be supplied for each four receptacles, installed of a given configuration, figured to the next larger standard carton. Plugs shall be delivered in original sealed cartons to the Resident Engineer.
7. Plug Strips: Plug strips shall be of steel sheet metal or special stainless steel where called for. The dimensions of the plug strips shall be such that standard duplex receptacles and devices can be mounted in the cover section of the plug strip, with sufficient space behind the device for ten No. 12 AWG circuit conductors in accordance with NEC space rules. Plug strips shall be Wiremold No. G3000, SnapMark SMS3200, or equal.

8. Special Purpose NEMA Configuration Receptacles: Special purpose NEMA configuration receptacles shall be industrial grade, [corrosion resistant] and shall be as follows:

   a. Provide Manufacturer and Model Number, noted below, or approved equal.

   b. Non-locking 125/250 volt, 20 to 60 ampere ratings shall be NEMA 14-20 through 14-60 series:

Ampere Rating	NEMA Rating	Cooper	Hubbell
20	14-20R	5479	HBL8410
30	14-30R	n/a	n/a
50	14-50R	5759	HBL9450A
60	14-60R	AH5754AP	HBL9460A

   c. Non-locking 250 volt, 3 phase, 15 to 60 ampere ratings shall be NEMA 15-15 through 15-60 series:

Ampere Rating	NEMA Rating	Cooper	Hubbell
15	15-15R	n/a	n/a
20	15-20R	n/a	HBL8420
30	15-30R	8430N	HBL8430A
50	15-50R	8450N	HBL8450A
60	15-60R	8460N	HBL8460A

   d. Locking 120/208 volt, 3 phase, 20 or 30 ampere ratings shall be NEMA L21-20 and L21-30:

Ampere Rating	NEMA Rating	Cooper	Hubbell
20	L21-20R	CWL2120R	HBL2510SW
30	L21-30R	CWL2130R	HBL2610SW

   e. Locking 250 volt, 3 phase receptacles shall be NEMA L15-20 or L15-30 as applicable:

Ampere Rating	NEMA Rating	Cooper	Hubbell
20	L15-20R	CWL1520R	HBL2420SW
30	L15-30R	CWL1530R	HBL2720SW

9. Water Proof Three-Phase Receptacles and Plugs: Three phase receptacles shall be for 3 phase, 4 wire, 480 volt service, with ampere rating as shown, of the type manufactured from high impact thermoplastic housing with an Arc resistant UL94-VO phenolic thermoset inserts. The receptacles and plugs shall be of the grounding type and shall be so designed that the grounding pole is permanently connected to the housing. The grounding prong or pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. The receptacles and plugs shall be UL listed and CSA certified for circuit interrupting at full rated current. Shrouded contacts shall comply with California Code Title 8, Article 51, S2510.7 (b) for devices exceeding 300 VAC with horsepower ratings per NEC 420-151. The receptacles and plugs shall be moisture resistant per UL 1682 Paragraph 40. Receptacles shall have watertight/flap screw covers, O-rings on all pins and

sleeves, interiors and plug shell. The receptacles and plugs shall be watertight even when not engaged. The receptacles and plugs shall meet requirements for NEMA 4, 4x, 6 and IP67. Receptacles and Plugs shall be Russellstoll DuraGard Series, Hubbell Insulgrip or equal.

C. Switches

1. General Purpose: General-purpose switches shall be quiet AC type, industrial specification grade, UL listed for motor loads up to 80 percent of rated amperage, and shall be installed in accordance with the required rated capacities. Switches shall match receptacles in color. Switches shall be rated 20 Amps, 120 – 277 volts, and shall be as follows:

   a. Single Pole On-Off Operation: Cooper 2221V, Hubbell HBL1221I or equal.

   b. Double Pole On-off Operation: Cooper 2222V, Hubbell HBL1222I or equal.

   c. Three-Way On-Off Operation: Cooper 2223V, Hubbell HBL1223I or equal.

   d. Four Way On-Off Operation: Cooper 2224V, Hubbell HBL1224I or equal.

2. Weather-Exposed and Corrosive: Maintained contact switches in weather- exposed and corrosive areas or where shown on the drawings shall be the tap action type with weather proof yellow switch plate. Switches shall be rated 20 Amps, 120 – 277 volts, and shall be as follows:

   a. Single Pole On-Off Operation: Cooper 2991V with AH2881, Hubbell HBL1281I with HBL17CM50 or equal.

   b. Double Pole On-off Operation: Cooper 2992V with AH2881, Hubbell HBL 1281I with HBL17CM50 or equal.

   c. Three-Way On-Off Operation: Cooper 2993V with AH2881, Hubbell HBL 1281I with HBL17CM50 or equal.

   d. Four Way On-Off Operation: Cooper 2994V with AH2881, Hubbell HBL 1281I with HBL17CM50 or equal.

3. Tap-Action switches in weather-exposed and corrosive areas shall be mounted in "FS" type mounting boxes with weatherproof Hypalon or neoprene cover plates.

D. Timer Switches: Timer switches shall have a black knob and a brushed aluminum plate with a spiral time scale to provide easy selection of time setting desired. The knob shall be a press on type requiring no screws or other hardware to secure. The timer shall have a UL listed rating of 1 HP 125 VAC, 50/60 Hz. The timer shall be SPDT. The timer shall not have a hold feature and shall have a time cycle of 15 minutes. The timer shall be Intermatic Model FF15MC, Paragon SWP15M, or equal.

2.03 Components and Accessories

A. Communication Wiring Interface

1. The communication wiring interface shall consist of a six-port wall plate and device box for user connection with telephone and computer networks at the various locations shown on the drawings. The communication wiring interface shall be the Leviton Quickport MOS 3, Hubbell iStation or approved equal to the criteria that follows:

   a. All communication modules shall fully comply with NEC Article 800, be UL listed and meet FCC Part 68 requirements.

   b. Modules shall be of a high-impact, self-extinguishing plastic that is UL 94V-0 rated.

c. Contacts shall be spring wire with phosphor bronze plated with 50 micro-inches of hard gold over 100 micro-inches of nickel. Jacks shall be Cat 5, Cat 5e, Cat 5e + or Cat 6 as required by the drawings.

d. Wall plates and jacks shall be provided as follows:

e. Six-port wall plates shall be flush mounted and field convertible. Wall plates shall house any combination of six (6) eight-conductor keyed jacks. Jacks shall be interchangeable depending on the application.

f. Two-port wall plates shall have up to two eight conductor keyed jacks using insulation displacement connectors with punchdown caps for installation.

g. The color key for the jacks shall be as follows:

1) Telephone network:	Ivory
2) Data Network – Cat 5:	Blue
3) Data Network – Cat 5e:	Red
4) Data Network – Cat 6:	Yellow
5) Spare:	Black

2. Wall plates shall be mounted in a 2” x 4” (minimum device box).

B. Device Plates

1. General

a. Stainless steel device plates shall be engraved directly with the service legend. Engraving shall be 1/8 inch high with black filling. Cast ferrous metal plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background. Nameplates for switches shall identify the panel and the circuit number and the area served. Nameplates for receptacles shall identify circuit and voltage, if other than 120 volts single phase. Engraving schedule shall be submitted for review prior to engraving.

b. Device plates located in areas with suspended ceilings and stud walls shall be Type 302 stainless steel, satin finish, and 0.40-inch minimum thickness. Device plates in all other areas shall be cast ferrous metal with neoprene gasket and corrosion-resistant hardware. Receptacle covers exposed to weather shall be provided with [lift][while-in-use] covers.

c. Device covers for corrosion-resistant applications shall be yellow thermoplastic or aluminum construction with a spring-closed cover for the outlet. The receptacle cover shall be Hubbell 52CM22, or Cooper 7879FSCR or equal.

2. Switch Covers: Switch covers shall be heavy cast aluminum with bat-handle toggle operators and shall be Appleton, Killark or Crouse-Hinds. Stainless steel screws and neoprene gasket shall be provided with each cover. Where scheduled, nameplates shall be phenolic in accordance with the specifications for nameplates, except the lettering shall be 1/8 inch high.

3. Receptacle Covers: Receptacle covers shall be heavy cast copper-free aluminum with a gasketed spring floor cover over each outlet. The receptacle cover shall have all exposed metal surfaces factory coated with a durable epoxy coating. Stainless steel screws and a neoprene gasket shall be provided with each receptacle cover

PART 3 - EXECUTION

3.01 Examination

3.02 Preparation

A. Galvanized brackets, expansion bolts, toggle bolts or machine or wood screws according to the type of construction shall secure boxes. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes.

B. Finish Plates and Devices: Do not install items until finish painting is complete. Scratched or splattered finish plat and devices shall be replaced at the Contractor's expense.

C. GFCI Outlets: One GFCI receptacle may be used to provide GFCI protection to downstream duplex receptacles on the same branch circuit provided the following conditions are met.

   1. The downstream receptacles are in the same room as the upstream GFCI duplex receptacles, and.

   2. The downstream duplex receptacles are labeled as being protected by an upstream GFCI receptacle in the same room.

3.03 Installation

A. Unless otherwise shown, receptacle boxes shall be mounted 12 inches above the floor in offices, control rooms, and similar areas; shall be mounted 6" above back splash of countertops, and shall be mounted 48 inches above the floors in other locations unless otherwise shown.

B. Upon installation of wall plates and receptacles, Contractor shall use care regarding their proper and cautious use. At time of substantial completion, replace those items which have been damaged, including those burned or scored by faulty receptacles or cord caps.

C. Plumb: Install devices and finish plates plumb with building lines and equipment cabinets.

D. Wall-Mounted Receptacles: Install with long dimension oriented vertically at centerline height shown on the drawings or specified herein.

E. Vertical Alignment: When more that one outlet is shown on the drawings in close proximity to each other, but at different elevations, align the outlets on a common vertical center line for best appearance. Verify alignment with Construction Manager

3.04 Field Quality Control

A. Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements.

B. Test receptacles for line to neutral, line to ground and neutral to ground faults.

C. Test ground-fault circuit interrupter operation according to manufacturer recommendation.

D. Correct any defective wiring.

E. Replace damaged or defective components.

3.05 Adjusting / Cleaning / Protection

A. General: Internally clean devices, device outlet boxes and enclosures. Replace stained or improperly painted wall plates or devices.

****END OF SECTION****

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SECTION 16155
MOTOR STARTERS

PART 1 - GENERAL

1.01 Summary

A. Scope: This Section provides specifications for all motor starters and associated equipment, except for variable frequency drives:

1. The Contractor shall furnish and install all group-mounted and unit motor control as required for each motor furnished for installation all in accordance with the requirements of the Contract Documents.
2. When motors furnished differ from the indicated, the Contractor shall, at no additional cost to the Owner, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed.

B. Type: Motor starters shall be the full voltage combination magnetic type, reduced voltage solid state starter type, or manual type with fully magnetic circuit breakers and thermal overload elements.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices

Section 16250	Motor Control Center
Section 16330	Variable Frequency Drives
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System
Section 17924	Control Strategies

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
CCR, Title 8, Subch.5	California Code of Regulations, Title 8, Industrial Relations, Subchapter 5, Electrical Safety Orders
UL 508	Standard for Safety Industrial Control Equipment
UL 845	Standard for Safety Electric Motor Control Centers
NEMA ICS-1	General Standard for Industrial Control and Systems
NEMA ICS-2	Industrial Control Devices, Controllers and Assemblies

1.03 System Description

A. Refer to contact drawings and the control strategy requirement described in Section 17924.

1.04 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 and 16010.

B. Final submittal shall include spare parts lists, catalog data for various motor control elements in addition to the submittals requirement by Section 01300 and 16010.

C. The following submittals and specific information shall be provided:

1. One-line diagrams.
2. Elementary wiring diagrams.
3. Connection wiring diagrams.
4. Interconnection wiring diagrams.
5. Written Operational Description.

6. Installation instructions.
7. Maintenance instructions.
8. Spare parts list.

1.05 Quality Assurance

A. Performance and Design Requirements

1. Motor starters furnished shall be of the type indicated on the drawings and shall be suitable for 480-volt, 3-phase, 60-hertz, AC service with 120 volt controls. Motor starters and their components shall be sized in accordance with NEMA standards. Starters smaller than NEMA Size 1 will not be permitted.
2. Unless installed within a service pedestal, motor starters shall be installed in NEMA 1 gasketed or NEMA 12 enclosures or in motor control centers for all indoor locations, in NEMA 7 enclosures in classified areas and in NEMA 4X enclosures for all non-rated outdoor or corrosive locations.

B. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.

C. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

D. Electrical and Mechanical Testing: All components shall be factory tested in accordance with the applicable NEMA ICS requirements.

E. Field Testing: Field tests shall be performed in accordance with Section 16030 Electrical Tests.

1.06 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.07 Project / Site Conditions

A. All motor starters and associated equipment will be installed in a wastewater facility where the ambient temperatures may range between 10 degrees F and 115 degrees F. Relative humidity is expected to range between 10 and 100 percent. In some areas, the equipment may be subjected to hydrogen sulfide gas, dust, moisture, and methane gas.

1.08 Sequencing and Scheduling

1.09 Warranty

A. Refer to Section 17506 for requirements.

1.10 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Make like items of equipment the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service. Motor starters shall be Eaton Cutler-Hammer, Allen Bradley, Square D or equal.

2.02 Equipment and Materials

A. General:

1. Provide each motor with a suitable controller and devices that will function as specified for the respective motors and meeting NEMA ICS 2, the NEC, and UL. Each motor control shall consist of a manually operated circuit protective device and controller mounted in a common enclosure, complete with control power transformer, if required, and auxiliary devices for control of the circuit as indicated.
2. Operating handle of the circuit protective device shall physically indicate “on”, “off”, and “tripped” positions. Handle shall accept three padlocks with heavy duty, industrial type shackles. Cover shall be interlocked with the operating handle to prevent opening with in the “on” position. A method shall be provided for releasing the interlock for inspection purposes when the switch is “on”.
3. Provide each motor controller with thermal overload protection in all ungrounded phases. Use protection consisting of thermal overload relays meeting NEMA ICS 2 which are sensitive to motor current and mounted within the motor controller, or a combination of thermal protectors embedded within the motor windings and controller-mounted overload relays, as indicated. Use overload protection devices of the inverse-time current characteristic type,
4. Provide controller-mounted overload relays of the manual-reset type with externally operated reset button when used without motor thermal protectors; when used in conjunction with thermal protectors, provide the automatic reset type. Select and install overload relay heaters after the actual nameplate full-load current rating of the motor has been determined.
5. If power factor correction capacitors are connected on the load side of the overload relays, incorporate the resulting reduction in line current in the selection of overload relay heaters.
6. Install and connect any required thermal protector monitoring relay provided by motor manufacturer in motor-control circuit and provide manual reset function.
7. Enclosures shall be as follows:
   a. Dry Locations: NEMA Type 12
      1) Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer’s standard paint inside and out.
      2) No knockouts, external mounting flanges, hinged and gasketed door.
   b. Corrosive Locations: NEMA Type 4X
      1) Body and cover: Type 304 or 316 stainless steel.
      2) No knockouts, external mounting flanges, hinged and gasketed door.
   c. Wet Locations: NEMA Type 4X
      1) Body and cover: Type 304 or 316 stainless steel
      2) No knockouts, external mounting flanges, hinged and gasketed door
   d. Hazardous Locations: NEMA Type 7
      1) Cast gray iron allow or copper-free aluminum with manufacturer’s standard finish.
      2) Drilled and tapped openings or tapered threaded hub.
      3) Gasketed cover bolted-down with stainless steel bolts.
      4) External mounting flanges.

5) Front operating handle padlockable in the OFF position.

6) Accessories: 40 mil PVC exterior coating.

e. Where mounted in a MCC: meet the requirements of Section 16250.

B. Manually Operated Starters, Fractional Horsepower

1. Provide starters meeting NEMA ICS 2 with the enclosures shown, rated 1 HP at single-phase, AC voltages of 115 and 230 volts, and with thermal overload protection, and toggle or pushbutton operation. Provide for locking in the OFF position.

2. Provide Allen Bradley Bulletin 600, Cutler Hammer Series E34, or equal.

C. Manually Operated Starters, Integral Horsepower

1. Provide starters meeting NEMA ICS 2 of the horsepower rating, voltage, number of phases, and enclosure shown and with thermal overload protection, and pushbutton or toggle switch operation. Provide for locking in the OFF position. Provide running overcurrent protection.

2. Provide Crouse-Hinds NMM, Allen Bradley Bulletin 609, Eaton Cutler Hammer or equal.

D. Full Voltage Magnetic Starters

1. Provide starters meeting NEMA ICS 2, Class A, with the rating and enclosure shown. Starters shall be full voltage, non-reversing horsepower rated, providing combined protection against running and stalled overloads. Thermal overload relays on all phases shall be temperature compensated bimetallic type with manual reset and inherent single phasing prevention.

2. Starters shall be NEMA rated and no smaller than Size 1.

3. Provide Allen-Bradley Bulletin 513, Eaton Cutler Hammer Type A216 or equal.

E. Reduced Voltage Starters, Solid State Type

1. Each unit shall be provided as a standalone system packaged into an integral unit with an enclosure of motor control center construction as specified in section 16250. Component access shall be from the front of the enclosure to allow removal or service of any component. The controller shall include fans for cooling, NEMA rated overload protection, phase failure protection, under voltage, over voltage, and voltage unbalance.

2. The motor controller shall be of the latest technology used exclusively for providing ramp starting and stopping of 480 VAC, three phase induction motors used with blowers and centrifugal pumps.

3. The motor controller shall be microprocessor based and provided with both acceleration and deceleration pump speed controls with the following starting modes: soft start with selectable kick start; current limit and full voltage. The controller shall include a soft stop mode.

4. The motor controller shall include the following switch or keyboard selectable features:

a. Acceleration ramp time adjustable from 2 to 30 seconds.

b. Initial torque setting adjustable from 5 percent to 90 percent of locked rotor torque.

c. A kick start function providing an adjustable time pulse of current limit prior to the normal starting mode.

d. The current is held at 500 percent of full load for a time adjustable between 0.4 and 2.0 seconds.

e. A deceleration ramp time of soft start adjustable from 2 to 60 seconds. This feature shall be field defeatable.

f. One (1) normally open and one (1) normally closed Form C auxiliary contact where the contacts can be setup either to change state instantaneously on a start command or when the controller has determined that the motor is up to speed.

5. The motor controller shall functional provisions and termination point at terminal blocks for remote input of each of the following:

   a. Start/stop command from an external dry contact.

   b. Emergency stop shutdown.

   c. Lockout

6. The motor controller shall have functional provisions and termination points at terminal blocks for remote output contacts for each of the following:

   a. Run

   b. Fault

   c. Up to Speed

7. The motor controller shall include built-in communications capability, LCD display, excessive starts per hour protection, keypad programming, and power monitoring. At the Contractors option, with the Engineers approval and at no additional cost to the [Owner][City][District][County] the built-in communications network may be used to communication with the PLC, in lieu of the standard I/O shown on the drawings.

8. The motor controller shall be an Allen Bradley SMC-Flex with bypass contactor and pump control (soft start and soft stop) option, Eaton Cutler Hammer, or equal.

2.03 Components and Accessories

A. Magnetic Contactors: Magnetic contactors shall be capable of closing and holding when a minimum voltage of 85 percent is applied to the operating coil. All contactors and relays shall be equipped with at least two normally open and two normally closed auxiliary contacts.

B. Overload Elements:

   1. Overload elements shall be bimetallic ambient temperature compensated overload relays. Magnetic contactors for all 3-phase motor starters shall be equipped with overload relays on each phase.

   2. Single phase motor starters shall contain one overload trip element for 120 volt applications and two overload trip elements for 208 volt, 240 volt, or 480 volt applications.

C. Circuit Breakers:

   1. Motor circuit protectors shall be rated 65000 AIC symmetrical at 480V. The motor circuit protectors shall provide adjustable magnetic protection and be provided with pin insert to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a “tripped” position on the unit disconnect and a push-to- test button on the HMCP. The motor circuit protectors shall include transient override feature for motor inrush current.

   2. Molded case circuit breakers on combination type starters shall be fully magnetic with instantaneous trip adjustments. The breakers shall have continuous ratings to match the motor nameplate horsepower shown on the single line diagrams. The circuit breakers shall have a minimum of six trip adjustment points. Circuit breakers shall also have provisions for manual tripping. This trip device shall provide mechanical simulation of overcurrent tripping

through activation of linkages and latch surfaces that are not operated by the circuit breaker handle.

3. Magnetic circuit breakers shall have a current limiting fuse where indicated or when the short circuit rating is higher than the basic interruption rating.
4. Combination units without current limiting fuses shall be rated for 65,000 amperes rms; units with current limiting fuses shall be rated for 200,000 symmetrical rms amperes.
5. The circuit breaker shall be designed so the loss of any one or more fuses shall trip the breaker automatically. The external operating handle of the circuit breaker shall have provisions for installing a padlock in the open position. The circuit breakers shall comply with the requirements of sections of these specifications that specify overcurrent protective devices.

D. Control Power Transformers.

1. Supply individual control power transformers unless noted otherwise. The transformers shall be sized to a minimum of 100 percent in excess of the volt-ampere requirments of the holding coil and indicating lights. Fuse one side of the secondary winding and ground the other side. Provide primary, current limiting fuses where fuses shown on Drawings, or where required by applicable codes and standards.

E. Control Devices:

1. Provide control devices as indicated on the contract drawings and as described below.
2. Operating and Indicating Devices shall have a minimum rating of NEMA 13.
3. Operating and Indicated Devices mounted in outdoor panels, corrosive areas or where exposed to moisture shall be NEMA 4X.
4. Selector Switches:
   a. Selector Switches shall be for use on 120 volt control circuits.
   b. Contacts shall have a continuous rating of 10 amperes both inductive and resistive.
   c. Allen Bradley Bulletin 800H, Eaton Cutler Hammer or equal.
5. Pushbuttons:
   a. Pushbuttons and illuminated pushbuttons shall be for use on 120 volt control circuits.
   b. Shall have a continuous current rating of 10 amperes both inductive and resistive.
   c. Allen Bradley Bulletin 800H, Eaton Cutler Hammer or equal.
6. Indicating Lights:
   a. Indicating lights shall be push-to-test oil tight type.
   b. Units shall include a 120 – 6 volt transformer and 6-8 volt lamp and shall be of the illuminated pushbutton type with the pushbutton wired for the push-to-test function. Refer to contract drawings for appropriate lens cap color.
   c. Lamps shal be provide for each unit installed.
   d. Allen Bradley Bulletin 800H, Eaton Cutler Hammer or equal.

F. Interlock and auxiliary contacts, wired to terminal blocks:

1. Holding circuit contact, normally open.
2. Overload alarm contact, normally open.

3. Normally open auxiliary contact, for remote run status.
4. Additional field replaceable auxiliary contacts where shown on the contract drawings.
5. Additional field replaceable auxiliary contacts as required to meet the Control Strategies.
6. Two (2) additional normally open spare field replaceable auxiliary contacts.

G. Terminal Blocks

1. Terminal blocks for power leads shall be of ample rated capacity for the leads and shall have channel mounted solderless box lugs with pressure plates.
2. Terminal blocks for control wiring shall be of ample size to accept two 12 AWG filed conductors per point. The control terminal blocks shall be channel mounted type of nylon and shall have a binding head or washer-head screw.
   a. A minimum of 20 percent spare termination points shall be provided for each starter.
   b. Control Terminal blocks shall be rated at 20 amperes minimum at 600 volts, 90 degrees Celsius.
   c. Terminal marking shall be provided for purposes of indentifying terminations.

H. Nameplates:

1. Each starter shall have a nameplate designating the function of the device and its identifying number as defined on the P& IDs drawings of the contract drawings.
2. Nameplates shall be submitted for approval by the Engineer as part of the submittal review process.
3. Nameplates shall be engraved type made of 1/8 thick laminated black and white bake-like material with letters not less than 3/16 engraved through the white top lamination to the black interior.

PART 3 - EXECUTION

3.01 Examination

A. All multiphase motors shall be furnished with magnetic contactor or solid state starters unless otherwise noted on the drawings. Single phase motor starters shall either be magnetic or manual, as indicated on the drawings.

B. Motor starters for non-reversing, single speed motors rated up to 50 HP shall be full voltage, non-reversing starters unless noted on plans.

C. Motor starters for single speed non-reversing motors rated above 50 HP shall be solid-state reduced voltage.

D. Two speed-starters for controlling two-speed, two winding motors shall be full voltage, non-reversing starter as recommended by the supplier of the two-speed, two winding motors. Reversing motors shall be controlled by full voltage, reversing type starters with interlocks.

E. The combination starters shall be interchangeable with starters of the same size.

F. Motor starters shall have replaceable, heavy-duty tungsten tipped contacts of the non-welding type with wipe action to keep contacts clean.

G. Motor starter wiring and components shall be readily accessible.

3.02 Preparation

A. Any special protection relays for pumps, mechanical equipment or motors that are required by any pump or motor manufacturer shall be incorporated into the motor starter control circuit at no extra cost.

3.03 Installation

A. Motor starters installed in service pedestals shall be located as shown in service pedestal furnished by the service pedestal manufacturer.

B. For motor control centers the starter units and the associated "stab-on" connectors shall include provisions for guiding the units from their disconnected or withdrawn position to their connected position.

C. Retighten to NEMA standards all current-carrying bolted connections and all support framing and panels.

3.04 Field Quality Control

A. Perform work in a workmanlike manner with craftsman skilled in the particular trade. Provide work presenting a neat and finished appearance.

B. Provide a qualified, factory-trained representative to supervise installation, final adjustment, and initial energization of this equipment. Make this representative available for as long as his services are required, but in any case for a period of **5** days minimum. At the end of installation and adjustment, provide certification signed by this representative that the equipment has been properly installed and tested, and is ready for energization.

C. Testing: Each installed motor starter shall be individually tested to ensure that the starter has been properly installed and connected and that it operates as required and specified.

D. Grounding circuits shall be tested for circuit continuity and that the circuit resistance is not excessive. Readings in excess of 25 ohms will not be acceptable.

E. Test all ungrounded circuits to verify that short circuits or accidental grounds do not exists. Reading of at least 50 megaohms to ground shall be obtained on all phase conductors.

F. Phase rotation tests shall be performed on all three phase circuits with a phase rotation-indicating meter.

G. Test data shall be recorded and submitted to the Engineer for approval.

3.05 Material and Equipment Schedules

A. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in the equipment or its location prior to roughing in without incurring any additional cost,

B. Field adjust the trip settings of all motor starter magnetic trip only circuit breakers. Adjust as per manufacturer’s recommendations. Determine motor rated current from motor nameplate following installation. In the selection of overload relay heaters, allow for motor current reduction where power factor correction capacitors are installed on the load side of the overload heaters. Prepare a typed tabulation of motor name, motor horsepower, nameplate full load current, measured load current, heater catalog number, protective device, trip setting, and include copy in the Technical Manual. Attach to the tabulation a copy of the starter manufacturer's overload heater selection tables, including only the tables for the particular starters provided.

C. After the equipment is installed, touch up any scratches, marks, etc., incurred during shipment or installation of equipment. If required by the ENGINEER because of undue amount of scratches, repaint the entire assembly.

D. Repair all scratched or damaged surfaces to “like new” condition.

E. All panels, condultets, pull boxes and junction boxes shall have covers securely in place.

****END OF SECTION****

SECTION 16160
PILOT DEVICES

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all control stations, pushbuttons, selector switches, elapsed time meters, indicating lamps, control transformers, control fuses, control relays, and related control device appurtenances.

B. Type: All pilot devices shall be heavy-duty type as shown or as otherwise specified.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16330	Variable Frequency Drives
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17924	Control Strategies

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
ANSI C80.1	Electrical Rigid Steel Conduit
UL 1	Flexible Metal Conduit
UL 5	Surface Metal Raceway and Fittings
UL 6	Electrical Rigid Metal Conduit – Steel
UL 514B	Conduit, Tubing and Cable Fittings
UL 651	Schedule 40 and 80 Rigid PVC Conduit and Fittings
NEMA RNI-2005	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC-2-2003	Electrical PVC Tubing and Conduit
NEMA TC-3-2004	PVC Fittings for Use With Rigid PVC Conduit and Tubing

1.03 System Description

1.04 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 - Submittals and 16010 – General Electrical Provisions.

1.05 Quality Assurance

A. The pilot devices shall be heavy-duty type suitable for installation in water facilities.

1.06 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.06 for requirements.

1.07 Project / Site Conditions

A. The pilot devices will be installed in water facilities where the ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent. The pilot devices may be subjected to dust and moisture.

1.08 Sequencing and Scheduling

A. Sequencing and scheduling plan shall be provided that minimizes pump station downtime. Note that the pump station must remain operational during all phases of construction. For additional requirements refer to Specification Section 01014 – Work Sequence.

1.09 Warranty

A. Refer to Section 17506 for requirements.

1.10 Maintenance

A. Standby Components

1. The following standby components shall be provided:

   a. Twelve (12) - Indicating lamps of each type.

   b. Six (6) - Control fuses of each type.

   c. Two (2) - Control relay and time delay relay of each type.

   d. Four (4) - Indicating lamps lenses of each color.

   e. One (1) - Spare starter operating coil of each type.

   f. Four (4) - Control devices contact blocks

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. Control Stations: For non-classified areas, control stations shall be heavy-duty industrial units, NEMA 12 oil-tight and dust-tight cast aluminum enclosures unless otherwise specified or shown. Control stations exposed to weather or located in corrosive environments shall be NEMA 4X of fiberglass reinforced high impact plastic, Allen Bradley 800 H series, Crouse-Hinds NCS series, or equal.

1. Legend Plates - ("STOP", "AUTO", etc.) shall be as shown on the plans and nameplates shall be as shown on the plans.

2. Nameplates – Nameplates shall be as shown on the plans.

B. Pushbuttons: Pushbuttons shall be heavy-duty oil-tight type; lockout-stop buttons shall be equipped with integral locking device and shall additionally be capable of receiving one 3/8-inch shackle padlock. Contact shall be rated as specified for selector switches. Unless otherwise shown, pushbuttons for field stations shall be provided with a watertight boot if the pushbutton is mounted on the outer surface of the enclosure.

C. Selector Switches: Selector switches located in motor control centers, field stations (generally for HAND-OFF-AUTO or LEAD-FOLLOW operations) shall be heavy-duty oil-tight type.

1. Switches shall be provided complete with cover, front escutcheon, handle and with the legend plate engraved by the switch manufacturer in accordance with the drawings. The manufacturer's standard contact development diagram shall be submitted for each different switch arrangement required. The development diagram shall identify each switch it describes and shall call out all special operating features in addition to providing the standard contact status for each switch position.

2. Where no callout is given, the Contractor shall use the diagrammatic symbol to determine the type of selector to apply in conformance with the electrical symbols drawings.

D. Elapsed Time Meters: Elapsed time meters shall be of the 2-1/2-inch square case type for flush panel mounting. The totalizing type meter shall have 6-digit register with the last digit indicating tenths of an hour.

E. Indicating Lamps: Indicating lamps shall be oil-tight units. Units for alternating current systems shall include a 6-volt transformer and 6-8 volt No. 44 lamp and shall be of the illuminated pushbutton type with the pushbutton wired for the push-to-test function required. Lamps for 24

volts or less DC systems shall be full voltage type. Higher voltage DC systems shall utilize a No. 1835 lamp with resistor as required. Appropriate lens caps shall be provided.

2.02 Components and Accessories

A. Control Transformers: Control transformers shall be of the voltampere rating required to supply the coil and device loads in the control circuit, but not less than the size if shown, without exceeding their rating or overheating.

   1. Control transformers will be required on each starter unless otherwise indicated and shall be connected to terminals on the load side of the branch circuit breaker. Control transformers shall be rated for 480 to 120 volts.

B. Control Circuit Protection: Draw-out indicating fuse holders and fuses shall be provided as shown for the protection of all control circuits. Fuse holders for service at 150 volts or less shall be MIL-F019207/2, Type FHL 11U with 1/4 x 1-1/4 inch ceramic tube fuse rated to interrupt 25,000 amperes at 125 volts.

   1. Fuse holders for service at over 150 volts but less than 600 volts shall be MIL-F-19207/3, Type FHL 12U with 13/32 by 1-1/2 inch ceramic tube fuse rated to interrupt 100,000 amperes at 600 volts.

   2. Fuse holders for the protection of a control circuit transformer which is also provided with an indicating secondary fuse shall be of the double porcelain type having a barrier between the fuses and shall accept the 13/32 by 1-1/2 inch ceramic fuse specified above.

   3. Each control circuit transformer shall be protected by two primary fuses and one secondary fuse as a minimum.

C. Nameplates: Each individual controller, control station, field panel, and control device shall have a nameplate designating the function of the device and its identifying number. All relays, pressure switches, solenoid valves and similar devices mounted outside of their associated motor controller cubicle shall be identified with nameplates. All numbered instruments and devices shall be identified with nameplates.

   1. Nameplates shall be made of 1/16-inch thick machine-engraved laminated phenolic having white letters not less than 5/32 inch high on black background. Equipment titles shall be completely spelled out on nameplates as shown on the drawings. The name plate schedules shall be submitted for review and acceptance prior to inscription. Nameplates on steel panels shall be secured with stainless steel drive screws.

D. Nameplates for identifying relays and devices that are located inside of panels may be of the sandwich phenolic type described above or they may be of white fiber strips marked with the identification in India ink. In large relay panels, relays may be identified with painted designation in clear space adjacent to the relay. Relays shall be identified with number as shown on control diagram and the equipment number which it controls.

E. Relays, Pilot Devices and Related Control Accessories

   1. Relays: Control relays shall be of the heavy-duty solenoid type with contacts having an A600 rating by NEMA standards. Control relays shall have a minimum of four reversible poles at four universal or double-throw poles.

   2. Relays rated 300 volts AC may be used only as control circuit interposing relays where voltages are less than 150 volts AC and the 300 volt relay is specified.

   3. All control relays shall be rated to "make" 60 amperes and "break" 6 amperes at 120 volts AC and 0.35 power factor lagging and shall be rated 2.0 amperes at 125 volts DC.

F. Time Delay Relays: Time delay relays shall be electro-pneumatic with appropriate ranges and fully adjustable within the range by a readily accessible control. Snap action switch assemblies shall have contacts rated for more than 10 million operations at 15 amperes, 120 volts AC.

G. Terminal Blocks: The terminal blocks shall have ample size and capacity to accommodate required loads and shall be of the solderless compression lug type. All terminals shall be numbered and shall be provided with white fiber marking strips.

H. Door Intrusion Switches: Provide a door intrusion switch on each building and generator door. Provide Sentrol Model 2507A or equal.

PART 3 - EXECUTION

3.01 Installation

A. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Engineer reserves the right to require minor changes in equipment or its location prior to roughing in, without incurring any additional cost.

3.02 Field Quality Control

A. After completion of installation, each pilot device shall be individually tested to ensure that the device is properly installed, connected, and operates as required and as specified.

****END OF SECTION****

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SECTION 16160
PILOT DEVICES

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all control stations, pushbuttons, selector switches, elapsed time meters, indicating lamps, control transformers, control fuses, control relays, and related control device appurtenances.

B. Type: All pilot devices shall be heavy-duty type as shown or as otherwise specified.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16330	Variable Frequency Drives
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17924	Control Strategies

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
ANSI C80.1	Electrical Rigid Steel Conduit
UL 1	Flexible Metal Conduit
UL 5	Surface Metal Raceway and Fittings
UL 6	Electrical Rigid Metal Conduit – Steel
UL 514B	Conduit, Tubing and Cable Fittings
UL 651	Schedule 40 and 80 Rigid PVC Conduit and Fittings
NEMA RNI-2005	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC-2-2003	Electrical PVC Tubing and Conduit
NEMA TC-3-2004	PVC Fittings for Use With Rigid PVC Conduit and Tubing

1.03 System Description

1.04 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 - Submittals and 16010 – General Electrical Provisions.

1.05 Quality Assurance

A. The pilot devices shall be heavy-duty type suitable for installation in water facilities.

1.06 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.06 for requirements.

1.07 Project / Site Conditions

A. The pilot devices will be installed in water facilities where the ambient temperatures are expected to range between 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent. The pilot devices may be subjected to dust and moisture.

1.08 Sequencing and Scheduling

A. Sequencing and scheduling plan shall be provided that minimizes pump station downtime. Note that the pump station must remain operational during all phases of construction. For additional requirements refer to Specification Section 01014 – Work Sequence.

1.09 Warranty

A. Refer to Section 17506 for requirements.

1.10 Maintenance

A. Standby Components

1. The following standby components shall be provided:

   a. Twelve (12) - Indicating lamps of each type.

   b. Six (6) - Control fuses of each type.

   c. Two (2) - Control relay and time delay relay of each type.

   d. Four (4) - Indicating lamps lenses of each color.

   e. One (1) - Spare starter operating coil of each type.

   f. Four (4) - Control devices contact blocks

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. Control Stations: For non-classified areas, control stations shall be heavy-duty industrial units, NEMA 12 oil-tight and dust-tight cast aluminum enclosures unless otherwise specified or shown. Control stations exposed to weather or located in corrosive environments shall be NEMA 4X of fiberglass reinforced high impact plastic, Allen Bradley 800 H series, Crouse-Hinds NCS series, or equal.

1. Legend Plates - ("STOP", "AUTO", etc.) shall be as shown on the plans and nameplates shall be as shown on the plans.

2. Nameplates – Nameplates shall be as shown on the plans.

B. Pushbuttons: Pushbuttons shall be heavy-duty oil-tight type; lockout-stop buttons shall be equipped with integral locking device and shall additionally be capable of receiving one 3/8-inch shackle padlock. Contact shall be rated as specified for selector switches. Unless otherwise shown, pushbuttons for field stations shall be provided with a watertight boot if the pushbutton is mounted on the outer surface of the enclosure.

C. Selector Switches: Selector switches located in motor control centers, field stations (generally for HAND-OFF-AUTO or LEAD-FOLLOW operations) shall be heavy-duty oil-tight type.

1. Switches shall be provided complete with cover, front escutcheon, handle and with the legend plate engraved by the switch manufacturer in accordance with the drawings. The manufacturer's standard contact development diagram shall be submitted for each different switch arrangement required. The development diagram shall identify each switch it describes and shall call out all special operating features in addition to providing the standard contact status for each switch position.

2. Where no callout is given, the Contractor shall use the diagrammatic symbol to determine the type of selector to apply in conformance with the electrical symbols drawings.

D. Elapsed Time Meters: Elapsed time meters shall be of the 2-1/2-inch square case type for flush panel mounting. The totalizing type meter shall have 6-digit register with the last digit indicating tenths of an hour.

E. Indicating Lamps: Indicating lamps shall be oil-tight units. Units for alternating current systems shall include a 6-volt transformer and 6-8 volt No. 44 lamp and shall be of the illuminated pushbutton type with the pushbutton wired for the push-to-test function required. Lamps for 24

volts or less DC systems shall be full voltage type. Higher voltage DC systems shall utilize a No. 1835 lamp with resistor as required. Appropriate lens caps shall be provided.

2.02 Components and Accessories

A. Control Transformers: Control transformers shall be of the voltampere rating required to supply the coil and device loads in the control circuit, but not less than the size if shown, without exceeding their rating or overheating.

   1. Control transformers will be required on each starter unless otherwise indicated and shall be connected to terminals on the load side of the branch circuit breaker. Control transformers shall be rated for 480 to 120 volts.

B. Control Circuit Protection: Draw-out indicating fuse holders and fuses shall be provided as shown for the protection of all control circuits. Fuse holders for service at 150 volts or less shall be MIL-F019207/2, Type FHL 11U with 1/4 x 1-1/4 inch ceramic tube fuse rated to interrupt 25,000 amperes at 125 volts.

   1. Fuse holders for service at over 150 volts but less than 600 volts shall be MIL-F-19207/3, Type FHL 12U with 13/32 by 1-1/2 inch ceramic tube fuse rated to interrupt 100,000 amperes at 600 volts.

   2. Fuse holders for the protection of a control circuit transformer which is also provided with an indicating secondary fuse shall be of the double porcelain type having a barrier between the fuses and shall accept the 13/32 by 1-1/2 inch ceramic fuse specified above.

   3. Each control circuit transformer shall be protected by two primary fuses and one secondary fuse as a minimum.

C. Nameplates: Each individual controller, control station, field panel, and control device shall have a nameplate designating the function of the device and its identifying number. All relays, pressure switches, solenoid valves and similar devices mounted outside of their associated motor controller cubicle shall be identified with nameplates. All numbered instruments and devices shall be identified with nameplates.

   1. Nameplates shall be made of 1/16-inch thick machine-engraved laminated phenolic having white letters not less than 5/32 inch high on black background. Equipment titles shall be completely spelled out on nameplates as shown on the drawings. The name plate schedules shall be submitted for review and acceptance prior to inscription. Nameplates on steel panels shall be secured with stainless steel drive screws.

D. Nameplates for identifying relays and devices that are located inside of panels may be of the sandwich phenolic type described above or they may be of white fiber strips marked with the identification in India ink. In large relay panels, relays may be identified with painted designation in clear space adjacent to the relay. Relays shall be identified with number as shown on control diagram and the equipment number which it controls.

E. Relays, Pilot Devices and Related Control Accessories

   1. Relays: Control relays shall be of the heavy-duty solenoid type with contacts having an A600 rating by NEMA standards. Control relays shall have a minimum of four reversible poles at four universal or double-throw poles.

   2. Relays rated 300 volts AC may be used only as control circuit interposing relays where voltages are less than 150 volts AC and the 300 volt relay is specified.

   3. All control relays shall be rated to "make" 60 amperes and "break" 6 amperes at 120 volts AC and 0.35 power factor lagging and shall be rated 2.0 amperes at 125 volts DC.

F. Time Delay Relays: Time delay relays shall be electro-pneumatic with appropriate ranges and fully adjustable within the range by a readily accessible control. Snap action switch assemblies shall have contacts rated for more than 10 million operations at 15 amperes, 120 volts AC.

G. Terminal Blocks: The terminal blocks shall have ample size and capacity to accommodate required loads and shall be of the solderless compression lug type. All terminals shall be numbered and shall be provided with white fiber marking strips.

H. Door Intrusion Switches: Provide a door intrusion switch on each building and generator door. Provide Sentrol Model 2507A or equal.

PART 3 - EXECUTION

3.01 Installation

A. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Engineer reserves the right to require minor changes in equipment or its location prior to roughing in, without incurring any additional cost.

3.02 Field Quality Control

A. After completion of installation, each pilot device shall be individually tested to ensure that the device is properly installed, connected, and operates as required and as specified.

****END OF SECTION****

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SECTION 16250
MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 Summary

A. Scope: This Section specifies motor control centers (MCC) furnished under this contract.

B. Type: The motor control centers shall be of the mechanical group type or a combination of motor controllers, with feeder top and/or other units arranged in a convenient assembly. Motor control centers shall be Allen Bradley, Cutler Hammer, or equal.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16130	Wiring Devices
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16261	Automatic Transfer Switch
Section 16310	Panelboards
Section 16320	Surge Protective Devices
Section 16325	Dry-Type Transformers

Section	Title
Section 16330	Variable Frequency Drives
Section 16400	Electric Service
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System Modifications
Section 17924	Control Strategies

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
NEMA ICS-1	General Standards for Industrial Control and Systems
NEMA ICS-2	Standards for Industrial Control Devices, Controllers, and Assemblies
NEMA ICS-18	Industrial Control and Systems: Motor Control Centers
NFPA 70	National Electric Code
UL 508	Industrial Control Equipment
UL 845	Motor Control Centers

1.03 System Description

A. Performance and Design Requirements

1. General: The motor control centers shall contain equipment to start, stop and monitor the status of the various groups of motors from a convenient central assembly. In addition, equipment shall be provided to protect motors, machines and operators. Connection points shall be provided from the common horizontal power bus to the operating units. The MCC shall be suitable for connection to an available fault as shown on MCC single-line diagrams.
2. Unit Responsibility: The motor control centers shall be the product of a manufacturer regularly engaged in the manufacturer of motor control centers and associated control equipment and overcurrent devices.
3. Operating Requirements
   a. Voltage shall be 480 volts, three phase, 60 hertz.

b. Number of wires shall be 3 wire or 4 wire as indicated on the single line diagrams of the Contract Drawings.

c. Main Bus Rating shall be as indicated on the single line diagrams of the Contract Drawings.

4. Incoming feeder line connection shall be in accordance with the MCC elevation and single-line drawings.

5. Power shall be provided to the motor control center compartments from the main bus by vertical bus bars, which shall have minimum 300 amperes rating unless underground feeder requires greater capacity. A ground bus with appropriate lugs shall be provided across the bottom of the motor control center

1.04 Submittals

A. Submittals shall comply with the provisions set forth in Sections 01300 and 16010. Additionally, the submittals shall consist of the following data, drawings and descriptive material:

1. Manufacturer's qualifications
2. Master Drawing Index
3. Front view elevation
4. Floor Plan
5. Top View
6. Unit Wiring Diagrams
7. Nameplate Schedule
8. Conduit Entry/Exit Locations
9. Assembly ratings including short-circuit rating, voltage and continuous currentl
10. Layout wiring diagrams and shop drawings
11. Cable Terminal Sizes
12. Complete catalog data, including manufacturer's catalog number, function, size, complete applicable data for each item of equipment.

B. All submittals shall be prepared by the System Integrator. Factory supplied drawings including bill of materials, motor control center elevations, and wiring diagrams are not acceptable.

1.05 Quality Assurance

A. A system integrator shall be retained by the contractor to purchase and customize the motor control centers to meet the wiring and control requirements of the contract diagram. The system integrator shall be Tesco, KBL Associates or approved equal.

B. Motor control centers shall be built in strict accordance with the overall sizing and component layouts as detailed on the Drawings and no deviations will be allowed without prior approval of the Engineer.

C. Any special protection relays for the pumps or motors that are required by any pump or motor manufacturer shall be incorporated into the motor starter control circuits at no extra cost to the Owner. Contractor shall be responsible for coordination of these special protection relays between the pump, motor and motor control center manufacturers or suppliers.

1.06 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.06 (?) for requirements.

1.07 Project / Site Conditions

A. The motor control centers shall be installed indoors as noted on the plans, in a water facility. Temperatures are expected to range from 10 degrees F to 115 degrees F. Relative humidity should range from 10 percent to 100 percent. In some installations, the equipment will be subjected to small amounts of dust and may operate in damp rooms that are not force ventilated.

1.08 Sequencing and Scheduling

A. Sequencing and scheduling plan shall be provided that minimizes pump station downtime. Note that the pump station must remain operational during all phases of construction. For additional requirements refer to Specification Section 01014 – Work Sequence

1.09 Warranty

A. Refer to Section 17506 for requirements.

1.10 Maintenance

A. Refer to Section 17506 for requirements.

B. Overload Heater Elements

1. All motor starters shall be furnished with overload heater elements. As mechanical equipment arrives, the Electrical Contractor shall check the nameplates for FLA and verify that the appropriate overload element for the furnished motor is installed.

C. Standby Components

1. Fuses: A set of spare fuses shall be provided. It shall include [five] [ten] fuses for every rating used in the delivered equipment.
2. Lamps: A set of replacement lamps shall be provided for each motor control center. At least 10 percent of each type of lamp used in MCC assembly shall be provided as spares.
3. Two (2) pilot device contact blocks of each type supplied.
4. Supply all spares sealed in plastic bags, labeled with part numbers in a plywood storage box.

D. Devices and Instruments: Where a spare unit is indicated on the drawings, it shall be complete combination starter of the type and size shown. Where a future unit is indicated on the drawings, it shall be provided with all facilities except the drawout unit. The future compartment door shall be provided with covered cutouts for the devices shown. Spare and futures are shown on the MCC elevation drawings.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Make like items of equipment the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service. Motor Control Centers shall be Allen Bradley, Eaton Cutler-Hammer, Square D or equal.

2.02 Equipment and Materials

A. Bus bars shall be silver-plated copper. Sheet metal gage shall be in accordance with UL 845.

B. Structure and Structure Arrangement

1. Structures shall be totally enclosed, dead-front, free-standing assemblies, 90 inches high and not less than 16 inches deep for front mounted units (21 inches deep for back to back mounted units). Working height shall be 72 inches to accommodate starter units in multiples of 6-inch increments with a minimum of 12 inches. Removable lifting angles shall be provided.
2. Structures shall contain a horizontal wireway at the top, isolated from horizontal bus and readily accessible. Each structure shall contain an isolated vertical wireway with cable supports, accessible through hinged doors. Each structure shall also contain a bottom horizontal wireway.
3. All bus bars shall be braced to withstand a fault of 42,000 symmetrical RMS amperes. The main horizontal bus shall have ratings as shown and in no case lower than 600 amperes.
4. All structure doors shall be mounted on removal pin hinges and secured with quarter turn indicating type fasteners. The enclosure shall be NEMA 12 with gasketed doors and door openings for all indoor type units. The structure shall have ANSI 61 light gray baked enamel over bonderized finish on the exterior and flat white on all interior surfaces.
5. The motor control center shall be designed for against- the-wall mounting. All wiring, bus joints, and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.
6. The motor control center shall have engraved laminated nameplates screwed to the doors of each individual compartment and wiring diagrams pasted inside each door. Compartments containing starters shall have an overload heater selection table pasted inside the door.
7. The motor control center shall provide equipment of type, capacity, and trip ratings shown on the Drawings or otherwise specified. Minimum starter size shall be NEMA Size 1. No more than six starters shall be mounted in each section.
8. An engraved laminated nameplate shall be screwed to the MCC near the top of the main compartment with the MCC name. A manufacturer's plaque shall be attached to the MCC giving model number, bus amps, voltage and other applicable information.

C. Compartments

1. Compartments for NEMA Size 4 and (full voltage) and smaller starters shall be drawout type. Guide rails shall be provided in the structure for supporting and aligning a unit during its removal or replacement. Drawout units shall have pressure-type line-disconnecting stabs of high strength alloy and shall be held in place by means of quick-acting, captive machine-screw fasteners arranged so that the units can be removed or remounted readily without access to the rear of the structure. Each compartment, whether drawout or stationary, shall be enclosed and effectively baffled to isolate any fault which may occur and shall be covered by an individual door fixed to the structure with a continuous full length piano hinge or two (three for doors over 36 inches high) semi concealed, heavy-duty, pin-type hinges. Doors shall be secured with captive quick-acting machine-screw fasteners, and shall be arranged to completely cover all live parts whether the drawout unit is present or not. The interior of each compartment shall be painted white.
2. Starter and feeder tap unit doors shall be interlocked mechanically with the unit disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while the door is open. An interlock between the unit disconnect device and the structure will prevent removal or reinsertion of a unit when the disconnect is in the ON or TRIPPED positions. Means shall be provided for releasing the interlock for intentional access and/or application of power. Starters smaller than NEMA Size 1 shall not be used.

3. Padlocking arrangements shall permit locking the disconnect device in the OFF position with at least three padlocks with the door closed or open. Means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.
4. The vertical bus bars shall be protected to prevent accidental contact by insulating them with a single sheet of glass-reinforced polyester with cutouts for stab connections. A labyrinth barrier shall be provided with isolation shutters, which automatically cover stab opening when the units are withdrawn.
5. The motor control center shall have NEMA Class II, Type "B" wiring

2.03 Components and Accessories

A. Devices and Instruments: Pilot devices and instruments including pushbuttons, reset buttons, indicating lights and elapsed time meters, shall be as specified in Section 16160 and flush mounted in the compartment doors. The indicating fuse holders shall be mounted on a bracket or pan located within the starter unit close to the circuit breaker and control transformer. All equipment within the Section shall be arranged to provide ample electrical clearances and easy access for maintenance. Drawout combination starter units of a given type and size shall be made interchangeable. Door mounted indicating lights and pushbuttons shall be removable without removing related wiring. All pilot lights shall be "push to test" type. Control devices shall be as specified in other sections of this project manual pertaining to pilot devices. Special sequencing relay timer, load shedding control relays or other devices shall be located in a special relay compartment and connected to the various drawout unit starters through terminal blocks.

B. Motor Controllers

1. Motor starters shall be of the variable frequency drives (VFDs) or combination type or solid-state type as shown on one-line diagrams.
2. Each motor controller compartment shall contain a red RUN light, a green READY light and an elapsed time meter in addition to other devices shown on the control schematics. The controller compartments shall also contain a set of normally open and a set of normally closed auxiliary contacts rated at 10 amperes at 600 volts for each relay and contactor. All pilot lights in MCCs shall have push-to-test feature.
3. Variable Frequency Drives
   a. Variable Frequency Drives shall be sized as shown on the single line diagram.
   b. Where mounted in Motor Control Centers provide fans and filter louvers.
   c. Variable Frequency Drives shall be as specified under Section 16330.
4. Non- Reversing Starters for motor loads below 50 HP.
   a. Magnetic starters through NEMA Size 3 shall be equipped with double-break silver allow contacts. The starter must have straight-through wiring. Each starter shall interchangeable NO/NC auxiliary contacts as shown on the wiring diagrams of the contract drawings or where none are shown on the wiring diagram a minimum of one NO auxiliary contact.
   b. Coils shall be of molded construction through NEMA Size 3. All coils shall be color-coded through NEMA Size 3 and permanently marked with voltage, frequency and part number.
   c. Magnetic starters shall be a minimum rating of NEMA 1.
   d. Motor Starters shall be as specified under Section 16155.
5. Solid-State Reduced-Voltage Motor Control for motor loads 50 HP and above:

a. The solid-state reduced-voltage starter shall be UL and CSA listed and as specified under Section 16155. .

C. Circuit Breakers: The combination type motor starter circuit breakers shall be the fully magnetic type with adjustable instantaneous trip setting.

1. The circuit breakers shall be as shown on the single line diagram and as specified in Section 16155 and Section 16200.

2. When the circuit breaker size changes due to a different motor size and full load amps than that shown on the Contract Drawings, the Contactor shall provide the properly sized circuit breaker at no additional cost to the Owner.

D. Control Power: Control power shall be obtained from an individual control transformer located in each motor controller cubicle. Control transformers shall be as specified in applicable Sections of the specifications.

E. Terminal Blocks: Terminal blocks shall be furnished for all starter units and shall comply with the requirements of other Sections in this project manual pertaining to pilot devices.

F. Identification

1. An engraved, plastic nameplate with white letters on black background shall be provided for each compartment. The nameplate shall indicate equipment controlled, as shown on the single-line diagram the nameplates shall be 1-inch by 3-1/8- inches and shall be mechanically fastened to the compartment door.

2. All component and control identification nameplates shall be engraved with the device name and number exactly as it appears on the drawings, in the nameplate schedule. For devices not shown on the single line drawing such as time delay relays, the names will be as shown on the Control Schematic Drawings or as assigned by the Engineer.

3. All control wires will be coded with the identification number as shown on the Control Schematic Drawings. Coding will be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent non-smearing solvent resistant type similar to Raychem TMS, Ideal Industries 3M Co., or equal

PART 3 - EXECUTION

3.01 Preparation

A. Submit seismic calculations and installation details prior to installation.

3.02 Installation

A. Motor control centers shall be mounted on channel iron sills embedded in the 4” high concrete “housekeeping” pads. Sills shall be accurately leveled to ensure that the panel structure will not be distorted. The concrete pads shall be

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps.

C. All motor control centers shall be mounted to angle iron channels securely attached to the floor. Motor Control Centers shall meet seismic requirements by anchoring to floors and walls to prevent overturning. Submit calculations and installation details for approval including weight and dimensions of all motor control centers. The sections shall be set plumb and true with all sections at the same height.

D. In general, all conduit entering or leaving a MCC shall be stubbed into the bottom horizontal wireway directly below the vertical wireway.

3.03 Field Quality Control

A. Tests and Checks

1. The following minimum test and checks shall be made twice: (1) Before energizing the motor control centers, and (2) six months after acceptance by owners:

   a. Megger terminals and buses for grounds after disconnecting devices sensitive to meter voltage

   b. Remove all current transformer shunts after completing secondary circuit

   c. Install overload relay heaters based on actual motor nameplate current. If capacitors are installed between starter and motor, use overload relay heaters based on measured motor current.

   d. Check all mechanical interlocks for proper operation

3.04 Adjusting / Cleaning / Protection

A. Vacuum clean all interior equipment.

****END OF SECTION****

SECTION 16300
ELECTRICAL SERVICE EQUIPMENT

PART 1 - GENERAL

1.01 Summary

A. The Contractor shall furnish and install the main service equipment, Main Switchboard 'MSB' as specified herein and as shown on the contract drawings.

B. This section provides specifications for all service related equipment required to accept electrical power from the utility company.

C. Type: The Main Service Equipment shall be free standing outdoor type as noted on contract drawings. It shall have an incoming pull section, metering section, service disconnect, etc. all in accordance with Southern California Edison (SCE) requirements.

D. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment
Section 16310	Panelboards
Section 16320	Surge Protective Devices
Section 16400	Electric Service

Section	Title
Section 16450	Grounding
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System Modifications
Section 17924	Control Strategies

1.02 References

A. All equipment and installation procedures shall be in accordance with the latest applicable standards, codes, and practices of NEMA and ANSI and shall, where applicable, conform to regulations of UL, ASA, IEEE, NEC and other applicable standards.

B. The low voltage metering switchboard shall be UL labeled.

Reference	Title
IEEE C37.13	Standard For Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	Switchgear - Low Voltage Power Circuit Breakers and AC Power Circuit Protectors – Preferred Ratings, Related Requirements, and Application Recommendations
IEEE C37.20.1	Metal-Clad Low Voltage Power Circuit Breakers Used in Enclosures
IEEE C37.20.3	Metal Enclosed Interrupter Switchgear
IEEE C37.50	Switchgear – Low Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures
IEEE C37.100	Standard Definitions for Power Switchgear, Supplement C37.100B
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70	National Electrical Code
UL 489	Standard for Safety Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1025	Standard for Safety Electric Air Heaters
UL 1558	Standard for Safety Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear

1.03 Submittals

A. Scope: Submittals shall comply with the provisions set forth in Sections 01300 and 16010.

1.04 Quality Assurance

A. Performance and Design Requirements

1. General:

a. The equipment furnished under this section shall provide the required protection for a system distributing continuous 24-hour per day, 7-day per week operation. For Well 22, the Main Service Equipment for the main switchboard 'MSB' shall be 1000 Amp, 480-volt, 3-phase, 4-wire 60Hz AC. For Well 26, the Main Service Equipment for the main switchboard 'MSB' shall be 600 Amp, 480-volt, 3-phase, 4-wire 60Hz AC. The AIC ratings shall be 42,000A. The bus bracing shall be as noted on the Plans.

b. The service equipment shall have pull sections to receive cables from the Owner and metering compartments all in accordance with SCE's requirements. In addition, they shall have feeder breakers as shown. The main switchboard shall be indoor NEMA 1 as indicated on the plans.

2. Power Distribution System:

a. Electric power will be supplied to the service equipment by Owner from a transformer located at the site.

b. The power distribution system shall be a completely integrated assembly for automatic unattended operation and distribution of power.

B. Qualifications

1. The Contractor shall cause service equipment to be furnished by a same system integrator of the motor control centers who shall be regularly engaged in the design, procurement, installation, start-up and maintenance of such a system. A statement setting forth the manufacturer's experience, knowledge, and the ability of personnel available for the work shall be submitted to the Engineer.

2. These requirements shall not be construed as relieving the Contractor of its responsibility for this portion of the work. It is the intent of these Specifications that the system integrator, furnish satisfactory evidence that it has the requisite experience and ability and that it has the facilities and prior proven experience in such systems.

3. The system integrator shall also provide complete documentation of its service facilities. The service facilities shall be located within 150 miles of the project location.

4. Service Equipment Components: All contactors, transformers, relays, circuit breakers, instruments, switches, push buttons, pilot lights and devices shall be manufactured by Square D. No substitutes allowed.

5. The manufacturer of the assembly shall be the manufacturer of the circuit breakers within the assembly.

6. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

7. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, UBC: a peak of 2.15g's (3.2 – 11 Hz), and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

8. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra

1.05 Delivery, Storage, and Handling

A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location agreeable with the Engineer, secure from weather or accidental damage.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 Project / Site Conditions

A. All materials used in connection with the electrical service will be installed outdoors in a water facility. Temperatures are expected to range from 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent.

1.07 Sequencing and Scheduling

A. Sequencing and scheduling plan shall be provided that minimizes pump station downtime. Note that the pump station must remain operational during all phases of construction. For additional requirements refer to Specification Section 01014 – Work Sequence

1.08 Warranty

A. Refer to Section 17506 for requirements

1.09 Maintenance

A. Operation and Maintenance Manuals

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Standby Components

1. The following standby components shall be provided:

a. One complete set of special maintenance tools

C. Refer to Section 17506 for requirements

PART 2 - PRODUCTS

2.01 Manufacturers

A. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed below are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

   1. Square 'D'

2.02 Equipment and Materials

A. Ratings

   1. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

B. Construction – Main Distribution Switchboards

   1. Steel enclosures shall be a minimum of G-90 galvanized steel. All edges shall be smooth after forming. Enclosure shall be painted after fabrication. Finish coat shall be minimum of 2 mils thickness and provide a tough, non-chalking weather resistant finish. Construction shall be in accordance with ANSI/UL50. Indoor enclosures shall be rated NEMA Type 1. Mounting bosses shall provide 0.125-inch minimum air space between back of the meter main/combinations and the mounting surface. Meter main/combinations sealing shall be provided by minimum 304 stainless steel latches and rivet with provision for 3/8-inch padlock and/or ribbon seal.
   2. The entire assembly shall consist of a underground pull section, a service entrance rated transfer switch and distribution breakers where shown on plans.
   3. For Well 22, the main section shall include:
      a. A service rated main breaker and automatic transfer switch
      b. A transient voltage surge suppressor
      c. A power monitor
      d. Main lugs for use with conductor connection
      e. Current transformers, potential transformers and fusing for SPD and power monitor
   4. For Well 26, the main section shall include:
      a. A service rated main breaker and generator breaker. The two breakers shall be mechanically interlock such that only one of the circuit breaker can be in the energized state at any one time.
      b. A transient voltage surge suppressor
      c. A power monitor
      d. Main lugs for use with conductor connection
      e. Current transformers, potential transformers and fusing for SPD and power monitor
   5. Distribution Panel

a. Where shown on the drawings, provide a 480/277 volt three-phase, 4-wire or 3-phase, 3-wire (as noted on plans) distribution panel. Provide branch circuit breakers as indicated on the contract drawings.

C. Enclosures

1. NEMA 1 Enclosure for indoor where required

a. Ventilating openings shall be provided complete with replacement fiberglass air filters

b. Provide space heaters thermostatically controlled for each structure with adequate wattage to prevent the accumulation of moisture

c. Provide exhaust fan in any section to contain a transformer and as shown on plans

d. Power for space heaters, lights, exhaust fans, and receptacles shall be obtained from a source as indicated on the drawings. Supply voltage shall be 120 volts AC

D. Finish

1. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.03 Components and Accessories

A. Meter main/combination jaws:

1. Block assemblies shall be replaceable from the front. Current carrying meter main/combinations jaws shall be reinforced and have meter blade guides. The jaws shall be tin plated, capable of carrying full rated (continuous) current and withstand the mechanical and heat rise requirements of ANSI/UL 414.

B. Bus

1. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

2. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

3. A copper ground bus (minimum ¼ x 2 inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

4. All hardware used on conductor shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

C. Terminal Connectors:

1. Terminal connectors shall be suitable for use with aluminum and copper conductors. Connectors shall be tin plated and capable of carrying full rated (continuous) current and withstand the mechanical and heat rise requirements of ANSI/UL 486B

D. Terminal Blocks

1. All connections shall be made at terminal blocks and shall comply with other portions of the Specifications.

E. Circuit breakers

1. Circuit Breakers: Provide circuit breakers of adequate interrupting capacity. Circuit breaker shall have a minimum rating not less that the KAIC rating indicated on single line diagrams in

the contract documents. If no specific value for a specific bus is shown on the drawings, the contract shall supply devices rated for 65 KAIC symmetrical.

2. Main Circuit breaker shall be insulated case fixed mounted type. The main circuit breaker shall be UL listed for application in the switchboard for 100% of their continuous rating. Frame size shall be as shown on the plans. Cutler Hammer SPB POW-R Breakers or equal.
3. Supply integral ground fault protection for circuit breakers where shown on the plans or required by code.
4. Submit short circuit calculations based upon Utility Company supplied information for approval.

F. Metering

1. Current transformers shall, in general, be mounted in the breaker compartment to provide easy access and maintenance. Transformers shall have an ANSI rated 0.3 B accuracy class with 0.5 ohm burden and a 10 kV BIL insulation.

G. Utility Metering - Where shown on drawings, provide separate barriered-off utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements. The Supplier shall obtain Utility approval of the line and metering sections PRIOR to construction of the gear.

H. Customer Monitoring

1. Provide customer monitoring devices where shown on the drawings. Where indicated provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.
2. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.
3. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings

I. The solid-state metering device with a multi-function LED display shall monitor the power system parameters including Amps, Volts, Watts, Vars, Power Factor, Frequency. Watt Demand and Watt-hours and Ethernet-connected to the SCADA system to allow for full monitoring of the distribution switchboards using the software supplied as part of the power monitor system. The device shall have adjustable protective contact outputs where shown on the drawings. Allen Bradley Powermonitor Series, Cutler Hammer IQ Analyzer 6600 Series with Ethernet PONI, Electro Industries, Square D Powelogic Circuit Monitor Series with Ethernet Connection Card, or approved equal.

J. Nameplates

1. Nameplates shall be provided for each compartment. Additionally, each device shall be identified by appropriate nameplates which indicate equipment controlled as shown.
2. Nameplates for switches, devices and circuit breakers shall be laminated phenolic plastic with black face and white core engraved through the outer layer.
3. Nameplates shall be secured to the front of the enclosure with self-tapping screws or machine bolts and nuts. Embossed pressure sensitive plastic tape labels shall not be used.
4. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams

PART 3 - EXECUTION

3.01 Installation

A. Examine the area to receive the service equipment to assure adequate clearance for switchboard installation and workspace required by code (NEC Article 110).

B. All equipment shall be located and installed to be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in location of equipment prior to roughing in without incurring any additional cost.

C. Although the Drawings and Specifications have been prepared in compliance with regulations of SCE, it shall be the responsibility of the Contractor to coordinate the arrangements with SCE and the Contractor shall bear all costs associated with the electrical power installation.

D. The sections shall be securely bolted to floor and to wall to meet seismic requirements to prevent overturning. Installation requirements shall be as recommended by service equipment manufacturer. Submit calculations and installation details for approval including weight and dimensions of all switchboards. The sections shall be set plumb and true with all sections at the same height.

E. Submit seismic calculations prior to installation.

3.02 Field Quality Control

A. Operation and Maintenance Manuals

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Factory Testing

1. General: The power distribution system shall be subjected to static and operational testing. The tests shall be conducted in accordance with IEEE standards and recommendations in addition to other applicable standards.

2. Static Testing: The power distribution system as described above and including all accessories shall be set up and tested using the static method. All safety devices and control circuits shall be properly installed, adjusted, and connected. All interconnecting wiring shall be checked to ensure proper interconnection. Insulation tests shall be performed on the control circuits and the bus circuits.

3. Operating Testing: The complete system shall be set up in a test cell and operated with simulated power sources and loads to determine the characteristics under load. Performance of various safety operating requirements as specified in this section and in other sections.

C. Field Testing

1. After completion of installation, static testing shall be performed which shall include visual inspection and verification of various functions.

2. Power shall be applied to the main service equipment and the Contractor shall demonstrate the ability of the equipment to perform the required functions as specified. A manufacturer's qualified technical representative shall be present and assist the Contractor during testing. The Contractor shall demonstrate to the Engineer that the entire system operates as specified

****END OF SECTION****

SECTION 16300
ELECTRICAL SERVICE EQUIPMENT

PART 1 - GENERAL

1.01 Summary

A. The Contractor shall furnish and install the main service equipment, Main Switchboard 'MSB' as specified herein and as shown on the contract drawings.

B. This section provides specifications for all service related equipment required to accept electrical power from the utility company.

C. Type: The Main Service Equipment shall be free standing outdoor type as noted on contract drawings. It shall have an incoming pull section, metering section, service disconnect, etc. all in accordance with Southern California Edison (SCE) requirements.

D. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment
Section 16310	Panelboards
Section 16320	Surge Protective Devices
Section 16400	Electric Service

Section	Title
Section 16450	Grounding
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System Modifications
Section 17924	Control Strategies

1.02 References

A. All equipment and installation procedures shall be in accordance with the latest applicable standards, codes, and practices of NEMA and ANSI and shall, where applicable, conform to regulations of UL, ASA, IEEE, NEC and other applicable standards.

B. The low voltage metering switchboard shall be UL labeled.

Reference	Title
IEEE C37.13	Standard For Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	Switchgear - Low Voltage Power Circuit Breakers and AC Power Circuit Protectors – Preferred Ratings, Related Requirements, and Application Recommendations
IEEE C37.20.1	Metal-Clad Low Voltage Power Circuit Breakers Used in Enclosures
IEEE C37.20.3	Metal Enclosed Interrupter Switchgear
IEEE C37.50	Switchgear – Low Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures
IEEE C37.100	Standard Definitions for Power Switchgear, Supplement C37.100B
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70	National Electrical Code
UL 489	Standard for Safety Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 1025	Standard for Safety Electric Air Heaters
UL 1558	Standard for Safety Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear

1.03 Submittals

A. Scope: Submittals shall comply with the provisions set forth in Sections 01300 and 16010.

1.04 Quality Assurance

A. Performance and Design Requirements

1. General:

a. The equipment furnished under this section shall provide the required protection for a system distributing continuous 24-hour per day, 7-day per week operation. For Well 22, the Main Service Equipment for the main switchboard 'MSB' shall be 1000 Amp, 480-volt, 3-phase, 4-wire 60Hz AC. For Well 26, the Main Service Equipment for the main switchboard 'MSB' shall be 600 Amp, 480-volt, 3-phase, 4-wire 60Hz AC. The AIC ratings shall be 42,000A. The bus bracing shall be as noted on the Plans.

b. The service equipment shall have pull sections to receive cables from the Owner and metering compartments all in accordance with SCE's requirements. In addition, they shall have feeder breakers as shown. The main switchboard shall be indoor NEMA 1 as indicated on the plans.

2. Power Distribution System:

a. Electric power will be supplied to the service equipment by Owner from a transformer located at the site.

b. The power distribution system shall be a completely integrated assembly for automatic unattended operation and distribution of power.

B. Qualifications

1. The Contractor shall cause service equipment to be furnished by a same system integrator of the motor control centers who shall be regularly engaged in the design, procurement, installation, start-up and maintenance of such a system. A statement setting forth the manufacturer's experience, knowledge, and the ability of personnel available for the work shall be submitted to the Engineer.

2. These requirements shall not be construed as relieving the Contractor of its responsibility for this portion of the work. It is the intent of these Specifications that the system integrator, furnish satisfactory evidence that it has the requisite experience and ability and that it has the facilities and prior proven experience in such systems.

3. The system integrator shall also provide complete documentation of its service facilities. The service facilities shall be located within 150 miles of the project location.

4. Service Equipment Components: All contactors, transformers, relays, circuit breakers, instruments, switches, push buttons, pilot lights and devices shall be manufactured by Square D. No substitutes allowed.

5. The manufacturer of the assembly shall be the manufacturer of the circuit breakers within the assembly.

6. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

7. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, UBC: a peak of 2.15g's (3.2 – 11 Hz), and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

8. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.

a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra

1.05 Delivery, Storage, and Handling

A. Deliver materials and equipment to project site in manufacturer's original packaging with labeling showing product name, brand, model, project name, address, and Contractor's name. Store in a location agreeable with the Engineer, secure from weather or accidental damage.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 Project / Site Conditions

A. All materials used in connection with the electrical service will be installed outdoors in a water facility. Temperatures are expected to range from 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent.

1.07 Sequencing and Scheduling

A. Sequencing and scheduling plan shall be provided that minimizes pump station downtime. Note that the pump station must remain operational during all phases of construction. For additional requirements refer to Specification Section 01014 – Work Sequence

1.08 Warranty

A. Refer to Section 17506 for requirements

1.09 Maintenance

A. Operation and Maintenance Manuals

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Standby Components

1. The following standby components shall be provided:

a. One complete set of special maintenance tools

C. Refer to Section 17506 for requirements

PART 2 - PRODUCTS

2.01 Manufacturers

A. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed below are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

   1. Square 'D'

2.02 Equipment and Materials

A. Ratings

   1. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

B. Construction – Main Distribution Switchboards

   1. Steel enclosures shall be a minimum of G-90 galvanized steel. All edges shall be smooth after forming. Enclosure shall be painted after fabrication. Finish coat shall be minimum of 2 mils thickness and provide a tough, non-chalking weather resistant finish. Construction shall be in accordance with ANSI/UL50. Indoor enclosures shall be rated NEMA Type 1. Mounting bosses shall provide 0.125-inch minimum air space between back of the meter main/combinations and the mounting surface. Meter main/combinations sealing shall be provided by minimum 304 stainless steel latches and rivet with provision for 3/8-inch padlock and/or ribbon seal.
   2. The entire assembly shall consist of a underground pull section, a service entrance rated transfer switch and distribution breakers where shown on plans.
   3. For Well 22, the main section shall include:
      a. A service rated main breaker and automatic transfer switch
      b. A transient voltage surge suppressor
      c. A power monitor
      d. Main lugs for use with conductor connection
      e. Current transformers, potential transformers and fusing for SPD and power monitor
   4. For Well 26, the main section shall include:
      a. A service rated main breaker and generator breaker. The two breakers shall be mechanically interlock such that only one of the circuit breaker can be in the energized state at any one time.
      b. A transient voltage surge suppressor
      c. A power monitor
      d. Main lugs for use with conductor connection
      e. Current transformers, potential transformers and fusing for SPD and power monitor
   5. Distribution Panel

a. Where shown on the drawings, provide a 480/277 volt three-phase, 4-wire or 3-phase, 3-wire (as noted on plans) distribution panel. Provide branch circuit breakers as indicated on the contract drawings.

C. Enclosures

1. NEMA 1 Enclosure for indoor where required

a. Ventilating openings shall be provided complete with replacement fiberglass air filters

b. Provide space heaters thermostatically controlled for each structure with adequate wattage to prevent the accumulation of moisture

c. Provide exhaust fan in any section to contain a transformer and as shown on plans

d. Power for space heaters, lights, exhaust fans, and receptacles shall be obtained from a source as indicated on the drawings. Supply voltage shall be 120 volts AC

D. Finish

1. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.03 Components and Accessories

A. Meter main/combination jaws:

1. Block assemblies shall be replaceable from the front. Current carrying meter main/combinations jaws shall be reinforced and have meter blade guides. The jaws shall be tin plated, capable of carrying full rated (continuous) current and withstand the mechanical and heat rise requirements of ANSI/UL 414.

B. Bus

1. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

2. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.

3. A copper ground bus (minimum ¼ x 2 inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

4. All hardware used on conductor shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

C. Terminal Connectors:

1. Terminal connectors shall be suitable for use with aluminum and copper conductors. Connectors shall be tin plated and capable of carrying full rated (continuous) current and withstand the mechanical and heat rise requirements of ANSI/UL 486B

D. Terminal Blocks

1. All connections shall be made at terminal blocks and shall comply with other portions of the Specifications.

E. Circuit breakers

1. Circuit Breakers: Provide circuit breakers of adequate interrupting capacity. Circuit breaker shall have a minimum rating not less that the KAIC rating indicated on single line diagrams in

the contract documents. If no specific value for a specific bus is shown on the drawings, the contract shall supply devices rated for 65 KAIC symmetrical.

2. Main Circuit breaker shall be insulated case fixed mounted type. The main circuit breaker shall be UL listed for application in the switchboard for 100% of their continuous rating. Frame size shall be as shown on the plans. Cutler Hammer SPB POW-R Breakers or equal.
3. Supply integral ground fault protection for circuit breakers where shown on the plans or required by code.
4. Submit short circuit calculations based upon Utility Company supplied information for approval.

F. Metering

1. Current transformers shall, in general, be mounted in the breaker compartment to provide easy access and maintenance. Transformers shall have an ANSI rated 0.3 B accuracy class with 0.5 ohm burden and a 10 kV BIL insulation.

G. Utility Metering - Where shown on drawings, provide separate barriered-off utility metering compartment or structure complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements. The Supplier shall obtain Utility approval of the line and metering sections PRIOR to construction of the gear.

H. Customer Monitoring

1. Provide customer monitoring devices where shown on the drawings. Where indicated provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.
2. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.
3. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings

I. The solid-state metering device with a multi-function LED display shall monitor the power system parameters including Amps, Volts, Watts, Vars, Power Factor, Frequency. Watt Demand and Watt-hours and Ethernet-connected to the SCADA system to allow for full monitoring of the distribution switchboards using the software supplied as part of the power monitor system. The device shall have adjustable protective contact outputs where shown on the drawings. Allen Bradley Powermonitor Series, Cutler Hammer IQ Analyzer 6600 Series with Ethernet PONI, Electro Industries, Square D Powelogic Circuit Monitor Series with Ethernet Connection Card, or approved equal.

J. Nameplates

1. Nameplates shall be provided for each compartment. Additionally, each device shall be identified by appropriate nameplates which indicate equipment controlled as shown.
2. Nameplates for switches, devices and circuit breakers shall be laminated phenolic plastic with black face and white core engraved through the outer layer.
3. Nameplates shall be secured to the front of the enclosure with self-tapping screws or machine bolts and nuts. Embossed pressure sensitive plastic tape labels shall not be used.
4. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams

PART 3 - EXECUTION

3.01 Installation

A. Examine the area to receive the service equipment to assure adequate clearance for switchboard installation and workspace required by code (NEC Article 110).

B. All equipment shall be located and installed to be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in location of equipment prior to roughing in without incurring any additional cost.

C. Although the Drawings and Specifications have been prepared in compliance with regulations of SCE, it shall be the responsibility of the Contractor to coordinate the arrangements with SCE and the Contractor shall bear all costs associated with the electrical power installation.

D. The sections shall be securely bolted to floor and to wall to meet seismic requirements to prevent overturning. Installation requirements shall be as recommended by service equipment manufacturer. Submit calculations and installation details for approval including weight and dimensions of all switchboards. The sections shall be set plumb and true with all sections at the same height.

E. Submit seismic calculations prior to installation.

3.02 Field Quality Control

A. Operation and Maintenance Manuals

1. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. Factory Testing

1. General: The power distribution system shall be subjected to static and operational testing. The tests shall be conducted in accordance with IEEE standards and recommendations in addition to other applicable standards.

2. Static Testing: The power distribution system as described above and including all accessories shall be set up and tested using the static method. All safety devices and control circuits shall be properly installed, adjusted, and connected. All interconnecting wiring shall be checked to ensure proper interconnection. Insulation tests shall be performed on the control circuits and the bus circuits.

3. Operating Testing: The complete system shall be set up in a test cell and operated with simulated power sources and loads to determine the characteristics under load. Performance of various safety operating requirements as specified in this section and in other sections.

C. Field Testing

1. After completion of installation, static testing shall be performed which shall include visual inspection and verification of various functions.

2. Power shall be applied to the main service equipment and the Contractor shall demonstrate the ability of the equipment to perform the required functions as specified. A manufacturer's qualified technical representative shall be present and assist the Contractor during testing. The Contractor shall demonstrate to the Engineer that the entire system operates as specified

****END OF SECTION****

SECTION 16320
SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 Summary

A. Scope: This section describes the electrical and mechanical requirements for a high energy Surge Protection Device (i.e. SPD) previously referred to as a Transcient Voltage Surge Supressor (i.e. TVSS). The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C3 environments, as tested by ANSI/IEEE C62.11, and C62.45. The system shall be connected in parallel with the protected system; no series-connected elements shall be used.

B. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16300	Electrical Service Equipment
Section 16310	Panelboards
Section 16400	Electric Service
Section 16450	Grounding
Section 17201	Control Panels
Secton 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests

Section 17512	Site Acceptance Tests
Section 17924	Control Strategies

1.02 References

A. The specified system shall be designed, manufactured, tested, and installed in compliance with:

Reference	Title
ANSI/IEEE C62.62	Test Specifications for Surge Protection Devices for Low Voltage AC Power Circuits
ANSI/IEEE C62.41	Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits
ANSI/IEEE C62.45	Recommended Practice on Surge Testing for Equipment Connected to Low Voltage (1000V and Less) AC Power Circuits
FIPS Pub 94	Guideline on Electrical Power for ADP Installations
NEMA LS-1	Low Voltage Surge Protective Devices
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 70	National Electrical Code
NFPA 75	Standard for the Protection of Information Technology Equipment
NFPA 780	Standard for the Installation of Lightning Protection Equipment
UL 1449	Surge Protective Devices
UL 1283	Electromagnetic Interference Filters

B. International Standards Organization (ISO) Company certified ISO 9001 for manufacturing, design and service.

C. The systems individual units shall be UL Listed and labeled under UL 1449 Standard for Surge Protective Devices (SPD) and the surge ratings shall be permanently affixed to the SPD. The units shall also be listed and labeled to UL1283 Standard for Electromagnetic Interference Filters, and CSA Listed.

D. The specified system shall be thoroughly factory-tested before shipment. Testing of each system shall include but shall not be limited to quality control checks, "Hi-Pot" tests at two times rated voltage plus 1000 volts per UL requirements, IEEE C62.41 Category B surge tests, UL ground leakage tests, and operational and calibration tests.

1.03 System Description

A. 480 Volt Connections

1. These specifications are based on the Liebert Transient Voltage Surge Suppression Interceptor II Series or the Cutler Hammer Clipper CPS Series for use on the 480V power connection points indicated on the contract documents. Other manufacturers shall provide detailed compliance or exception statements to all provisions of this specification to allow consideration.

2. The system shall be constructed using multiple surge current diversion modules utilizing metal oxide varistors (MOV) computer matched to +/- 1 volt variance and tested for manufacturer's

defects. The modules shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes, or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

3. Environmental Requirements
   a. Storage Temperature: Storage temperature range shall be -55 to +85 C (-67 to + 187 F).
   b. Operating Temperature and Relative Humidity: Operating temperature range shall be -40 to +60 C (-40 to 140 F). Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
   c. Audible Noise and Magnetic Fields: less than 45dBa at 5 feet (1.5 m).
   d. Operating Altitude: The system shall be capable of operation up to an altitude of 18,000 feet above sea level.
4. Electrical Requirements
   a. System Operation Voltage: The nominal system operating voltage shall be 277/480, three phase wye, 4 wire plus ground.
   b. Maximum Continuous Operating Voltage: The SPD and all components in the suppression path (including all MOV's, SAD's, and selenium cells) maximum continuous operating voltage shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell conditions).
   c. Operating Frequency: The operating frequency range of the system shall be at least 47 to 63 Hertz.
5. Life Cycle Testing
   a. The SPD system shall be duty life cycle tested to survive 20KV, 10kA, IEEE C62.41 Category C3 surge current with less than 5% degradation of clamping voltage. The minimum numbers of surges the unit shall be able to protect against are 12,000 Life Cycle Surges per mode and 24,000 Life Cycle Surges per phase.
6. Overcurrent Protection (Fusing)
   a. All components, including suppression, filtering, and monitoring components, shall be individually fused and rated to allow maximum specific surge current capacity. For every 100 kAmps of Surge Current Capacity, 120 amps RMS of internal, integral fusing shall be required.
   b. Individual surge components shall be sand packed and fused at a maximum of 7 1/2 amps to prevent violent failure. The fusing shall be UL listed to be capable of interrupting up to 300 KA symmetrical fault current with 600VAC applied. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable.
7. Design Requirements
   a. Protection Modes: The SPD shall provide protection as follows:All modes, L-N or L-L, L-G and N-G (where applicable). Note: L – Line, G – Ground, N – Neutral
   b. UL 1449 Ratings:
      1) The maximum UL 1449 listed surge ratings for each and/or all of the specified protection modes shall not exceed the following in any mode of protection:

System voltage	Without disconnect	With disconnect
208, 240, 277, 230/400, or 277/480 volt	800 volts	1000 volts
480 volt	1500 volts	1500 volts

c. The unit shall be UL 1283 Listed as an electromagnetic interference filter. The filter shall provide insertion loss with a maximum of 60 dB from 100 KHz to 100 MHz per 50 Ohm Insertion Loss Methodology from MIL 220A. The system shall provide up to 120 dB insertion loss from 100 KHz to 100 MHz when used in a coordinated facility system.

8. Performance Ratings

a. Surge Current Capacity: The minimum SPD surge current capacity, per NEMA LS-1 1992 shall be as follows:

480 Volt Service	Surge Rating per mode	Surge Rating per phase (L-N + L-G)
MDSB	160 kA	320 kA

B. 120/208 Volt Connections

1. These specifications are based on the Liebert Transient Voltage Surge Suppression Acuvar Series for use on the 120/208 V power connection points indicated on the contract documents. Other manufacturers shall provide detailed compliance or exception statements to all provisions of this specification to allow consideration.

2. The SPD/Filter shall be constructed using multiple surge current diversion arrays of metal oxide varistors (MOV), matched to a variance of ± 1 volt. The array shall consist of multiple gapless metal oxide varistors, with each MOV individually fused. The arrays shall be designed and constructed in a manner that ensures MOV surge current sharing. No gas tubes, silicon avalanche diodes or selenium plates/rectifiers shall be used. The status of each array shall be continuously monitored and a green LED shall be illuminated if the array is in full working order. All protection modes, including N-G, shall be monitored and internally fused for compliance with NEC Article 110.9, 110.10, and 280.22.

3. Electrical Requirements

a. System Operation Voltage: The nominal system operating voltage shall be 120/208, three phase wye, 4 wire plus ground.

b. Maximum Continuous Operating Voltage: The SPD and all components in the suppression path (including all current diversion components) maximum continuous operating voltage (MCOV) shall be greater than 115% of temporary RMS over-voltage (swell conditions).

c. Operating Frequency: The operating frequency range of the system shall be at least 47 -63 Hz.

4. Life Cycle Testing

a. Life Expectancy Testing: The unit shall be capable of protecting against and surviving at least 6000 kA surges per ANSI/IEEE C62.41-1991 Category C without failing or degrading the UL 1449 surge suppression ratings by more than 5%.

b. Maximum Continuous Operating Voltage (MCOV) Testing: The unit shall be factory-tested to ensure proper MCOV of the unit.

5. Overcurrent Protection

a. Fusing: All protection modes (including neutral to ground) of the SPD shall be internally fused at the component level with the fuses I^2T capability to allow the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low-impedance fault conditions. The fusing shall be capable of interrupting up to 200 kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored and provide indication of suppression failure/operability. Conductor level fuses or circuit breakers internal or external to the SPD shall not be acceptable.

6. Design Requirements

a. Protection Modes: Surge Modes Required – Line to Line, Line to Neutral, Line to Ground, and Neutral to Ground.

7. Performance Ratings

a. Surge Current Capacity: The SPD surge current capacity, based on an 8 x 20 microsecond waveform, shall be 130 kA Rating per Phase.

b. UL 1449 Ratings: The system performance ratings shall be based on the UL 1449 listing ratings for IEEE C62.41 Category B3 impulse waveforms of 6 kV 1.2 x 50 microseconds, 3 kA 8 x 20 microsecond waveshapes. The maximum UL 1449 listed surge rating for the specified protection modes shall not exceed 400 volts for 120/208 volt systems.

c. Noise Attenuation Option: Typical noise attenuation shall be a minimum of 50dB for 50 ohm measurement method, 10 kHz to 500 MHz. The unit shall be complementary listed to UL 1283. Only UL 1283 complementary listed products will be acceptable for this requirement; all others shall be rejected.

d. Response Time: The typical response time of all suppression components shall be 0.5 nanoseconds

1.04 Submittals

A. Submittals shall comply with Sections 01340 and 16010.

B. Documentation

1. Equipment Manual: The manufacturer shall furnish an installation manual with installation, start-up, and operating instructions for the specified system.

2. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.

3. UL 1449 Ratings: Documentation of specified system's UL 1449 listing and clamping voltage ratings shall be included as required product data submittal information.

4. Spare Parts: A list of recommended spare parts shall be supplied at the customer's request

1.05 Quality Assurance

A. The manufacturer shall be ISO 9001 certified. The specified system shall be tested at the component and fully assembled level, under surge conditions with AC power applied for a minimum of 1 hour. Testing shall include but not be limited to quality control checks, dielectric

voltage withstand test per UL and CSA requirements, UL ground continuity tests and operational and calibration tests.

1.06 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.07 Project / Site Conditions

A. The SPD may be installed indoors in a wastewater treatment facility as shown on the contract drawings or as specified herein. The ambient temperature may range from 10 degrees F and 115 degrees F. Relative humidity may range from 10 to 95 percent

1.08 Warranty

A. Refer to Section 17506 for additional requirements.

B. 480 Volt Connections

1. The manufacturer shall provide a full five-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL Listing requirements, and any applicable national, state or local electrical codes. Direct, factory trained, ISO 9001 certified employees must be available for 48 hour assessment. A 24 hour 800 number must be available to support warranty.

C. 120/208 Volt Connections

1. The manufacturer shall provide a 10 year parts limited warranty from date of shipment against failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes. Manufacturer shall make available for consultation, local engineering service support

1.09 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Manufacturers

A. 480 Volt Connections

1. Liebert Transient Voltage Surge Suppression Interceptor II Series
2. Cutler Hammer Clipper CPS Series
3. Or approved equal.

B. 120/208 Volt Connection

1. Liebert Transient Voltage Surge Suppression Acuvar Series
2. Or approved equal.

2.02 Equipment and Materials

A. 480 Volt Connections

1. Enclosure: The specified system shall be mounted open case style within a Switchboard Enclosure. All monitoring indication must be visible without opening the Switchboard door.

The open case style enclosure maximum dimensions shall be (20) inches high and (24) inches wide and (9) inches deep.

2. Connections: The terminals shall be provided to accommodate wire sizes up to #2/0 AWG.
3. Internal Connections and Serviceability: All surge current diversion module intra-unit connections shall be by way of low impedance copper plates. Surge current diversion modules shall use bolted connections to the plates for reliable, low impedance connections. The system shall be designed for simple change out of any or all SPD component modules by a qualified electrician. Designs that require factory service are not acceptable. All connections, conductors, and terminals must be appropriately sized for specified surge current capacity.

B. 120/208 Volt Connection

1. Enclosure: The unit case shall be an enclosure rated UL94-5V, the best rating for resistance to flammability available. Further, the enclosure shall be designed and tested to NEMA 12, 4 and 4X standards. The enclosure dimensions shall be 7 in. long x 4.25 in. wide x 4 in. deep. The unit shall weigh a maximum of 7 lbs.
2. Connections: The unit shall be designed to be installed using the flexible conduit provided by the SPD manufacturer. All parallel connections to the SPD shall be kept as short as possible. The connection to the SPD shall be made using #10 AWG maximum (ring terminal shall be provided).
3. Features
   a. Unit Status Indicators: The unit shall have an integral status circuit that monitors the operational status of all modes of protection, including Line to Neutral, Line to Ground, and Neutral to Ground. No manual testing is required to confirm the integrity of the suppression and filter systems. If the unit does fail, the green LED will go out and the red LED will be lit.
   b. Undervoltage Detection: Unit shall be equipped with 70% undervoltage detection capability.
   c. Phase Loss Monitoring: Unit shall be equipped with phase loss monitoring.
   d. Power Loss Monitoring: Unit shall be equipped with power loss monitoring.

2.03 Components and Accessories

A. 480 Volt Connections

1. Unit Status Indicators: Red and green solid state indicators with printed labels shall be provided on the hinged front cover to redundantly indicate on-line unit status. The absence of the green light and the presence of the red light shall reliably indicate that surge protection is reduced and service is needed to restore full operation.
2. Dry Contacts for Remote Monitoring: Electrically isolated Form C dry contacts, one normally open and one normally closed set standard on all units for remote monitoring.
3. Under-voltage Detection: Unit shall be equipped with 70% under-voltage detection capability.
4. Phase Loss Monitoring: Unit shall be equipped with phase loss monitoring.
5. Power Loss Monitoring: Unit shall be equipped with power loss monitoring.
6. Audible Alarm: The specified system shall be equipped with an audible alarm that shall be activated when summary alarm contacts are activated. In conjunction with alarm, an alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be

provided to test the alarm function. A visible LED will confirm whether alarm is on or disabled. Both switches and the audible alarm shall be located on the unit's hinged front cover.

7. Transient Counters: Dual, adjustable transient counters shall be available to totalize transient voltage surges in both normal and common modes. The readout shall be at least a seven digit LCD located on the unit's hinged front cover or mounted directly to the switchboard. The counter reset switches may be inhibited and must be remotely located. Counter must utilize lithium batteries with a 10 year nominal life to maintain accurate counts in the event of total power loss.

B. 120/208 Volt Connection

1. Summary Alarm Relay Contacts: In addition to the LED indicators, the unit shall be equipped with a summary alarm relay with one set of Normally Open and Normally Closed (Form C) dry contacts rated for 125 VAC, 1 amp (minimum). The contacts will change state and indicate a failure of the unit, a phase loss condition or a full power loss condition.

2.04 Source Quality Control

A. 480 Volt Connections

1. Testing

a. Component Testing and Monitoring: Unit shall include an on-line circuit which tests and redundantly monitors individual components in all protection modes including neutral to ground (where applicable). Units that require external test sets or equipment is unacceptable.

b. External Test Capability: External testing demonstrating surge suppression capability and/or degradation shall be available.

B. 120/208 Volt Connections

1. Testing

a. In compliance with NEMA LS-1 1992 paragraphs 2.2.9 and 3.9, the proposed product shall be single pulsed surge current testing in all modes at the rated surge currents by an industry recognized independent test laboratory. The test shall include a UL 1449 surge impulse (6kV [1.2 x50µs], 500 amp [8 x 20 µs] waveform) to benchmark the unit's suppression voltage. The applied impulse is followed by a single pulse surge of the maximum rated surge current magnitude, followed by a second UL 1449 impulse as a means of measuring clamping deviation (component degradation). Compliance is achieved if the two measured suppression voltage do not vary by more than 5%.

PART 3 - EXECUTION

3.01 Installation

A. The installing contractor shall install the parallel SPD units with short and straight conductors as practically possible. The contractor shall twist the SPD input conductors together to reduce input conductor inductance. The contractor shall follow the SPD manufacturer's recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes.

B. 480 volt SPD units shall be provided for the Main Switchboard.

C. 120/208 SPD units shall be provided at all 120/208 circuit breaker panels that provide power to the new and existing control panels

END OF SECTION

SECTION 16325
DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all transformers with primaries of 600V or less and ratings up to 112.5 kVA.

B. Type: All transformers shall be of the dry type

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16300	Electrical Service Equipment
Section 16310	Panelboards
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Secton 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests

1.02 References

A. All work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these specifications.

Reference	Title
IEEE C57.96	Guide for Loading Dry Type Transformers
NECA 409	Recommended Practice for Installing and Maintaining Dry-Type Transformers
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	Dry-Type Transformers for General Applications
NEMA TP 1	Guide for Determining Energy Efficiency for Distribution Transformers
NFPA 70	National Electrical Code
UL 486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
UL 489	Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures
UL 1561	Standard for Dry-Type, General Purpose, and Power Transformers

1.03 Submittals

A. Submittals shall comply with Sections 01300 and 16010.

1.04 Quality Assurance

A. Performance and Design Requirements: General: Unless an integral part of a motor control center, the dry type transformers shall be either wall or floor mounted. The coil and core shall be installed on a vibration isolation mounting. Coils shall be copper wire wound and epoxy encased. Where transformers are mounted within motor control centers or variable frequency drive units, they shall be open type protected with insulating barriers. The secondary voltage, kVA and the type of connections shall be as shown on the drawings. The units shall have separate primary and secondary windings.

B. Operating Requirements: The dry type transformers shall have a primary voltage of 480 volts, 3-phase or 1-phase as indicted on the drawings. The primary tap arrangement shall be 2 - 2-1/2 percent above and 4 - 2-1/2 percent below, the normal 480 volt primary voltage. Winding insulation shall be Class B or Class F with rated temperature rises not to exceed 80 degrees C at 40 degrees C ambient temperature when measured by the resistance method.

C. Standards: Transformer sound levels: NEMA ST 1 4 11.

D. Conform to requirements of the NEC, latest adopted version with amendments by local authority having jurisdiction (AHJ).

E. Furnish products listed by UL or other testing firm acceptable to AHJ.

1.05 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.06 Project / Site Conditions

A. The transformers may be installed indoors in a wastewater facility. The ambient temperature may range from 10 degrees F to 115 degrees F. Relative humidity may range from 10 to 100 percent. In some installations, the equipment will be subjected to small amounts of dust, hydrogen sulfide gas and may operate in damp rooms that are not force ventilated.

1.07 Sequencing and Scheduling

1.08 Warranty

A. Refer to Section 17506 for requirements.

1.09 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Eaton Electrical, Federal Pacific, General Electric, Jefferson Electric, Siemens, Square D or approved equal.

2.02 Equipment and Materials

A. Dry type transformers shall have enclosures of 12-gage steel with ventilating openings. The enclosure shall be degreased, phosphatized, and finished in ANSI 61 baked gray enamel.

B. Provide transformer coils of the continuous wire wound construction and impregnate with non-hygroscopic, thermosetting varnish prior to baking.

C. Maximum temperature rise at full load NEMA TP-1 compliant, 80 degrees above 40C ambient temperature.

D. Provide each coil layer with end fillers or tie-downs to provide maximum mechanical strength. Braze tap terminations to magnet wire. Primary and secondary magnet wire to be brazed directly to bus stubs or lugs firmly mounted.

E. Provide windings continuous from start to finish. Splicing is unacceptable. Materials incorporated must have at least a minimum of 1 year of proven field usage. Accelerated laboratory test not acceptable.

F. All cores manufactured from a high-grade, non-aging silicon steel with high magnetic permeability, low hysteresis and eddy current losses. Magnetic flux densities are kept well below saturation to allow for a minimum of 10 percent over-voltage excitation.

G. Cut all laminations with direction of grain and be free from burrs, core plated, and stacked without gaps.

H. Maximum case temperature, 35C above ambient.

I. Sound levels guaranteed by manufacturer, 45dB through 150KVA and 50dB through 300KVAh.

2.03 Fabrication

A. Clamp cores with structural angles and bolted to enclosure to prevent damage during shipment or rough handling.

B. Provide lifting brackets on all sizes.

C. Ventilated openings must be designed in a manner as to prevent accidental access to live parts.

D. Degrease, clean, phosphatize, prime and finish all enclosures with a gray, baked enamel. Visibly ground the core of the transformer to this enclosure by means of a flexible ground strap.

E. Mount all transformers, core and coil, on vibration mounting pads designed to suppress transmission of 120 cycle frequencies and harmonics thereof. Arrange and select pads in consideration of core and coil weight. Provide additional noise suppressing mountings external to transformers where transformers are located in mechanical spaces.

F. Transformer Supports: Provide additional vibration isolation hangers and pads, brackets and supports as may be required for a complete installation.

G. Winding Taps

   1. Less than 15KVA: 4-2-1/2 percent FCBN, FCAN.

   2. 15KVA and Larger: 4-2-1/2 percent-2+2-.

H. Provide weather resistant enclosure and factory rating for exterior where shown at exterior locations.

I. Provide non-ventilated transformer where shown in areas where airborne combustible or conductive particles are present, where transformer is subject to spray from any direction, or where dust conditions are extreme.

J. Lugs: Provide mechanical type lugs for conductor terminations

PART 3 - EXECUTION

3.01 Installation

A. All equipment shall be installed so that it is readily accessible for operation and maintenance.

B. Equipment shall be anchored per CBC 2007, ASCE 7 and ACI 318 App D. Unmanned buildings shall be considered Occupancy Category 3 unless noted otherwise. Calculations shall be stamped by a California registered Civil Engineer.

C. The transformer manufacturer shall furnish certified test data on efficiency and no load power factor prior to acceptance. After completion of installation, each transformer and associated load equipment shall be tested individually and as a combined unit to ensure that each unit is properly connected and operating as required and as specified.

D. Comply with all other applicable Sections of this Specification. Transformers up to 45KVA may be floor mounted, wall mounted or suspended where so indicated on Drawings. Floor mount all transformers above 45KVA rating.

E. Provide transformers with concrete working or housekeeping pad minimum 8 inches larger than transformer and minimum 3 inches above finish grade. Install plumb and level. Provide exterior pads of 2500 to 3000 psi concrete reinforced with 8 gauge wire fabric or No. 6 reinforcing bars on 12-inch centers. Provide 10-inch thick base of gravel below pad for support. Pad extends 6 inches on all sides from the exterior most prominent dimension. Provide 3/4-inch by 10-foot ground rod at each corner thermally bonded to No. 2 copper ground conductor, bonded to transformer, and concrete reinforcement.

F. Do not mount transformers closer to combustible materials than allowed by NEC. Provide adequate ventilation, mount transformers away from adjacent surfaces as recommended by manufacturer.

G. Provide transformers with 8-inch round by 24-inch (above and below grade) concrete and steel bollards where subject to vehicular traffic.

H. Mount transformers on vibration isolating pads suitable for isolating the transformer housing from building structure.

I. Use flexible conduit, 18 inches minimum length, for connections to transformer case. Make connections to side panel or bottom of enclosure. Include ground conductor in flex.

J. Provide seismic restraints per local requirements.

K. Mount wall mounted transformers with a minimum of 6'-6" headroom below unit.

L. Where transformers are grouped exterior together or with switchgear, refinish transformer or switchgear resulting in transformers and switchgear finishes matching in color and type

3.02 Field Quality Control

A. Testing

1. The transformer manufacturer shall furnish certified test data on efficiency and no load power factor prior to acceptance. After completion of installation, each transformer and associated load equipment shall be tested individually and as a combined unit to ensure that each unit is properly connected and operating as required and as specified.
2. Check for damage and tight connections prior to energizing transformers.
3. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Revise the installation of noisy units to achieve an acceptable noise level or replace with a new unit with an acceptable sound level.

****END OF SECTION****

SECTION 16400
ELECTRIC SERVICE

PART 1 - GENERAL

1.01 Summary

A. Scope:

1. This section provides specifications for the electric service requirements associated with the project site that consists of relocating an existing utility service point from an existing Main Switchboard to a new Main Switchboard. The existing main switchboard will be abandoned in place.
2. The work of this section consists of furnishing and installing service entrance equipment, raceways, and conductors.

B. Coordination

1. Permanent electric power of the phasing, voltage, and characteristics shown will be supplied by the Owner. Coordinate all work with the Owner. Where work by Owner is required in conjunction with construction, such as installation of cable in common trench with other utilities, the Contractor is responsible for coordinating the work and ensuring that all required work is completed.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16300	Electrical Service Equipment
Section 16450	Grounding

1.02 Quality Assurance

A. The electrical service shall meet the requirements of the power company.

B. All work shall meet the requirements of the power company.

1.03 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.04 Project / Site Conditions

A. All materials used in connection with the electrical service will be installed in a wastewater facility. Temperatures are expected to range from 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent.

1.05 Warranty

A. Refer to Section 17506 for requirements.

1.06 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. Equipment

1. Service Raceway
   a. Underground
   b. Size and material shown.
   c. Install nylon pull cords of 100-pound test instead of pull wires in all unused conduit.
2. Service Conductors
   a. Contractor will furnish secondary service cable service conductors and conduits. Coordinate with the Owner for connection of these cables to the Main Switchboard ‘MSB’.
3. Service Disconnect
   a. UL listed as "Service Entrance Equipment", refer to specification section 16300 and the contract drawings for details regarding the Main Switchboard ‘MSB’.
4. Meter Socket
   a. Switchboard Mounting Type approved by Power Company.

2.02 Components and Accessories

A. Meters

1. Power Company furnished

PART 3 - EXECUTION

3.01 Preparation

A. The Contractor shall make all equipment approval arrangements and scheduling with PG&E. The Contractor shall schedule within 30 days after award of contract service installation and connection with PG&E.

B. The Contractor shall obtain PG&E Engineered drawings necessary for this project including but not limited to service conductor conduits, pole risers, pull boxes, vaults, wire size requirements and pull rope requirements.

3.02 Installation

A. Service Raceway

1. The Contractor shall be responsible for providing all utility service connection conduit, trenching work, trench backfill work, and pullboxes from the connection point denoted by the Utility Service to the Main Switchboard 'MSB'.
2. The Contractor shall field verify the location for underground utility service conduit runs and pullboxes with the local service provider prior to installation.

B. Service Conductors

1. The contractor will provide and install secondary conduits and conductors.

C. Service Disconnect

1. Install and ground in accordance with NEC and as shown.

D. Meter Socket

1. Install where shown.

E. Meter

1. Install where shown.

****END OF SECTION****

SECTION 16400
ELECTRIC SERVICE

PART 1 - GENERAL

1.01 Summary

A. Scope:

1. This section provides specifications for the electric service requirements associated with the project site that consists of relocating an existing utility service point from an existing Main Switchboard to a new Main Switchboard. The existing main switchboard will be abandoned in place.
2. The work of this section consists of furnishing and installing service entrance equipment, raceways, and conductors.

B. Coordination

1. Permanent electric power of the phasing, voltage, and characteristics shown will be supplied by the Owner. Coordinate all work with the Owner. Where work by Owner is required in conjunction with construction, such as installation of cable in common trench with other utilities, the Contractor is responsible for coordinating the work and ensuring that all required work is completed.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16120	Wire and Cables, 600 Volts and Below
Section 16200	Overcurrent Protective Devices
Section 16300	Electrical Service Equipment
Section 16450	Grounding

1.02 Quality Assurance

A. The electrical service shall meet the requirements of the power company.

B. All work shall meet the requirements of the power company.

1.03 Delivery, Storage, and Handling

A. Refer to Section 16010, 1.07 for requirements.

1.04 Project / Site Conditions

A. All materials used in connection with the electrical service will be installed in a wastewater facility. Temperatures are expected to range from 10 degrees F and 115 degrees F. Relative humidity is expected to range from 10 percent to 100 percent.

1.05 Warranty

A. Refer to Section 17506 for requirements.

1.06 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Equipment and Materials

A. Equipment

1. Service Raceway
   a. Underground
   b. Size and material shown.
   c. Install nylon pull cords of 100-pound test instead of pull wires in all unused conduit.
2. Service Conductors
   a. Contractor will furnish secondary service cable service conductors and conduits. Coordinate with the Owner for connection of these cables to the Main Switchboard ‘MSB’.
3. Service Disconnect
   a. UL listed as "Service Entrance Equipment", refer to specification section 16300 and the contract drawings for details regarding the Main Switchboard ‘MSB’.
4. Meter Socket
   a. Switchboard Mounting Type approved by Power Company.

2.02 Components and Accessories

A. Meters

1. Power Company furnished

PART 3 - EXECUTION

3.01 Preparation

A. The Contractor shall make all equipment approval arrangements and scheduling with PG&E. The Contractor shall schedule within 30 days after award of contract service installation and connection with PG&E.

B. The Contractor shall obtain PG&E Engineered drawings necessary for this project including but not limited to service conductor conduits, pole risers, pull boxes, vaults, wire size requirements and pull rope requirements.

3.02 Installation

A. Service Raceway

1. The Contractor shall be responsible for providing all utility service connection conduit, trenching work, trench backfill work, and pullboxes from the connection point denoted by the Utility Service to the Main Switchboard 'MSB'.
2. The Contractor shall field verify the location for underground utility service conduit runs and pullboxes with the local service provider prior to installation.

B. Service Conductors

1. The contractor will provide and install secondary conduits and conductors.

C. Service Disconnect

1. Install and ground in accordance with NEC and as shown.

D. Meter Socket

1. Install where shown.

E. Meter

1. Install where shown.

****END OF SECTION****

SECTION 17010
GENERAL REQUIREMENTS, INSTRUMENTATION

PART 1 - GENERAL

1.01 Summary

A. Scope: General requirements for Instrumentation and Control System (ICS) design, procurement, delivery, and implementation as shown on the Contract Drawings (Drawings) and as specified in these Specifications.

B. The contactor shall retain the service of a System Integrator. The System Integrator will purchase, assemble, configure, prepare submittal material and prepare Operations and Maintenance Manuals all of the components that make up the ICS. In addition, the System Integrator will purchase, assemble, configure, prepare submittal material and prepare Operation and Maintenance Manuals for the Main Switchboards, Motor Control Centers, Control Panels, programmable logic controller, Operator Interface Terminal. The System Integrator shall conduct associated Factory Acceptance Testing and Site Acceptance Testing noted.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01600	Material and Equipment Substitution
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 01720	Record Drawings
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 11345	Chemical Metering Pumps
Section 11800	Arsenic Filter System
Section 11810	In-Line Blender
Section 11820	Flow Meters
Section 16010	General Electrical Provisions
Section 16120	Wire and Cables, 600 Volts and Below
Section 16130	Wiring Devices
Section 16160	Pilot Devices

Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17924	Control Strategies

D. The work of this section shall be performed by an Owner pre-approved and pre-qualified System Integrator. The contractor shall retain the services of a Owner pre-approved and pre-qualified System Integrator to provide complete, assembled, installed, setup and testing of all instrumentation and control system components. The following System Integrators have been pre-approved and pre-qualified for this project:

1. Telstar, Hanford, Ca.
2. or Approved System Integrator prior to Bid Opening and as noted by Addendum.

E. Approved System Integrator Prior to Bid Opening:

1. Prior to Bid Opening, the Contractor may submit the qualifications of a System Integrator not listed as pre-approved and pre-qualified for consideration by the Owner. If the Owner accepts the System Integrators qualifications and issues an addendum prior to bid, then the System Integrator is considered acceptable for the project.
2. The Contactor may submit qualifications package for a System Integrator for approval by the Owner. Any qualifications package that does not include all of the following information will automatically be considered unresponsive and will be rejected. Only one submission per System Integrator shall be allowed.
3. To be considered the System Integrator must meet the following pre-conditions.
   a. System Integrator Facility is located within 90 miles of the project site.
   b. System Integrator is certified by Control System Integrators Association (CSIA)
4. The qualifications package shall include the following:
   a. An introduction letter including the following:
      1) Actual distance from project site not to exceed 90 miles
      2) Copy of CSIA certification
      3) System Integrator Company Information
         a) Company Name
         b) Company Address
         c) Company Internet Website

d) Company Telephone Number

e) Company Fax Number

f) Project Contact Name, E-mail address and telephone number

4) Number of years in business – the system integrator shall have been in business performing control, integration, configuration and programming activities for at least 15 years.

b. Provide a minimum of four projects of the size and complexity described herein in the last three years including an owner contact name, e-mail address and telephone number, project descriptions, and PLC system information.

c. Provide the names and resumes of the System Integrator's programmer or programming team that have a minimum of 5 years experience in the design, coordination, and supply of computer-based monitoring, control and data acquisitions systems.

1) Shall have programming and configuration experience with Automation Direct DL-205 Series PLCs.

2) The submitted and approved programmer(s) shall provide all programming associated with this project. The programmers assigned to perform the scope outlined in this contract may not be replaced without submitting additional qualified resumes and obtaining written approval from the Owner.

F. The System Integrator shall have a minimum of ten Automation Direct DL-205 Series PLC based control systems in water or wastewater applications. The System Integrator shall also be responsible for the PLC System, Control Panels, Motor Control Centers, field instrumentation as well as providing for data transfer between the Plant Control Panel PLC and the Owner's existing SCADA system. The system integrator shall also coordinate SCADA requirements from the Pump Station with the designated Owner of Delano SCADA System In-House Programmer.

G. System Integrator must be pre-approved by the Engineer in order to submit a bid for this project. Any bid listing a System Integrator that has not been pre-approved will be automatically disqualified.

H. Interpretation of Drawings

1. General: Any error or omissions of details in either the Drawings or Specifications shall not relieve the System Integrator from correctly installing all materials necessary for a complete and operating ICS.

2. Site Verification: The System Integrator shall inspect the project site and verify all measurements and conditions and shall be responsible for the correctness of final installation. No extra compensation will be allowed because of differences between work shown on the Drawings and measurements at the site.

3. Drawings: The Instrumentation Drawings are diagrammatic, but shall be followed as closely as existing conditions and work of OTHERS will permit. All deviations from the Drawings required to make the work conform to structures as constructed, and to the work of OTHERS, shall be made at the System Integrator's own expense.

4. Coordination: The System Integrator shall examine the architectural, structural, mechanical and manufacturer's drawings for all equipment to coordinate and determine the exact routing and final terminations of all conduits and cables. Conduits shall be stubbed up as near as possible to equipment enclosure.

5. Accessibility: The Drawings do not show the exact locations of equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance.

The Owner reserves the right to require minor changes in location of outlets or equipment, prior to roughing in, without incurring any additional costs or charges.

I. Manufacturer's Directions

1. Manufacturer's directions shall be followed in all cases where manufacturers furnish instructions covering points not shown on the Drawings or specified in these Specifications.

J. Inspection

1. The System Integrator and Contractor shall cooperate with the Construction Manager and shall provide assistance at all times for the inspection of the instrumentation work. Remove covers, or perform any reasonable work, which in the opinion of the Construction Manager will be necessary to determine the quality or adequacy of the work.
2. If any material does not conform to these Specifications the Contractor shall, within three (3) days after being notified by the Construction Manager, remove the materials from the premises.
3. Work shall not be closed in or covered before inspection and approval by the Construction Manager. Cost of uncovering and making repairs where un-inspected work has been closed in shall be borne by the Contractor.

K. Supervision and Workmanship

1. The Contractor shall employ a competent instrumentation foreman on the job throughout the entire period of construction to see that his work is carried on without delay and completed as rapidly as possible.
2. Before the start of construction and in conjunction with the schedule of others, the Instrumentation Sub-Contractor shall furnish to the General Contractor a tentative construction schedule showing the order of the work, the process control panel shop drawings submittal dates and the anticipated delivery dates of all instrumentation equipment.

L. Cooperative Work with Others

1. The System Integrator and Contractor shall cooperate with others, with due regard to their work, towards promotion of rapid completion of project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provision in time by System Integrator or the Contractor, then it shall bear expense of such changes as necessary to be made in work of others.
2. Labor and materials, including templates, sleeves, anchors, concrete inserts and the like shall be furnished in ample quantities at such times as necessary to ensure uninterrupted progress of work.
3. The Contractor shall cease work at any particular point temporarily and transfer its operations to such points or execute such portions of work as directed, when in the judgment of the Construction Manager it is necessary to do so.

M. Quality of Materials

1. All instrumentation components used on this project shall be new and free from defects.
2. All instrumentation components used on this project shall conform where applicable, to the Codes and Standards in Section 1.02, References.
3. Each type of material shall be of the same manufacturer and quality throughout the work.

N. Substitutions

1. No substitutions shall be allowed unless specifically noted as "or equal" or as "or approved equal." Specific brand names and catalog numbers are used to describe materials in order to establish standards of performance and quality.
2. The decision of the Engineer or Construction Manager shall govern as to what is equal to the item specified. Equality will be judged on the basis of the following:
   a. Conformance to description or performance required
   b. Equality in quality
   c. Comparable in appearance and artistic effect where these are considerations
   d. Comparable operation, maintenance and performance
   e. Equal in longevity and service under conditions of climate and usage
   f. Conformance with space allocations and requirements for operations from mechanical or electrical services provided without necessitating changes in details and construction or related work
3. If the Engineer considers it necessary, tests to determine the quality of the proposed materials shall be made, at the expense of the Contractor, by an unbiased laboratory, satisfactory to the Engineer.
4. Any material, article, or method judged by the Engineer equal to that specified will be approved, provided the Contractor submit a single written request, in triplicate, to the Construction Manager, within 30 days after contract award, with the following information for each item:
   a. Complete data substantiating compliance of proposed substitution with Contract Documents.
   b. Product Identification including trade or brand name including type, model, style, and/or catalog number
   c. Manufacturer's literature marked to indicate specific model, type, size, and options to be considered
   d. Size or capaOwner rating
   e. Names and addresses of a minimum of three (3) references for similar installations to this Contract
   f. Manufacturers' statements that proposed products are equal or superior in all respects to that specified.
5. The System Integrator assumes full responsibility for including complete and correct data in its request for substitution. The System Integrator shall also attach complete referenced diagrams and technical data sheets for the Engineer's review and determination of equality or suitability of any substitution item. Only one such request may be submitted. The Engineer's rejection of any substitute shall automatically require the System Integrator furnish the specified item without further discussion or delay.

1.02 References

A. General: The work shall comply with the most recent Codes and Standards as published at the date of the Contract and as listed in the Specifications.

Reference	**Title**

Reference	Title
NFPA 70	National Electrical Code – Latest Edition
NFPA 101	Life Safety Code - Latest Edition
UBC	Uniform Building Code - Latest Edition
ANSI	American National Standard Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
JIC	Joint Industrial Council
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
SAMA	Scientific Apparatus Makers Association
UL	Underwriters' Laboratories, Inc
EIA	Electronic Industries Association
	Owner Mechanical and Electrical Codes
	Any additional codes effective at the job site

B. Additional Requirements: The System Integrator shall furnish without extra charge any additional material and labor which may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in the Specifications or shown on the Drawings.

C. Permit Requirements: The Contractor shall apply and pay for all permits required by any of the legally constituted public authorities for the installation or construction of the work included in these Specifications. The Contractor shall arrange and pay for any inspections or examinations so required and deliver certificates of all such inspections to the Construction Manager. When these Specifications call for materials or construction of a better quality or larger sizes than required by the above mentioned rules and regulations, the provisions of the Specifications shall take precedence.

1.03 System Description

A. General: Furnish all necessary labor, materials, equipment and incidentals required to install a complete and operational Instrumentation and Control System in accordance to the intent of these Specifications and Drawings.

B. Itemized Work: The following list shall be considered major work items, but not an inclusive and complete description of the scope of work. The Drawings in conjunction with the Specifications shall be used to determine the complete ICS work. The general scope of work includes the furnishing, installing, programming, testing, and commissioning of the following items:

1. Instrumentation and Control System: This Item includes programming and configuration of the new Programmable Logic Control (PLC) systems, Operator Interface Terminals (OITs) and Communication System.

2. Coordination with vendors or subcontractors (others) to interface with the control systems provided by others. This Item includes all interconnection wiring required for interfacing with such control systems to the pump station PLC as shown on the contract drawing P&IDs.
3. Coordination with Owner of Delano In-House SCADA programmer. The control system integrator shall coordinate with the Owner of Delano In-House SCADA programmer to insure from proper data transfer to and from the SCADA system and Pump Station PLC via the new telemetry radio. The coordination shall include any special data register confirmation, naming conventions and content as well as arrangement and participation in the site acceptance testing of the Pump Station Control System and the SCADA monitoring of the Pump Station.
4. All supports, bases, anchors, sleeves, hangers, conduit seals, and the like.
5. Shop Drawings and Operation and Maintenance (O&M) manuals.
6. Control Panels including all control components required for proper operation of the control system.
7. All power supplies, transformers, pushbuttons, pilot lights and selector switches.
8. Instrumentation system including but not limited to level transmitters, pressure transmitters, pressure switches, pressure gauges, and flow meters,
9. Interconnection wiring diagrams.
10. Telemetry including hardware and programming,
11. Factory Acceptance Tests
12. Site Acceptance Tests
13. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions specified elsewhere in these Specifications.
14. Throughout this Contract, follow manufacturer's recommendations for storage of equipment. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Store items subject to corrosion under damp conditions, in clean, dry, indoor, and heated locations.
15. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Energize all space heaters furnished with equipment

1.04 Submittals

A. General: Submittals for all ICS equipment shall be prepared and submitted in accordance to Section 01300.

B. Requirements: The submittal package for each individual equipment or groups of related equipment shall include all the required data and information and shall be complete. As a condition to the review of submittals required under these specifications, the System Integrator shall furnish the manufacturer's statement for the equipment accepting the unit responsibility. The purpose of this provision is to ensure compatibility of all components specified under the specific Technical Specifications; and to provide sole source responsibility for system performance and maintenance. Notwithstanding these provisions, however, the System Integrator is not relieved of his responsibility for the indicated portions of the work. The following submittal data shall be provided for each item of equipment. Additional data specific to individual equipment specified under individual Specifications shall be submitted in addition to the following.

C. Contract Drawings: The Drawings are generally diagrammatic unless detailed or dimensioned. Structural conditions, physical interference and locations of terminations of equipment shall govern the exact locations and routing of wiring, conduit and pipe. The Contractor and System Integrator

shall examine the architectural, structural, mechanical, electrical and instrumentation plans and shop drawings for the equipment to determine the exact routing and final terminations of conduit, cables and pipes. Conduits and pipes shall be stubbed as near as possible to equipment terminals.

D. Deviations from Specifications: Should the System Integrator's proposed system specifications deviate from these Specifications, such deviation shall be documented and submitted to the Engineer for approval. All deviations shall be stated on the submittal transmittal sheet.

E. Organization and Binding of Submittals: The initial and subsequent submittals of drawings and data for review shall be organized and bound so that eventually they may be used as guides for preparing the required maintenance manuals. The submittal shall be organized in three (3) parts, not including preliminary administrative material such as table of contents, as follows:

1. Part 1 shall consist of a series of sections, one for each process control system. Each section shall be divided by a tab and shall include the material specified below.
2. Part 2 shall include outline dimension drawings for panels, cabinets, consoles and the like, as specified below.
3. Part 3 shall include data on miscellaneous parts and accessories not included in Part 1.

F. Data Sheets: Data sheets shall be in a standardized format and shall include the following:

1. Components name used herein and on the drawings,
2. Manufacturer's model number or other product designation,
3. Project tag number,
4. System of which the component is a part,
5. Location or assembly at which the component is to be installed,
6. Input and output characteristics,
7. Scale range and units (if any) and multiplier (if any),
8. Requirements for electric supply (if any),
9. Requirements for air supply (if any),
10. Materials of component parts to be in contact with, or otherwise exposed to, process media,
11. Reference to manufacturer's descriptive technical bulletin or brochure,
12. References to other features so that all specified features are stated on the data sheet,
13. Following each data sheet, a technical product bulletin, or brochure (or clear photocopy thereof) shall be inserted; this shall provide amplifying technical information on the construction, characteristics, and capabilities of the component described in the related data sheet. Elaborate and extensive technical details shall not accompany these bulletins. All bulletins shall be of the most recent issue,
14. Part 2 of the submittal shall include outline and dimension drawings for all enclosed assemblies including cabinets, panels, consoles and the like. These drawings shall show the arrangements of panel-mounted and internally mounted components to scale and shall include enough details to clearly establish the style and overall appearance of each assembly, and
15. Part 3 of the submittal shall consist of a series of data sheets for accessory components together with supporting catalog pages or bulletins (or clear photocopies thereof). These shall be arranged in a logical sequence and shall cover such items as:
    a. Control circuit devices, components and wiring

b. Pneumatic components, fittings and tubing

16. Operation and Maintenance Manuals

a. General: The System Integrator shall provide Operation and Maintenance (O&M) manuals in accordance with Section 01330.

b. Content: A set of manuals shall include all the drawings and required data and shall be organized and bound as specified for the review submittals. These drawings and data shall be supplemented with installation, connection, operation, troubleshooting, maintenance and overhaul instructions in complete detail. This shall provide the OWNER with comprehensive information on all systems and components to enable operation, service, maintenance and repair. Exploded or other detailed views of all instruments, assemblies and accessory components shall be included together with complete parts lists and ordering instructions.

c. Format: In addition to the requirements set forth elsewhere, the O&M manuals shall consist of at least the following:

1) Table of contents,

2) Manufacturer's or its representative's contact information,

3) Equipment complete model number for ordering,

4) Spare parts with model numbers,

5) Special tools with model numbers,

6) System block and schematic diagrams,

7) Component schematic diagrams, and

8) Written step-by-step operating, troubleshooting and calibrating instructions for each of the systems and each of the components of each system

1.05 Quality Assurance

A. Performance and Design Requirements

1. Manufacturer's Qualifications: The equipment furnished under this division shall be the product of firms regularly engaged in the design and manufacture of the type of item specified, possessing the required technical competence, skill, resources and ability to complete the work specified herein with the requisite degree of quality in a timely and efficient manner. The Contractor shall be prepared to adequately document the qualifications of the manufacturers nominated to provide the equipment specified under this division. All documentation shall be submitted to the Owner's Representative prior to design fabrication and shipment of any component specified herein. Nothing contained within these provisions shall be construed as relieving the Contractor of his responsibility for any portion of the work covered by this Section.

2. Arrangement: The drawings are generally diagrammatic and the location of instruments and control panels are approximate unless detailed or dimensioned. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interferences and the location of electrical terminations on equipment.

3. The Contractor shall examine the structural and mechanical plans and shop drawings for the various equipment to determine exact routings and final terminations for all raceways and cables. Conduits shall be stubbed up as near as possible to field instruments and shall be within the concrete base for the equipment or a separate concrete curb.

4. All conduit, instruments and control panels shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Control Panels, metering, transmitters and similar items shall be located within finished rooms, as shown. Where the Drawings do not indicate exact locations, the Contractor shall submit proposed locations to the Engineer for review. Where equipment is installed without instruction and must be moved, it shall be moved without additional cost to the Owner.

5. All work, including installation, connection, calibration, testing, and adjustment, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.

6. Allowance has been made in the design for the number of raceways, cables and conductors considered adequate for feeding the various instruments and control panels. These circuits and diagrams are based on available data pertaining to the particular design of equipment and portray the systems, which the owner has chosen to effect the required operation and level of control. Equipment provided by the Contractor (even though of the make and model specified) may differ in detail, arrangement, or connections from that shown. If the Contractor uses equipment which differs from the equipment shown in major aspects and requires modifications to power, control or other electrical service, the Owner's acceptance of the equipment will be based upon the Contractor providing the modifications required, and they shall be of the same quality as shown and shall be provided at no additional cost to the Owner.

7. Protection of Equipment and Materials: The Contractor shall provide adequate means for and shall fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the work and until acceptable by the Owner's Representative.

8. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.

9. The Contractor shall replace or have refinished by the manufacturer, all damaged materials or equipment, including face plates of instruments and control panels, at no expense to the Owner.

10. Tests: The Contractor shall make all tests required by the Owner's Representative or other authorities having jurisdictions as per applicable standards. All such tests shall be performed in the presence of the Owner's Representative. The Contractor shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation. Operational testing shall be performed on all equipment furnished and/or connected in other Sections of Division 16. Electrical and all other divisions specifying electrical items including furnishing of support labor for testing.

11. Standard test reports for mass-produced equipment shall be submitted along with the shop drawing for such equipment. Test reports on testing specifically required for individual pieces of equipment shall be submitted to the Owner's Representative for review prior to final acceptance of the project.

12. Any test failure shall be corrected in a manner satisfactory to the Owner's Representative.

13. The Contractor shall furnish without extra charge any additional material and labor which may be required for compliance with these laws, rules, and regulations, even though the work is not mentioned in these particular specifications or shown on the drawings.

14. The Contractor shall apply and pay for all permits required by any of the legally constituted public authorities for the installation or construction of the work included under this Division. The Contractor shall arrange and pay for any inspections or examinations so required and

deliver certificates of all such inspections to the Owner's Representative. When these specifications call for materials or construction of a better quality or larger sizes than required by the above mentioned rules and regulations, the provisions of the specifications shall take precedence.

1.06 Delivery, Storage, and Handling

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Throughout this Contract, follow manufacturer's recommendations for storage. Protect everything from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as instruments, conductors, and control panels. Energize all space heaters furnished with equipment. Provide temporary heating, sufficient to prevent condensation, in control panels which do not bare space heaters.

B. Shipment: The major equipment items listed in this provision and furnished under this contract shall be shipped in sealed, weather-tight, enclosed conveyances in a manner designed to protect the equipment against damaging stresses during transport.

C. Inspection

1. The Contractor shall cooperate with the Owner's Representative and shall provide assistance at all times for the inspection of the electrical work. Remove covers, operate machinery, or perform any reasonable work which, in the opinion of the Owner's Representative, will be necessary to determine the quality or adequacy of the work.
2. If any material does not conform to these specifications, the Contractor shall, within three days after being notified by the Owner's Representative, remove the materials from the premises.
3. Work shall not be closed in or covered before inspection and approval by the Owner's Representative. Cost of uncovering and making repairs where un-inspected work has been closed in shall be borne by the Contractor.

1.07 Project / Site Conditions

A. The ICS shall be installed in a Water Well Pump Station which will be subjected to environmental conditions where temperatures may vary from 10 degrees F and 115 degrees F; relative humidity may vary from 10 to 100 percent; and trace quantities of moisture and dust may be present.

1.08 Sequencing and Scheduling

A. Modifications to existing Control Panels and existing motor control centers shall be pre-planned to minimize facility shutdown intervals and presented with a sequencing and scheduling plan. Once approved by the Owner and the Engineer, work may proceed.

B. Installation of new equipment shall not interfere for ongoing facility operations. Where a facility shutdown interval is required, provide a sequencing and scheduling plan that minimizes the shutdown interval. Once approved by the Owner and the Engineering, work may proceed.

1.09 Warranty

A. Refer to Section 17506 for requirements.

1.10 Maintenance

A. Refer to Section 17506 for requirements.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Refer to Division 17 specifications.

2.02 Equipment and Materials

A. Refer to Section 17110.

2.03 Components and Accessories

A. Refer to Section 17110.

2.04 Fabrication

A. Refer to Section 17110.

2.05 Source Quality Control

A. Refer to Section 17110.

PART 3 - EXECUTION

3.01 Examination

A. Refer to Section 17110.

3.02 Preparation

A. Refer to Section 17110.

3.03 Installation

A. Refer to Section 17110.

3.04 Field Quality Control

A. Tests and Instrument Calibration

1. General: All tests shall be in accordance with the requirements of Sections 17510 and 17512 of these Specifications.
2. Individual Component Calibration: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure.
3. Loop Tests: Each instrument loop shall be treated as an integrated system. This test shall be designed to verify that all components within the loop operate correctly and that the loop functions correctly.

B. System Start-Up

1. General: When all systems and components have been successfully calibrated and tested, a date for the Plant start-up involving the Owner's Representative shall be scheduled and agreed upon.
2. Procedure: The ICS shall be rechecked to verify proper operation. Final adjustments shall be made as required.

3. Report: Provide a written report to the Engineer verifying the operation of the ICS. Note any problems or concerns in this report.

C. Operator Training

1. General: Operator training shall be provided for the ICS after the System Startup has been successfully executed.

2. Format: The Plant operating personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require readjustment, resetting, or checking and re-calibration by them from time to time. The O&M manuals in addition to the System Integrator's prepared materials shall be used for this training.

D. Duration: The training shall consist of a two (1) day course per site, a minimum of 16 hours total instruction, for up to five (5) students. This course shall be conducted at the jobsite on an agreed upon date independent of any testing or startup dates. A detailed outline of this course shall be submitted to the ENGINEER at least 10 days in advance of the training start date. The class shall be scheduled a minimum of 2 weeks in advance of the week it is to be held. Submit a course syllabus.

3.05 Adjusting / Cleaning / Protection

A. Refer to Section 17110.

****END OF SECTION****

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SECTION 17110
INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all instrumentation and control system equipment, panels, and necessary appurtenances for an integrated control system. These Specifications and Drawings include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems capable of providing the functions and meeting the performance set forth hereinafter.

B. The work of this section shall be performed by a qualified System Integrator. The contractor shall retain the services of a System Integrator to provide complete, assembled, installed, setup and testing of all instrumentation and control system components. The System Integrator shall have a minimum of ten Automatic Direct PLC based control systems in water or wastewater pump station applications including the use of Automatic Direct C-More Operator Interface Terminals. The System Integrator shall also be responsible for the Main Switchboard, PLC and OIT System, Control Panels, Motor Control Centers, and field instrumentation. The System Integrator will coordinate SCADA issues and telemetry with the Owner SCADA programmer and the Engineer. The System Integrator shall be Tesco Controls, Krug-Bixby-Long Associates or pre-approved equal.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01330	Submittals Procedures
Section 01360	Operating and Maintenance Information
Section 01600	Material and Equipment Substitution
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 01720	Record Drawings
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 11060	Electric Motors
Section 11345	Chemical Metering Pumps
Section 11800	Arsenic Filter System

Section 11810	In-Line Blender
Section 11820	Flow Meters
Section 16010	General Electrical Provisions
Section 16120	Wire and Cables, 600 Volts and Below
Section 16160	Pilot Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 17010	General Requirements, Instrumentation
Section 17201	Control Panels
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17924	Control Strategies

1.02 References

A. General: The work shall comply with the most recent Codes and Standards as published at the date of the Contract and as listed in the Specifications.

Reference	Title
NFPA 70	National Electrical Code – Latest Edition
NFPA 101	Life Safety Code - Latest Edition
UBC	Uniform Building Code - Latest Edition
ANSI	American National Standard Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
JIC	Joint Industrial Council
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
SAMA	Scientific Apparatus Makers Association
UL	Underwriters' Laboratories, Inc
EIA	Electronic Industries Association
	Owner Mechanical and Electrical Codes

Reference	Title
	Any additional codes effective at the job site

1.03 Submittals

A. Submittals for all ICS equipment shall be prepared and submitted in accordance with Section 01300 and as described in Section 17010.

B. Operation and Maintenance Manuals

1. General: The CONTRACTOR shall provide Operation and Maintenance (O&M) manuals in accordance with Section 01360 and as described in Section 17010.

1.04 Quality Assurance

A. Performance and Design Requirements: For the purpose of standardization, all components shall be manufactured or furnished by one manufacturer, except as noted or approved.

B. Equipment Surge Protection:

1. All electronic equipment shall successfully withstand surges in AC power circuits as specified in IEEE C62.41. Successfully withstanding transients requires that none of the following conditions occur as a result of the transient:

   a. Erroneous output

   b. Component failure

   c. Calibration change exceeding normal tolerances

1.05 Delivery, Storage, and Handling

A. Refer to Section 17010, General Conditions, Instrumentation

1.06 Project / Site Conditions

A. The Instrumentation and Control System (ICS) shall be installed in a Water Facility which will be subjected to environmental conditions where temperatures may vary from 20 to 115 degrees F; relative humidity may vary from 10 to 100 percent; and trace quantities of moisture and dust may be present.

1.07 Warranty

A. Refer to Section 17506, Extended Warranty and Maintenance

1.08 Maintenance

A. Refer to Section 17506, Extended Warranty and Maintenance

PART 2 - PRODUCTS

2.01 Manufacturers

A. These specifications describe equipment of a specific manufacturer and are not designed to limit competition. Unless noted as a “sole source.” “no or equal,” or “No substitutions allowed”; the naming of the manufacturer on which the specifications and plans are based is not an

endorsement of that manufacture, but is instead intended to describe a level of quality and demonstrate the functionality of the system.

1. If equipment is noted at “sole source;” “no or equal,” or “No substitutions allowed”; then that equipment is currently used elsewhere in Owner as a Owner Standard.

B. The ICS components specified in these Specifications and shown on the Drawings are based upon the use of equipment, devices and panels manufactured by the companies specified in the following Sections of these Specifications.

C. The use of substitute or “or ENGINEER approved equal” equipment will be considered. Such equipment will be acceptable only on the basis that any revisions in the engineering, design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc., required to accommodate such a substitution, shall be made at no additional cost to the Owner

2.02 Equipment and Materials

A. All furnished instruments and control system components shall be as specified in these Specifications. Equals or exceptions shall be approved by ENGINEER prior to procurement.

B. All products shall be new and approved for the specific applications shown on Contract Drawings or specified in these Specifications.

C. Same products shall be of a single manufacturer.

D. Products furnished for modification of existing control panels, except for the PLCs, shall be compatible with the existing products and from the same manufacturer, unless the existing products are no longer available.

E. Products installed in classified areas shall be approved for that classification and meet all the pertinent Standards and Code requirements.

F. Control Panels:

1. The Control Panels shall be of same construction and configuration as shown on the Drawings and specified in these Specifications. All indicator lights, switches, recorders and digital displays shall be mounted on the doors. All Operator Interface Terminals (OITs) shall be accessible from the front door.

2. The back-panel and side-panels shall be used to install instrument modules, signal conditioners, relays, power supplies and other associated components within the Control Panel.

3. The Control Panels shall be fully gasketed and NEMA rated for the specific Plant areas. The panels shall be completely factory assembled, wired and tested. All field wiring shall be terminated in terminal blocks. All components shall be mounted so as to facilitate easy removal for service.

4. The panels shall be provided with adequate forced ventilation to ensure that the temperature rise within the panel section does not exceed design temperatures for the components within the panel section. The panels shall also be provided with heaters, to prevent condensation and sunshields to dissipate heat, as required.

G. Programmable Logic Controllers:

1. The Programmable Logic Controller (PLC) system shall operate in ambient conditions of 20 to 120°F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

2. Where the PLC is utilized to control multiple trains of equipment, the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of one component does not

affect equipment of all trains. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

3. The PLC program modules shall dictate control outputs to a known and safe state prior to running of control program, under PLC fault conditions, and PLC runtime errors.
4. Access to the PLC program, downloading, uploading and diagnostic functions shall incorporate password protection or key lock operation.
5. The PLC system shall be designed with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, harmonic distortions, relay and circuit breaker noise or conducted and radiated radio frequency interference.
6. The PLC system shall be grounded to the panel ground bus with a separate ground conductor sized per the manufacturer's grounding requirements. The minimum ground connection shall be AWG #12.
7. The PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering (up to 60 degrees C and 95 percent humidity).
8. The PLC shall be furnished as a complete assembly with I/O (input/output) modules and peripheral equipment suitable for the interface with the new and existing PLC equipment, components and field devices.
9. The PLC chassis shall contain all I/O modules, communications equipment, and power supplies required to provide the specified functions. PLC chassis shall be sized to house the required PLC modules plus an additional two slots for future expansion capability.
10. The PLC power supplies shall be sized to provide power for the maximum total module load plus an additional 40 percent for future expansion. The PLC power supply shall provide the following operational characteristics:
    a. 120 VAC RMS plus or minus 15 percent continuously
    b. 120 VAC RMS plus or minus 30 percent maximum 30 seconds
    c. 120 VAC RMS plus or minus 100 percent maximum milliseconds
    d. Line spikes at 1000V ac (5000 micro-seconds duration; 0.05 percent maximum duty cycle).
11. The central processor shall contain all firmware logic, relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus an additional 25 percent excess capaOwner. The power supply shall contain capacitors to provide orderly shutdown in the event incoming power does not meet specifications. If this occurs, the processor shall cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes. The central processor shall be 32-bit, minimum.
12. The programmable controller memory shall be Complementary Metal Oxide Semi-conductor (CMOS) based memory with battery backup or Erasable Programmable Read-Only Memory (EPROM) based memory. The CMOS memory shall be a minimum of 64K with sufficient battery backup to retain the program during power interruptions of up to 1 year. An indicator shall show the status of the batteries. A reference shall be available through the discrete outputs to alarm the operator that the batteries should be changed.

13. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capaOwner of 25 percent of the total provided. This reserve capaOwner shall be totally free from any system use. Memory size shall be 30.4 K total available words. However, System Integrator shall calculate the memory size based on the program requirements and provide PLCs with memories adequate for the Project.
14. The PLC shall be provided with a 15.8 K Flash Memory module for memory back-up.
15. The PLC shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.
16. The PLC shall have provision for programming, besides other common programming languages, in "ladder diagram" language. It shall be easily reprogrammed with a portable programming unit. Two documented copies of the operating program shall be furnished which shall allow direct, step-by-step, reloading of the system program.
17. The PLC system shall have provision for RS-232, K-Sequence, DirectNET, Modbus RTU Master Slave and Ethernet 10/100BaseT communications network interfaces.
18. The PLC processor shall be Automation Direct DL205 Series, Model D2-260, as shown on the Contract Drawings.
19. All Input/Output (I/O) module housings and I/O modules shall be of rugged construction with modules installed in I/O chassis. Sufficient input and sufficient output modules shall be provided with the PLC to implement the specified control functions plus a reserve capaOwner of 25 percent of the total provided.
20. All Discrete Input (DI) Modules, defined as contact closure inputs from devices external to the programmable logic controller module shall be shielded from short time constant noise. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O Modules. The modules shall have LED lights to indicate a discrete input. Input modules shall be supplied with a maximum of 16 points per module, except where 32-point modules are required. Input voltage rating shall be provided as indicated on the Contract Drawings. Discrete input modules shall be Automation Direct DL205 Series, Model D2-32ND3 or Model D2-16NA.
21. All Discrete Output (DO) Modules, defined as contact closure outputs for ON/OFF operation of devices external to the programmable logic controller module shall be rated for 10.2 through 26.4VDC or Relay Output type. All output modules shall have LED lights to indicate output has been cycled ON by the controller. Discrete output modules shall be Automation Direct DL205 Series, Model D2-16TD1 or Model D2-12TR.
22. All Analog Input (AI) Modules, defined as analog inputs for 1 to 5 VDC or 4 to 20 mA dc signals, where an analog to digital conversion is performed and the digital result is entered into the processor. New inputs shall be provided for every scan. Analog inputs shall be supplied with a minimum resolution of 12 bits. Each Analog Input Module shall accept 8 isolated inputs. Each analog input shall be isolated from common. Analog input modules shall be Automation Direct DL205 Series, Model F2-08AD-1.
23. All Analog Output (AO) Modules, defined as analog output to output 4-20 mA dc signals, where a digital to analog conversion is performed and the analog result is produced on every scan. Analog output resolution shall be 12 bit minimum. Each Analog Output Module shall have 8 sink or source outputs. Each analog output shall be capable of driving into a 1500 ohm load. Analog Output modules shall be Automation Direct DL205 Series Model F2-08DA-1.

24. All Combination Analog Input/Output Modules shall be provided with eight high-speed analog input channels and four current analog output channels. Combined modules shall be Automation Direct DL205 Series, Model F2-8AD4DA-1,

25. Remote Input/Output Communications Modules shall be used for the PLC to communicate with remote chassis utilizing Ethernet Communication modules. Ethernet Communication Modules shall be Automation Direct DL205 Series, Model H2-ERKIT-1.

26. The integrated PLC system shall be Automation Direct DL205 series as shown on the Contract Drawings. Equals are not accepted.

H. Operator Interface Panel:

1. An Operator Interface Panel shall be provided that will be capable of display information and implement actions via a communications network (i.e. Ethernet) to the programmable controller. The Operator Interface Panel shall be configured to serve as the primary operator interface to the programmable controller in the Control Panel Section of the Motor Control Center.

2. The Operator Interface Panel shall utilize a 10-inch TFT touch panel, 57k colors, 540 x480 pixel VGA screen resolution, NEMA 4x enclosure with built-in Ethernet and USB; supports Compact Flash.

3. The Operator Interface Panel shall be Automation Direct C-More EA7-T10C. No Substitutes Allowed.

I. Ethernet Switch: Provide an Ethernet Switch in the Control Panel to match Owner Standard. Provide a Ntron 306TX, no substitutes allowed.

J. Flow Meter:

1. For Well 22, provide a new well flow meter as described under Section 11820.

K. Level Transmitter – Ultrasonic:

1. Provide an ultrasonic single-point level controller with an integral transducer and temperature compensator as indicated on the Drawings.

2. The single-point level transmitter shall be a microprocessor based echo-time measuring type providing an electronic output signal proportional to the level of the material or the distance to the material being measured. It shall consist of an integral transmitter, transducer, and temperature sensor package.

3. Acoustic impulses emitted from an ultrasonic sensor are reflected back from the material surface and are received by the same sensor. The transit time of the pulse from the transmission generation to echo reception is recorded. The elapsed time is proportional to the distance between the sensor and material surface based on the speed of sound for that application.

4. The acoustic sensor/transducer shall be a polarized zirconium crystal type with acoustic impedance matching face and transformer.

5. The measurement range shall be as required by the contract drawings but not less than a range of 1 to 16 feet.

6. The power supply shall be 12 to 28 VDC and the output signal shall be 4-20 mA DC non-isolated into 750 ohms maximum.

7. The single point level controller shall be a Siemens Milltronics brand The Probe, or approved equal.

8. Well 22 Schedule:

Tag Number	Service	Drawing Reference
LE/LT-201	Sulfuric Acid Storage Tank Level	I-102
LE/LT-202	Ferric Chloride Storage Tank Level	I-103
LE/LT-203	Sodium Hypochlorite Storage Tank Level	I-101
LE/LT-205	Backwash Tank Level	I-106

9. Well 26 Schedule:

Tag Number	Service	Drawing Reference
LE/LT-201	Sulfuric Acid Storage Tank Level	I-203
LE/LT-202	Ferric Chloride Storage Tank Level	I-203
LE/LT-203	Sodium Hypochlorite Storage Tank Level	I-202

L. Pressure Gauge:

1. Pressure Gauges shall be 4-1/2 inch in diameter, bottom connected with white laminated dials and black graduations.
2. Gauges shall have a blowout disc and safety glass, encased in phenolic, steel or cast iron. Measuring element shall be a stainless steel bourbon tube with welded, stress-relieved joints. Socket shall have wrench flats.
3. Movement shall be rotary geared, all stainless steel material.
4. Accuracy shall be ½ percent of range.
5. All pressure gauges shall be provided with pulsation snubbers constructed of 316 stainless steel, pressure diaphragm seal, an isolation valve and a drain valve as shown on the Contract Drawings.
6. The pressure gauge shall be Ashcroft 1279, Ametek Solfrunt Series 1900 or equal.
7. Well 22 Schedule:

Tag Number	Service	Drawing Reference
PI 201A	Well Pump Discharge Pressure	I-101
PI 201B	Well Discharge Line Pressure	I-101
PI 201	Surface Wash Booster Pump #1 Inlet Pressure	I-104
PI 202	Surface Wash Booster Pump #1 Discharge Pressure	I-104
PI 203	Surface Wash Booster Pump #2 Inlet Pressure	I-104
PI 204	Surface Wash Booster Pump #2	I-104

Tag Number	Service	Drawing Reference
	Discharge Pressure	
PI 205	Backwash Pump #1 Inlet Pressure	I-106
PI 206	Backwash Pump #1 Discharge Pressure	I-106
PI 207	Backwash Pump #2 Inlet Pressure	I-106
PI 208	Backwash Pump #2 Discharge Pressure	I-106
PI 210	Distribution System Pressure	I-106

8. Well 26 Schedule:

Tag Number	Service	Drawing Reference
PI 210	Well Pump Discharge Pressure	I-201
PI 201	Surface Wash Booster Pump #1 Inlet Pressure	I-204
PI 202	Surface Wash Booster Pump #1 Discharge Pressure	I-204
PI 203	Surface Wash Booster Pump #2 Inlet Pressure	I-204
PI 204	Surface Wash Booster Pump #2 Discharge Pressure	I-204
PI 205	Backwash Pump #1 Inlet Pressure	I-206
PI 206	Backwash Pump #1 Discharge Pressure	I-206
PI 207	Backwash Pump #2 Inlet Pressure	I-206
PI 208	Backwash Pump #2 Discharge Pressure	I-206
PI 210	Distribution System Pressure	I-206

M. Pressure Diaphragm Seals:

1. Diaphragm seals shall consist of a bottom housing, lower ring, diaphragm capsule, fill screw, fusing connection and a top housing.
2. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid.

3. The space between the diaphragm and the instrument pressure element shall be completely filled with a suitable liquid.
4. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure directly to a gauge, transmitter, switch or any other pressure instrument.
5. The diaphragm seal shall have a removable bottom housing to permit the servicing of the diaphragm capsule without the need to refill.
6. All surfaces exposed to process fluids shall be Type 316 stainless steel.
7. Pressure diaphragm seals shall be Ashcroft 100 or equal:

N. Pressure and Differential Pressure Switches:

1. Pressure and differential pressure switches shall have an adjustable (10 percent) differential (deadband) to eliminate instability due to pressure cycling. Pressure tap connections shall be 1/2-inch NPT and conduit connection shall be 3/4-inch NPT or larger.
2. Materials:
   a. Bourdon tube: 316 stainless steel
   b. Diaphragm seal housing: 316 stainless steel
   c. Pulsation dampeners: 316 stainless steel
   d. Switch isolating ball valves: 316 stainless steel
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
   b. Provide pulsation dampeners on all pressure switch applications which involve positive displacement equipment including positive displacement plunger pump systems, positive displacement lube pump systems, diaphragm pump systems and positive displacement blower or compressor systems.
   c. Provide protector to separate process fluid from the pressure element,
   d. System fill applications – diaphragm seal and sealed sleeve.
4. System fill material: Utilize halocarbon fill for process applications involving strong oxidizing agents. Agents include but are not limited to: Chlorine (CL2), Potassium Permanganate ($KMNO_4$), Ferric Acid (FeCl), Sodium Hydroxide (NaOH), Sodium Hypochlorite (NaOCl), and Aluminum Sulfate, ($A1_2(SO_4)14\ H_20$). Utilize manufacturer's standard fill for other applications. Ensure fill is suitable for application temperatures.
5. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
6. Design and fabrication:
   a. Pressure Switches shall be hermetically sealed non-mercury contact switches.
   b. Two (2) SPDT contacts rated 1 amp inductive at 125 VDC and 5 amp inductive at 120 VAC. Set points between 30 and 70 percent of switch rated working range Operating pressure not to exceed 75 percent of switch rated working range.
   c. Accuracy: Better than 1 percent of full scale.
   d. The pressure switches shall have a watertight enclosure.

7. Pressure switches shall be United Electric Controls with appropriate diaphragm seals, Mercoid, Automatic Switch Company or approved equal.
8. Well 22 Schedule:

Tag Number	Service	Drawing Reference
PSL 201	Well 22 Pump Discharge Pressure Low	I-101
PSH 201	Well 22 Pump Discharge Pressure High	I-101
PSL 100	Filter Solenoid Panel Low Air Pressure	I-105
DPS 102	Filter Low Differential Pressure	I-105
PSL 104	Air Compressor Low Pressure	I-105

9. Well 26 Schedule:

Tag Number	Service	Drawing Reference
PSL 210	Well 26 Pump Discharge Pressure Low	I-201
PSH 210	Well 26 Pump Discharge Pressure High	I-201
PSL 100	Filter Solenoid Panel Low Air Pressure	I-205
DPS 102	Filter Low Differential Pressure	I-205
PSL 104	Air Compressor Low Pressure	I-205

O. Pressure Transmitter:

1. The gauge/ absolute pressure sensor shall provide a two-wire, loop-powered, 4-20 mA signal proportional to the process pressure. Optionally the transmitter shall be capable of providing a simultaneous digital signal superimposed on the analog output, but shall not affect this analog value. The digital signal shall utilize the HART protocol. The unit shall operate with 11.5 to 45 VDC in non-hazardous applications and 11.5 to 30 VDC in FM approved installations.
2. The sensor shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm construction for measuring range up to 600 PSIG/ A. The sensor shall utilize a polysilicon 316 SST diaphragm construction for measuring ranges up to 6000 PSIG/A .The ceramic diaphragm shall be immune to damage due to full vacuum and shall have an overpressure (overload) pressure rating of:
   a. 60 PSIG for URL of 0.075 to 1.5 PSIG
   b. 150 PSIG for URL of 0.3 to 6 PSIG/A
   c. 300 PSIG for URL of 1.5 to 30 PSIG/A
   d. 600 PSIG for URL of 7.5 to 150 PSIG/A
   e. 850 PSIG for URL of 30 to 600 PSIG/A

3. The polysilicon sensors shall have an overpressure (proof) pressure rating of:
   a. 6000 PSIG for URL of 75 to 1500 PSIG/A
   b. 9000 PSIG for URL of 300 to 6000 PSIG/A
4. The ceramic sensor type transmitter accuracy shall be 0.2% of calibrated span over an entire 10:1 turndown. The polysilicon sensor type transmitter accuracy shall be 0.3% of calibrated span over an entire 10:1 turndown. This accuracy shall include the effects of linearity, hysteresis, and repeatability. The transmitter shall have a Long Term Stability of 0.1%.per 12 months. The electronics shall be replaceable by, module exchange. The transmitter electronics housing shall be constructed of 304 Stainless Steel with no dead volume and meet the hygenic requirements of the food and pharmaceutical industries. The housing shall be rated NEMA 4X.
5. The transmitter shall have versions which allow the ceramic sensor to be mounted flush with the process connection, including but not limited to, threaded versions, flanged versions, and Tri-Clamp compatible versions. The process connection and process seal gasket wetted parts shall be interchangeable and replaceable on-site. There shall also be options which allow no metal contacting the process.
6. The transmitter shall have an optional digital LCD display showing both the digital value and a 0-100 % bar graph if used with Hart electronics or 0-100% bargraph when used in conjunction with analog electronics. The display shall be universal to all ranges and incorporate a plug-in modular design to allow field retrofit.
7. Diaphragm seal versions shall be available to expand the operating parameters of the transmitter.
8. The transmitter shall be Factory Mutual (FM) Approved Intrinsically Safe Class I, II, and III, Division 1, Groups A thru G with appropriate barriers and FM approved Non-Incendive Class I and II, Division 2 without the need for barriers.
9. The pressure measuring system shall be Endress + Hauser cerabar M, Rosemount, or approved equal.
10. Well 22 Schedule

Tag Number	Service	Pressure Range	Process Stream	Transmitter Mounting	Cable Length, FT	Dwg Ref
PE/PT 300	Distribution System Pressure	0-??	R/W	Pipe	N/A	I-206

11. Well 26 Schedule

Tag Number	Service	Pressure Range	Process Stream	Transmitter Mounting	Cable Length, FT	Dwg Ref
PE/PT 300	Distribution System Pressure	0-??	R/W	Pipe	N/A	I-206

P. Residual Chlorine Analyzer and pH Controller/Monitor

1. General:

a. The vendor shall supply all components necessary for a functional system, including sensor(s); sensor holder with flow meter, flow control valve and mounting brackets; chlorine monitor and all required cables and spare parts. The sensor, holder, and monitor shall all be made by the same manufacturer to assure compatibility and provide sole source responsibility.

b. The manufacturer shall provide a one-year warranty on all system components. All components shall be fully tested prior to shipment.

c. The power requirements shall be 115 VAC, 60 Hz, single phase.

2. Monitor/Controller

a. The monitor shall be microprocessor-based, with illuminated LCD display of measured value, status, and error annunciation. Unit shall feature non-volatile memory to retain settings in the event of power failure: menu-driven calibration, limit and control settings; sensor monitoring to alarm upon sensor failure or loss of sensitivity; programmable access code allowing calibration but not unauthorized adjustment of limits and outputs.

b. Mounting shall be in a NEMA 4X plastic enclosure with removable wall mounting bracket 96 mm H x 96 mm W x 140 mm D

c. The monitor shall provide dual, electronically isolated active analog (0/4…20mA) outputs, with 600 ohm maximum load. Analog outputs shall be independently configurable for measured value of chlorine and pH to allow for a remote device to monitor and control to a set point.

d. Relay outputs, rated 250 VAC, 3A, shall include ((CHOOSE ONE)):

1) one general fault alarm relay to change state upon exceeding limits, loss of input signals or sensor failure.

3. Sensor Holder

a. The sensor holder shall be transparent PVC material with integral flow control valve and rotameter for setting the sample flow rate at 8 – 20 gph. The flow shall be directed at the sensor membrane to provide continuous cleaning action.Mounting brackets for wall mounting shall be included. The sample line connections shall be 3/8” tubing fittings.

b. A flow switch shall be provided with the rotameter to pause chemical feed if the monitor is programmed for control function, and actuate an alarm upon loss of sample flow.

4. Sensor Chlorine

a. The chlorine sensor shall be an amperometric type, providing continuous measurement of residual chlorine without use of any reagents or buffers in the sample stream. A membrane shall protect the electrodes from flow, pressure, and conductivity-based interferences.

b. Measured value shall be: free chlorine.

c. The residual chlorine measuring range shall be 0.1 to 10.0 ppm. Measurement accuracy shall be better than +/- 3% of the sensor signal. Response time to 90% of measured value shall be better than two minutes. Drift shall be less than 2% per month.

d. The sensor shall include integral automatic temperature compensation. The signal to the monitor shall be 4-20mA via 2-wire technology. The sensor shall feature a terminal block with watertight cable gland for field connection of any length cable to the monitor

5. Sensor – pH

a. Potentiometric method: For pH measurement

b. pH – control is done by adding acid and/or base feed via metering pumps or valves to adjust pH.

c. The correct pH sensor shall be chosen to fit desired application

6. Instrument to be provided by Chemical Feed System supplier as described under Section 11345

Q. Chart Recorder

1. Instrument to be provided by Chemical Feed System supplier as described under Section 11345

2.03 Components and Accessories

A. Pilot Devices:

1. Indicating lights, pushbuttons, and selector switches shall be miniature oil-tight units. Time clocks in control circuits shall be NEMA IC1, B150, rated 5 amperes inductive at 120 volts AC. Contact blocks for signal circuits shall be rated at 0.06 amperes at 30 volts AC or DC and shall be hermetically sealed reed switches. Pilot lights for 120 volt AC circuits shall be transformer type with 6.3 volt lamps. Pilot lights of 24 volt circuits shall be rated 28 volts. Individual pilot light assemblies shall be "push-to-test" type.

B. Relays:

1. All relays used for instrumentation work shall be plug-in types utilizing EIA standard tube socket configuration plugs. Sockets shall be heavy-duty, surface mounted, industrial type with barrier protected screw type terminals and shall be a one-piece melamine plastic molding. Sockets shall be rated not less than 5 amperes at 125 RMS working volts.

2. As a minimum, relays for general purpose use shall have double-pole, double-throw (DPDT) contacts. They shall bear ratings of 10 amperes at 120 volts AC and 28 volts DC. Relay frames shall be constructed of laminated phenolic and shall be provided with a clear polycarbonate dust cover. Relays for switching high level signal circuits (4 to 20 mA) shall be similar to the above; except the contacts shall be rated 3 amperes and the relays shall be hermetically sealed.

3. Relays for switching power or control loads with in-rush currents in excess of 5 amperes shall be similar to the above except the contacts shall be single-pole, single-throw (SPST), double-break, rated 20 amperes at 120 volts AC and 28 volts DC, and 1 horsepower at 120 volts AC.

4. Relays shall be IDEC, or an approved equivalent.

C. Signal Isolator:

1. Signal isolators shall have complete isolation of input, output and power input. Signal input shall be 4-20 mA into 50 ohms maximum, signal output shall be 4-20 mA into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable. Accuracy shall be plus or minus 0.1 percent of span. Units shall be surface or rack mounted. Signal isolators shall be Moore Industries Model SCT, Rochester Instrument Systems Model SC-1302-LZ, AGM Electronics TA-4000, or equal.

D. Current Alarm Trip (Switches):

1. Current alarm trips shall be single- or multi-channel type as required. Units shall accept voltage or current input signals. Dead band shall be factory set at 1 percent of full span for single trips. Alarm trips shall be equipped with 10 AMP DPST contacts.

2. Alarm trips shall include setpoint dials calibrated 0-100 percent for each trip point. Single alarm trips shall include a dead band adjustment dial calibrated 0-100 percent.
3. Alarm trips shall be AGM Electronics Model TA-4030, Moore Industries Model DCA, or equal.

E. I/I Converters:

1. Current to Current (I/I) converters shall accept one 4-20 mA DC signal and convert to two (2) 4-20 mA DC signals with an uncertainty not exceeding 0.25 percent of full scale. Each output signal shall be independent of each other, and isolated from input signal. The units shall be AGM Series 4000 or equal.

F. DC Power Supplies:

1. Twenty-four volt units shall be used to supply instrument controls and loops as required in the plans and detailed specification schedules. Power output shall be free of noise, have negligible ripple, and remain stable under varying system load conditions.

G. TERMINAL BLOCKS AND WIRING

1. Terminal blocks shall be screw terminal type with box-clamp type pressure plates. Terminal blocks shall be rated minimum 300 volts. Each terminal block shall be identified by a distinct number (TB-1, TB-2, etc.) designated by the panel manufacturer. All terminal points shall be assigned a distinct number. All terminal points for “Common” bus shall be designated by “COM.” Terminal points dedicated for 120 VAC buses shall be identified by L-1, L-2, etc. Terminal points for the ground wires shall be labeled “GND.”
2. All interconnecting wiring between panels or between panels and field devices shall be connected to terminal blocks. All panel internal wiring shall be installed in plastic raceways (Panduit). Unless otherwise shown on the Drawings, all 120 VAC wiring shall be No. 14 AWG. All wiring for analog signals shall be No. 16 AWG. All wiring for 24 VDC discrete signals shall be No. 16 AWG. All wire shall be standard copper. Conductors shall be individually identified using colored thermoplastic insulation or distinct labels.
3. Conductor Identifications: Identify each conductor by a consecutive unique number, letter, or number-letter combination. Each conductor shall have the same identification at all terminals and tie points. Conductors connected to the same terminal or tie point shall have the same identification. Conductor identification shall be as shown below with modifications necessary to provide a unique conductor number for each interconnecting conductor:
   a. OPNLTB #T #/DPNLTB #T #/C #, where
      1) OPNL is Origination Control Panel, TB # is Terminal Block Number, T # is Terminal Number, DPNL is destination Control Panel, and C # is the three digit conductor sequential number. The following example is shown as the guidance for clarification:
         a) BBCPTB01T12/ASCPTB01T12/100, where
            (i) BBCP is Blower Building Control Panel, TB01 is Terminal Block 01, T12 is Terminal Point 12, ASCP is Activated Sludge Control Panel, and 100 is the conductor unique number.
            (ii) Use filed device Tag Numbers for connections between two filed devices and between a field device and a panel.
4. All relay contacts which will be connected to external panels or devices shall be wired to terminal blocks,

H. Accessories

1. Provide instruments with manufacturer's identification nameplate showing:

a. Manufacturer's model number

b. Manufacturer's serial number

c. Range (English units)

d. Power supply requirement

I. Nameplates

1. Machine engraved laminated phenolic nameplates shall be provided for all panel mounted equipment. Nameplate engraving shall be as shown on the Drawings. The nameplates shall also include the instrument tag number in small size lettering on the last line of the nameplates. Nameplates shall be attached to the panel with a minimum of two self-tapping stainless steel sheet metal screws. Adhesive attachment is not acceptable. The OWNER reserves the right to review and change nameplates wording at no additional cost prior to the engraving. Machine embossed adhesive labels shall identify the tag number of instruments inside panels. All nameplates shall be included in CONTRACTOR's submittal for review and approval

J. Telemetry Radio System: Provide a complete and operational telemetry radio with the following key features:

1. Microswave Data Systems MDS iNET900 Series Access Point/Dual Gateway to match Owner standard, no "or equal" allowed.

2. Maxrad 12 db Yagi 890-960 MHz antenna to match Owner standard, no "or equal" allowed.

3. Polyphaser Lightning Protection to match Owner standard, no "or equal" allowed.

4. 36" Coax whip(TNC(M)-N(M)) to connect the radio to the Polyphaser so that a ½" or ¾" coax to the radio is not required.

PART 3 - EXECUTION

3.01 Installation

A. Field instruments shall be mounted on 2-inch pipe stands unless shown adjacent to a well or otherwise noted. Instruments attached directly to concrete shall be spaced minimum two inches from the mounting surface by use of phenolic spacers or framing channel. Expansion shields or cast-in-place inserts shall be used for securing equipment or supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform. All instruments shall be installed so that taps, parts, and the like, are available for in-place calibration and test without removal.

3.02 Field Quality Control

A. The instruments shall be field calibrated and tested. Field testing shall be provided for verification of contract requirements and pertinent manufacturer published performance specifications for performance parameters essential to the proper operation of the system. As required by the OWNER, any instrument of suspicious operation shall be recalibrated and retested until proved satisfactory to the OWNER at no addition cost.

B. Elements such as controllers, electronic function modules, and the like, shall be tested and exercised to demonstrate correct operation, first individually and then collectively as part of a functional network system.

END OF SECTION

SECTION 17110
INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides specifications for all instrumentation and control system equipment, panels, and necessary appurtenances for an integrated control system. These Specifications and Drawings include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems capable of providing the functions and meeting the performance set forth hereinafter.

B. The work of this section shall be performed by a qualified System Integrator. The contractor shall retain the services of a System Integrator to provide complete, assembled, installed, setup and testing of all instrumentation and control system components. The System Integrator shall have a minimum of ten Automatic Direct PLC based control systems in water or wastewater pump station applications including the use of Automatic Direct C-More Operator Interface Terminals. The System Integrator shall also be responsible for the Main Switchboard, PLC and OIT System, Control Panels, Motor Control Centers, and field instrumentation. The System Integrator will coordinate SCADA issues and telemetry with the Owner SCADA programmer and the Engineer. The System Integrator shall be Tesco Controls, Krug-Bixby-Long Associates or pre-approved equal.

C. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01330	Submittals Procedures
Section 01360	Operating and Maintenance Information
Section 01600	Material and Equipment Substitution
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 01720	Record Drawings
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 11060	Electric Motors
Section 11345	Chemical Metering Pumps
Section 11800	Arsenic Filter System

Section 11810	In-Line Blender
Section 11820	Flow Meters
Section 16010	General Electrical Provisions
Section 16120	Wire and Cables, 600 Volts and Below
Section 16160	Pilot Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 17010	General Requirements, Instrumentation
Section 17201	Control Panels
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17924	Control Strategies

1.02 References

A. General: The work shall comply with the most recent Codes and Standards as published at the date of the Contract and as listed in the Specifications.

Reference	Title
NFPA 70	National Electrical Code – Latest Edition
NFPA 101	Life Safety Code - Latest Edition
UBC	Uniform Building Code - Latest Edition
ANSI	American National Standard Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
JIC	Joint Industrial Council
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
SAMA	Scientific Apparatus Makers Association
UL	Underwriters' Laboratories, Inc
EIA	Electronic Industries Association
	Owner Mechanical and Electrical Codes

Reference	Title
	Any additional codes effective at the job site

1.03 Submittals

A. Submittals for all ICS equipment shall be prepared and submitted in accordance with Section 01300 and as described in Section 17010.

B. Operation and Maintenance Manuals

1. General: The CONTRACTOR shall provide Operation and Maintenance (O&M) manuals in accordance with Section 01360 and as described in Section 17010.

1.04 Quality Assurance

A. Performance and Design Requirements: For the purpose of standardization, all components shall be manufactured or furnished by one manufacturer, except as noted or approved.

B. Equipment Surge Protection:

1. All electronic equipment shall successfully withstand surges in AC power circuits as specified in IEEE C62.41. Successfully withstanding transients requires that none of the following conditions occur as a result of the transient:

   a. Erroneous output

   b. Component failure

   c. Calibration change exceeding normal tolerances

1.05 Delivery, Storage, and Handling

A. Refer to Section 17010, General Conditions, Instrumentation

1.06 Project / Site Conditions

A. The Instrumentation and Control System (ICS) shall be installed in a Water Facility which will be subjected to environmental conditions where temperatures may vary from 20 to 115 degrees F; relative humidity may vary from 10 to 100 percent; and trace quantities of moisture and dust may be present.

1.07 Warranty

A. Refer to Section 17506, Extended Warranty and Maintenance

1.08 Maintenance

A. Refer to Section 17506, Extended Warranty and Maintenance

PART 2 - PRODUCTS

2.01 Manufacturers

A. These specifications describe equipment of a specific manufacturer and are not designed to limit competition. Unless noted as a “sole source.” “no or equal,” or “No substitutions allowed”; the naming of the manufacturer on which the specifications and plans are based is not an

endorsement of that manufacture, but is instead intended to describe a level of quality and demonstrate the functionality of the system.

1. If equipment is noted at “sole source;” “no or equal,” or “No substitutions allowed”; then that equipment is currently used elsewhere in Owner as a Owner Standard.

B. The ICS components specified in these Specifications and shown on the Drawings are based upon the use of equipment, devices and panels manufactured by the companies specified in the following Sections of these Specifications.

C. The use of substitute or “or ENGINEER approved equal” equipment will be considered. Such equipment will be acceptable only on the basis that any revisions in the engineering, design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc., required to accommodate such a substitution, shall be made at no additional cost to the Owner

2.02 Equipment and Materials

A. All furnished instruments and control system components shall be as specified in these Specifications. Equals or exceptions shall be approved by ENGINEER prior to procurement.

B. All products shall be new and approved for the specific applications shown on Contract Drawings or specified in these Specifications.

C. Same products shall be of a single manufacturer.

D. Products furnished for modification of existing control panels, except for the PLCs, shall be compatible with the existing products and from the same manufacturer, unless the existing products are no longer available.

E. Products installed in classified areas shall be approved for that classification and meet all the pertinent Standards and Code requirements.

F. Control Panels:

1. The Control Panels shall be of same construction and configuration as shown on the Drawings and specified in these Specifications. All indicator lights, switches, recorders and digital displays shall be mounted on the doors. All Operator Interface Terminals (OITs) shall be accessible from the front door.

2. The back-panel and side-panels shall be used to install instrument modules, signal conditioners, relays, power supplies and other associated components within the Control Panel.

3. The Control Panels shall be fully gasketed and NEMA rated for the specific Plant areas. The panels shall be completely factory assembled, wired and tested. All field wiring shall be terminated in terminal blocks. All components shall be mounted so as to facilitate easy removal for service.

4. The panels shall be provided with adequate forced ventilation to ensure that the temperature rise within the panel section does not exceed design temperatures for the components within the panel section. The panels shall also be provided with heaters, to prevent condensation and sunshields to dissipate heat, as required.

G. Programmable Logic Controllers:

1. The Programmable Logic Controller (PLC) system shall operate in ambient conditions of 20 to 120°F temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

2. Where the PLC is utilized to control multiple trains of equipment, the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of one component does not

affect equipment of all trains. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

3. The PLC program modules shall dictate control outputs to a known and safe state prior to running of control program, under PLC fault conditions, and PLC runtime errors.
4. Access to the PLC program, downloading, uploading and diagnostic functions shall incorporate password protection or key lock operation.
5. The PLC system shall be designed with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, harmonic distortions, relay and circuit breaker noise or conducted and radiated radio frequency interference.
6. The PLC system shall be grounded to the panel ground bus with a separate ground conductor sized per the manufacturer's grounding requirements. The minimum ground connection shall be AWG #12.
7. The PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering (up to 60 degrees C and 95 percent humidity).
8. The PLC shall be furnished as a complete assembly with I/O (input/output) modules and peripheral equipment suitable for the interface with the new and existing PLC equipment, components and field devices.
9. The PLC chassis shall contain all I/O modules, communications equipment, and power supplies required to provide the specified functions. PLC chassis shall be sized to house the required PLC modules plus an additional two slots for future expansion capability.
10. The PLC power supplies shall be sized to provide power for the maximum total module load plus an additional 40 percent for future expansion. The PLC power supply shall provide the following operational characteristics:
    a. 120 VAC RMS plus or minus 15 percent continuously
    b. 120 VAC RMS plus or minus 30 percent maximum 30 seconds
    c. 120 VAC RMS plus or minus 100 percent maximum milliseconds
    d. Line spikes at 1000V ac (5000 micro-seconds duration; 0.05 percent maximum duty cycle).
11. The central processor shall contain all firmware logic, relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus an additional 25 percent excess capaOwner. The power supply shall contain capacitors to provide orderly shutdown in the event incoming power does not meet specifications. If this occurs, the processor shall cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes. The central processor shall be 32-bit, minimum.
12. The programmable controller memory shall be Complementary Metal Oxide Semi-conductor (CMOS) based memory with battery backup or Erasable Programmable Read-Only Memory (EPROM) based memory. The CMOS memory shall be a minimum of 64K with sufficient battery backup to retain the program during power interruptions of up to 1 year. An indicator shall show the status of the batteries. A reference shall be available through the discrete outputs to alarm the operator that the batteries should be changed.

13. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capaOwner of 25 percent of the total provided. This reserve capaOwner shall be totally free from any system use. Memory size shall be 30.4 K total available words. However, System Integrator shall calculate the memory size based on the program requirements and provide PLCs with memories adequate for the Project.
14. The PLC shall be provided with a 15.8 K Flash Memory module for memory back-up.
15. The PLC shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.
16. The PLC shall have provision for programming, besides other common programming languages, in "ladder diagram" language. It shall be easily reprogrammed with a portable programming unit. Two documented copies of the operating program shall be furnished which shall allow direct, step-by-step, reloading of the system program.
17. The PLC system shall have provision for RS-232, K-Sequence, DirectNET, Modbus RTU Master Slave and Ethernet 10/100BaseT communications network interfaces.
18. The PLC processor shall be Automation Direct DL205 Series, Model D2-260, as shown on the Contract Drawings.
19. All Input/Output (I/O) module housings and I/O modules shall be of rugged construction with modules installed in I/O chassis. Sufficient input and sufficient output modules shall be provided with the PLC to implement the specified control functions plus a reserve capaOwner of 25 percent of the total provided.
20. All Discrete Input (DI) Modules, defined as contact closure inputs from devices external to the programmable logic controller module shall be shielded from short time constant noise. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O Modules. The modules shall have LED lights to indicate a discrete input. Input modules shall be supplied with a maximum of 16 points per module, except where 32-point modules are required. Input voltage rating shall be provided as indicated on the Contract Drawings. Discrete input modules shall be Automation Direct DL205 Series, Model D2-32ND3 or Model D2-16NA.
21. All Discrete Output (DO) Modules, defined as contact closure outputs for ON/OFF operation of devices external to the programmable logic controller module shall be rated for 10.2 through 26.4VDC or Relay Output type. All output modules shall have LED lights to indicate output has been cycled ON by the controller. Discrete output modules shall be Automation Direct DL205 Series, Model D2-16TD1 or Model D2-12TR.
22. All Analog Input (AI) Modules, defined as analog inputs for 1 to 5 VDC or 4 to 20 mA dc signals, where an analog to digital conversion is performed and the digital result is entered into the processor. New inputs shall be provided for every scan. Analog inputs shall be supplied with a minimum resolution of 12 bits. Each Analog Input Module shall accept 8 isolated inputs. Each analog input shall be isolated from common. Analog input modules shall be Automation Direct DL205 Series, Model F2-08AD-1.
23. All Analog Output (AO) Modules, defined as analog output to output 4-20 mA dc signals, where a digital to analog conversion is performed and the analog result is produced on every scan. Analog output resolution shall be 12 bit minimum. Each Analog Output Module shall have 8 sink or source outputs. Each analog output shall be capable of driving into a 1500 ohm load. Analog Output modules shall be Automation Direct DL205 Series Model F2-08DA-1.

24. All Combination Analog Input/Output Modules shall be provided with eight high-speed analog input channels and four current analog output channels. Combined modules shall be Automation Direct DL205 Series, Model F2-8AD4DA-1,

25. Remote Input/Output Communications Modules shall be used for the PLC to communicate with remote chassis utilizing Ethernet Communication modules. Ethernet Communication Modules shall be Automation Direct DL205 Series, Model H2-ERKIT-1.

26. The integrated PLC system shall be Automation Direct DL205 series as shown on the Contract Drawings. Equals are not accepted.

H. Operator Interface Panel:

1. An Operator Interface Panel shall be provided that will be capable of display information and implement actions via a communications network (i.e. Ethernet) to the programmable controller. The Operator Interface Panel shall be configured to serve as the primary operator interface to the programmable controller in the Control Panel Section of the Motor Control Center.

2. The Operator Interface Panel shall utilize a 10-inch TFT touch panel, 57k colors, 540 x480 pixel VGA screen resolution, NEMA 4x enclosure with built-in Ethernet and USB; supports Compact Flash.

3. The Operator Interface Panel shall be Automation Direct C-More EA7-T10C. No Substitutes Allowed.

I. Ethernet Switch: Provide an Ethernet Switch in the Control Panel to match Owner Standard. Provide a Ntron 306TX, no substitutes allowed.

J. Flow Meter:

1. For Well 22, provide a new well flow meter as described under Section 11820.

K. Level Transmitter – Ultrasonic:

1. Provide an ultrasonic single-point level controller with an integral transducer and temperature compensator as indicated on the Drawings.

2. The single-point level transmitter shall be a microprocessor based echo-time measuring type providing an electronic output signal proportional to the level of the material or the distance to the material being measured. It shall consist of an integral transmitter, transducer, and temperature sensor package.

3. Acoustic impulses emitted from an ultrasonic sensor are reflected back from the material surface and are received by the same sensor. The transit time of the pulse from the transmission generation to echo reception is recorded. The elapsed time is proportional to the distance between the sensor and material surface based on the speed of sound for that application.

4. The acoustic sensor/transducer shall be a polarized zirconium crystal type with acoustic impedance matching face and transformer.

5. The measurement range shall be as required by the contract drawings but not less than a range of 1 to 16 feet.

6. The power supply shall be 12 to 28 VDC and the output signal shall be 4-20 mA DC non-isolated into 750 ohms maximum.

7. The single point level controller shall be a Siemens Milltronics brand The Probe, or approved equal.

8. Well 22 Schedule:

Tag Number	Service	Drawing Reference
LE/LT-201	Sulfuric Acid Storage Tank Level	I-102
LE/LT-202	Ferric Chloride Storage Tank Level	I-103
LE/LT-203	Sodium Hypochlorite Storage Tank Level	I-101
LE/LT-205	Backwash Tank Level	I-106

9. Well 26 Schedule:

Tag Number	Service	Drawing Reference
LE/LT-201	Sulfuric Acid Storage Tank Level	I-203
LE/LT-202	Ferric Chloride Storage Tank Level	I-203
LE/LT-203	Sodium Hypochlorite Storage Tank Level	I-202

L. Pressure Gauge:

1. Pressure Gauges shall be 4-1/2 inch in diameter, bottom connected with white laminated dials and black graduations.
2. Gauges shall have a blowout disc and safety glass, encased in phenolic, steel or cast iron. Measuring element shall be a stainless steel bourbon tube with welded, stress-relieved joints. Socket shall have wrench flats.
3. Movement shall be rotary geared, all stainless steel material.
4. Accuracy shall be ½ percent of range.
5. All pressure gauges shall be provided with pulsation snubbers constructed of 316 stainless steel, pressure diaphragm seal, an isolation valve and a drain valve as shown on the Contract Drawings.
6. The pressure gauge shall be Ashcroft 1279, Ametek Solfrunt Series 1900 or equal.
7. Well 22 Schedule:

Tag Number	Service	Drawing Reference
PI 201A	Well Pump Discharge Pressure	I-101
PI 201B	Well Discharge Line Pressure	I-101
PI 201	Surface Wash Booster Pump #1 Inlet Pressure	I-104
PI 202	Surface Wash Booster Pump #1 Discharge Pressure	I-104
PI 203	Surface Wash Booster Pump #2 Inlet Pressure	I-104
PI 204	Surface Wash Booster Pump #2	I-104

Tag Number	Service	Drawing Reference
	Discharge Pressure	
PI 205	Backwash Pump #1 Inlet Pressure	I-106
PI 206	Backwash Pump #1 Discharge Pressure	I-106
PI 207	Backwash Pump #2 Inlet Pressure	I-106
PI 208	Backwash Pump #2 Discharge Pressure	I-106
PI 210	Distribution System Pressure	I-106

8. Well 26 Schedule:

Tag Number	Service	Drawing Reference
PI 210	Well Pump Discharge Pressure	I-201
PI 201	Surface Wash Booster Pump #1 Inlet Pressure	I-204
PI 202	Surface Wash Booster Pump #1 Discharge Pressure	I-204
PI 203	Surface Wash Booster Pump #2 Inlet Pressure	I-204
PI 204	Surface Wash Booster Pump #2 Discharge Pressure	I-204
PI 205	Backwash Pump #1 Inlet Pressure	I-206
PI 206	Backwash Pump #1 Discharge Pressure	I-206
PI 207	Backwash Pump #2 Inlet Pressure	I-206
PI 208	Backwash Pump #2 Discharge Pressure	I-206
PI 210	Distribution System Pressure	I-206

M. Pressure Diaphragm Seals:

1. Diaphragm seals shall consist of a bottom housing, lower ring, diaphragm capsule, fill screw, fusing connection and a top housing.
2. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid.

3. The space between the diaphragm and the instrument pressure element shall be completely filled with a suitable liquid.
4. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure directly to a gauge, transmitter, switch or any other pressure instrument.
5. The diaphragm seal shall have a removable bottom housing to permit the servicing of the diaphragm capsule without the need to refill.
6. All surfaces exposed to process fluids shall be Type 316 stainless steel.
7. Pressure diaphragm seals shall be Ashcroft 100 or equal:

N. Pressure and Differential Pressure Switches:

1. Pressure and differential pressure switches shall have an adjustable (10 percent) differential (deadband) to eliminate instability due to pressure cycling. Pressure tap connections shall be 1/2-inch NPT and conduit connection shall be 3/4-inch NPT or larger.
2. Materials:
   a. Bourdon tube: 316 stainless steel
   b. Diaphragm seal housing: 316 stainless steel
   c. Pulsation dampeners: 316 stainless steel
   d. Switch isolating ball valves: 316 stainless steel
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
   b. Provide pulsation dampeners on all pressure switch applications which involve positive displacement equipment including positive displacement plunger pump systems, positive displacement lube pump systems, diaphragm pump systems and positive displacement blower or compressor systems.
   c. Provide protector to separate process fluid from the pressure element,
   d. System fill applications – diaphragm seal and sealed sleeve.
4. System fill material: Utilize halocarbon fill for process applications involving strong oxidizing agents. Agents include but are not limited to: Chlorine (CL2), Potassium Permanganate ($KMNO_4$), Ferric Acid (FeCl), Sodium Hydroxide (NaOH), Sodium Hypochlorite (NaOCl), and Aluminum Sulfate, ($A1_2(SO_4)14\ H_20$). Utilize manufacturer's standard fill for other applications. Ensure fill is suitable for application temperatures.
5. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
6. Design and fabrication:
   a. Pressure Switches shall be hermetically sealed non-mercury contact switches.
   b. Two (2) SPDT contacts rated 1 amp inductive at 125 VDC and 5 amp inductive at 120 VAC. Set points between 30 and 70 percent of switch rated working range Operating pressure not to exceed 75 percent of switch rated working range.
   c. Accuracy: Better than 1 percent of full scale.
   d. The pressure switches shall have a watertight enclosure.

7. Pressure switches shall be United Electric Controls with appropriate diaphragm seals, Mercoid, Automatic Switch Company or approved equal.
8. Well 22 Schedule:

Tag Number	Service	Drawing Reference
PSL 201	Well 22 Pump Discharge Pressure Low	I-101
PSH 201	Well 22 Pump Discharge Pressure High	I-101
PSL 100	Filter Solenoid Panel Low Air Pressure	I-105
DPS 102	Filter Low Differential Pressure	I-105
PSL 104	Air Compressor Low Pressure	I-105

9. Well 26 Schedule:

Tag Number	Service	Drawing Reference
PSL 210	Well 26 Pump Discharge Pressure Low	I-201
PSH 210	Well 26 Pump Discharge Pressure High	I-201
PSL 100	Filter Solenoid Panel Low Air Pressure	I-205
DPS 102	Filter Low Differential Pressure	I-205
PSL 104	Air Compressor Low Pressure	I-205

O. Pressure Transmitter:

1. The gauge/ absolute pressure sensor shall provide a two-wire, loop-powered, 4-20 mA signal proportional to the process pressure. Optionally the transmitter shall be capable of providing a simultaneous digital signal superimposed on the analog output, but shall not affect this analog value. The digital signal shall utilize the HART protocol. The unit shall operate with 11.5 to 45 VDC in non-hazardous applications and 11.5 to 30 VDC in FM approved installations.
2. The sensor shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm construction for measuring range up to 600 PSIG/ A. The sensor shall utilize a polysilicon 316 SST diaphragm construction for measuring ranges up to 6000 PSIG/A .The ceramic diaphragm shall be immune to damage due to full vacuum and shall have an overpressure (overload) pressure rating of:
   a. 60 PSIG for URL of 0.075 to 1.5 PSIG
   b. 150 PSIG for URL of 0.3 to 6 PSIG/A
   c. 300 PSIG for URL of 1.5 to 30 PSIG/A
   d. 600 PSIG for URL of 7.5 to 150 PSIG/A
   e. 850 PSIG for URL of 30 to 600 PSIG/A

3. The polysilicon sensors shall have an overpressure (proof) pressure rating of:
   a. 6000 PSIG for URL of 75 to 1500 PSIG/A
   b. 9000 PSIG for URL of 300 to 6000 PSIG/A
4. The ceramic sensor type transmitter accuracy shall be 0.2% of calibrated span over an entire 10:1 turndown. The polysilicon sensor type transmitter accuracy shall be 0.3% of calibrated span over an entire 10:1 turndown. This accuracy shall include the effects of linearity, hysteresis, and repeatability. The transmitter shall have a Long Term Stability of 0.1%.per 12 months. The electronics shall be replaceable by, module exchange. The transmitter electronics housing shall be constructed of 304 Stainless Steel with no dead volume and meet the hygenic requirements of the food and pharmaceutical industries. The housing shall be rated NEMA 4X.
5. The transmitter shall have versions which allow the ceramic sensor to be mounted flush with the process connection, including but not limited to, threaded versions, flanged versions, and Tri-Clamp compatible versions. The process connection and process seal gasket wetted parts shall be interchangeable and replaceable on-site. There shall also be options which allow no metal contacting the process.
6. The transmitter shall have an optional digital LCD display showing both the digital value and a 0-100 % bar graph if used with Hart electronics or 0-100% bargraph when used in conjunction with analog electronics. The display shall be universal to all ranges and incorporate a plug-in modular design to allow field retrofit.
7. Diaphragm seal versions shall be available to expand the operating parameters of the transmitter.
8. The transmitter shall be Factory Mutual (FM) Approved Intrinsically Safe Class I, II, and III, Division 1, Groups A thru G with appropriate barriers and FM approved Non-Incendive Class I and II, Division 2 without the need for barriers.
9. The pressure measuring system shall be Endress + Hauser cerabar M, Rosemount, or approved equal.
10. Well 22 Schedule

Tag Number	Service	Pressure Range	Process Stream	Transmitter Mounting	Cable Length, FT	Dwg Ref
PE/PT 300	Distribution System Pressure	0-??	R/W	Pipe	N/A	I-206

11. Well 26 Schedule

Tag Number	Service	Pressure Range	Process Stream	Transmitter Mounting	Cable Length, FT	Dwg Ref
PE/PT 300	Distribution System Pressure	0-??	R/W	Pipe	N/A	I-206

P. Residual Chlorine Analyzer and pH Controller/Monitor

1. General:

a. The vendor shall supply all components necessary for a functional system, including sensor(s); sensor holder with flow meter, flow control valve and mounting brackets; chlorine monitor and all required cables and spare parts. The sensor, holder, and monitor shall all be made by the same manufacturer to assure compatibility and provide sole source responsibility.

b. The manufacturer shall provide a one-year warranty on all system components. All components shall be fully tested prior to shipment.

c. The power requirements shall be 115 VAC, 60 Hz, single phase.

2. Monitor/Controller

a. The monitor shall be microprocessor-based, with illuminated LCD display of measured value, status, and error annunciation. Unit shall feature non-volatile memory to retain settings in the event of power failure: menu-driven calibration, limit and control settings; sensor monitoring to alarm upon sensor failure or loss of sensitivity; programmable access code allowing calibration but not unauthorized adjustment of limits and outputs.

b. Mounting shall be in a NEMA 4X plastic enclosure with removable wall mounting bracket 96 mm H x 96 mm W x 140 mm D

c. The monitor shall provide dual, electronically isolated active analog (0/4…20mA) outputs, with 600 ohm maximum load. Analog outputs shall be independently configurable for measured value of chlorine and pH to allow for a remote device to monitor and control to a set point.

d. Relay outputs, rated 250 VAC, 3A, shall include ((CHOOSE ONE)):

1) one general fault alarm relay to change state upon exceeding limits, loss of input signals or sensor failure.

3. Sensor Holder

a. The sensor holder shall be transparent PVC material with integral flow control valve and rotameter for setting the sample flow rate at 8 – 20 gph. The flow shall be directed at the sensor membrane to provide continuous cleaning action.Mounting brackets for wall mounting shall be included. The sample line connections shall be 3/8” tubing fittings.

b. A flow switch shall be provided with the rotameter to pause chemical feed if the monitor is programmed for control function, and actuate an alarm upon loss of sample flow.

4. Sensor Chlorine

a. The chlorine sensor shall be an amperometric type, providing continuous measurement of residual chlorine without use of any reagents or buffers in the sample stream. A membrane shall protect the electrodes from flow, pressure, and conductivity-based interferences.

b. Measured value shall be: free chlorine.

c. The residual chlorine measuring range shall be 0.1 to 10.0 ppm. Measurement accuracy shall be better than +/- 3% of the sensor signal. Response time to 90% of measured value shall be better than two minutes. Drift shall be less than 2% per month.

d. The sensor shall include integral automatic temperature compensation. The signal to the monitor shall be 4-20mA via 2-wire technology. The sensor shall feature a terminal block with watertight cable gland for field connection of any length cable to the monitor

5. Sensor – pH

a. Potentiometric method: For pH measurement

b. pH – control is done by adding acid and/or base feed via metering pumps or valves to adjust pH.

c. The correct pH sensor shall be chosen to fit desired application

6. Instrument to be provided by Chemical Feed System supplier as described under Section 11345

Q. Chart Recorder

1. Instrument to be provided by Chemical Feed System supplier as described under Section 11345

2.03 Components and Accessories

A. Pilot Devices:

1. Indicating lights, pushbuttons, and selector switches shall be miniature oil-tight units. Time clocks in control circuits shall be NEMA IC1, B150, rated 5 amperes inductive at 120 volts AC. Contact blocks for signal circuits shall be rated at 0.06 amperes at 30 volts AC or DC and shall be hermetically sealed reed switches. Pilot lights for 120 volt AC circuits shall be transformer type with 6.3 volt lamps. Pilot lights of 24 volt circuits shall be rated 28 volts. Individual pilot light assemblies shall be "push-to-test" type.

B. Relays:

1. All relays used for instrumentation work shall be plug-in types utilizing EIA standard tube socket configuration plugs. Sockets shall be heavy-duty, surface mounted, industrial type with barrier protected screw type terminals and shall be a one-piece melamine plastic molding. Sockets shall be rated not less than 5 amperes at 125 RMS working volts.

2. As a minimum, relays for general purpose use shall have double-pole, double-throw (DPDT) contacts. They shall bear ratings of 10 amperes at 120 volts AC and 28 volts DC. Relay frames shall be constructed of laminated phenolic and shall be provided with a clear polycarbonate dust cover. Relays for switching high level signal circuits (4 to 20 mA) shall be similar to the above; except the contacts shall be rated 3 amperes and the relays shall be hermetically sealed.

3. Relays for switching power or control loads with in-rush currents in excess of 5 amperes shall be similar to the above except the contacts shall be single-pole, single-throw (SPST), double-break, rated 20 amperes at 120 volts AC and 28 volts DC, and 1 horsepower at 120 volts AC.

4. Relays shall be IDEC, or an approved equivalent.

C. Signal Isolator:

1. Signal isolators shall have complete isolation of input, output and power input. Signal input shall be 4-20 mA into 50 ohms maximum, signal output shall be 4-20 mA into 1000 ohms minimum. Power input shall be 120 VAC, 60 Hz. Span and zero shall be adjustable. Accuracy shall be plus or minus 0.1 percent of span. Units shall be surface or rack mounted. Signal isolators shall be Moore Industries Model SCT, Rochester Instrument Systems Model SC-1302-LZ, AGM Electronics TA-4000, or equal.

D. Current Alarm Trip (Switches):

1. Current alarm trips shall be single- or multi-channel type as required. Units shall accept voltage or current input signals. Dead band shall be factory set at 1 percent of full span for single trips. Alarm trips shall be equipped with 10 AMP DPST contacts.

2. Alarm trips shall include setpoint dials calibrated 0-100 percent for each trip point. Single alarm trips shall include a dead band adjustment dial calibrated 0-100 percent.
3. Alarm trips shall be AGM Electronics Model TA-4030, Moore Industries Model DCA, or equal.

E. I/I Converters:

1. Current to Current (I/I) converters shall accept one 4-20 mA DC signal and convert to two (2) 4-20 mA DC signals with an uncertainty not exceeding 0.25 percent of full scale. Each output signal shall be independent of each other, and isolated from input signal. The units shall be AGM Series 4000 or equal.

F. DC Power Supplies:

1. Twenty-four volt units shall be used to supply instrument controls and loops as required in the plans and detailed specification schedules. Power output shall be free of noise, have negligible ripple, and remain stable under varying system load conditions.

G. TERMINAL BLOCKS AND WIRING

1. Terminal blocks shall be screw terminal type with box-clamp type pressure plates. Terminal blocks shall be rated minimum 300 volts. Each terminal block shall be identified by a distinct number (TB-1, TB-2, etc.) designated by the panel manufacturer. All terminal points shall be assigned a distinct number. All terminal points for “Common” bus shall be designated by “COM.” Terminal points dedicated for 120 VAC buses shall be identified by L-1, L-2, etc. Terminal points for the ground wires shall be labeled “GND.”
2. All interconnecting wiring between panels or between panels and field devices shall be connected to terminal blocks. All panel internal wiring shall be installed in plastic raceways (Panduit). Unless otherwise shown on the Drawings, all 120 VAC wiring shall be No. 14 AWG. All wiring for analog signals shall be No. 16 AWG. All wiring for 24 VDC discrete signals shall be No. 16 AWG. All wire shall be standard copper. Conductors shall be individually identified using colored thermoplastic insulation or distinct labels.
3. Conductor Identifications: Identify each conductor by a consecutive unique number, letter, or number-letter combination. Each conductor shall have the same identification at all terminals and tie points. Conductors connected to the same terminal or tie point shall have the same identification. Conductor identification shall be as shown below with modifications necessary to provide a unique conductor number for each interconnecting conductor:
   a. OPNLTB #T #/DPNLTB #T #/C #, where
      1) OPNL is Origination Control Panel, TB # is Terminal Block Number, T # is Terminal Number, DPNL is destination Control Panel, and C # is the three digit conductor sequential number. The following example is shown as the guidance for clarification:
         a) BBCPTB01T12/ASCPTB01T12/100, where
            (i) BBCP is Blower Building Control Panel, TB01 is Terminal Block 01, T12 is Terminal Point 12, ASCP is Activated Sludge Control Panel, and 100 is the conductor unique number.
            (ii) Use filed device Tag Numbers for connections between two filed devices and between a field device and a panel.
4. All relay contacts which will be connected to external panels or devices shall be wired to terminal blocks,

H. Accessories

1. Provide instruments with manufacturer's identification nameplate showing:

a. Manufacturer's model number

b. Manufacturer's serial number

c. Range (English units)

d. Power supply requirement

I. Nameplates

1. Machine engraved laminated phenolic nameplates shall be provided for all panel mounted equipment. Nameplate engraving shall be as shown on the Drawings. The nameplates shall also include the instrument tag number in small size lettering on the last line of the nameplates. Nameplates shall be attached to the panel with a minimum of two self-tapping stainless steel sheet metal screws. Adhesive attachment is not acceptable. The OWNER reserves the right to review and change nameplates wording at no additional cost prior to the engraving. Machine embossed adhesive labels shall identify the tag number of instruments inside panels. All nameplates shall be included in CONTRACTOR's submittal for review and approval

J. Telemetry Radio System: Provide a complete and operational telemetry radio with the following key features:

1. Microswave Data Systems MDS iNET900 Series Access Point/Dual Gateway to match Owner standard, no "or equal" allowed.

2. Maxrad 12 db Yagi 890-960 MHz antenna to match Owner standard, no "or equal" allowed.

3. Polyphaser Lightning Protection to match Owner standard, no "or equal" allowed.

4. 36" Coax whip(TNC(M)-N(M)) to connect the radio to the Polyphaser so that a ½" or ¾" coax to the radio is not required.

PART 3 - EXECUTION

3.01 Installation

A. Field instruments shall be mounted on 2-inch pipe stands unless shown adjacent to a well or otherwise noted. Instruments attached directly to concrete shall be spaced minimum two inches from the mounting surface by use of phenolic spacers or framing channel. Expansion shields or cast-in-place inserts shall be used for securing equipment or supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform. All instruments shall be installed so that taps, parts, and the like, are available for in-place calibration and test without removal.

3.02 Field Quality Control

A. The instruments shall be field calibrated and tested. Field testing shall be provided for verification of contract requirements and pertinent manufacturer published performance specifications for performance parameters essential to the proper operation of the system. As required by the OWNER, any instrument of suspicious operation shall be recalibrated and retested until proved satisfactory to the OWNER at no addition cost.

B. Elements such as controllers, electronic function modules, and the like, shall be tested and exercised to demonstrate correct operation, first individually and then collectively as part of a functional network system.

END OF SECTION

SECTION 17506
EXTENDED WARRANTY & MAINTENANCE

PART 1 - GENERAL

1.01 Summary

A. Scope: The requirements for extended warranties and maintenance for equipment that is placed into operation prior to final completion.

B. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16110	Raceways, Fittings, and Supports
Section 16115	Junction and Device Boxes
Section 16120	Wire and Cables, 600 Volts and Below
Section 16125	Manholes, Handholes, and Pull Boxes
Section 16130	Wiring Devices
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment
Section 16310	Panelboards

Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 16325	Dry-Type Transformers
Section 16330	Variable Frequency Drives
Section 16400	Electric Service
Section 16450	Grounding
Section 16500	Lighting Fixtures and Accessories
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests
Section 17902	SCADA System
Section 17924	Control Strategies

1.02 References

A. General: Refer to equipment manufacturers' approved and certified documentations for the Extended Warranty and Maintenance (EW&M) agreements to provide EW&M for equipment installed.

B. Related Sections: Refer to General Requirements of Divisions "0" and "1" for the pertinent references addressing the EW&M requirements.

1.03 Submittals

A. General: Submittals shall be provided for all EW&M agreements for review and approval.

B. Related Sections: Refer to General Requirements of Divisions "0" and "1" and Divisions "16" and "17" for submittal requirements for the EW&M.

C. The Contractor shall include documentation in the submittal that EW&M's have been obtained for all equipment. The documentation shall include a "TABLE" listing all equipment tag numbers, manufacturer's contact information, EW&M effective date, EW&M expiration date, renewal requirements, and a comments column for general notes as specified below:

1.04 Quality Assurance

A. Extended Warranty and Maintenance Requirements

1. As a minimum, provide the EW&M for all hardware supplied under this CONTRACT for a period of one year after the manufacturers' Standard Warranty (SW) has expired. The SW shall become effective after the Final Commissioning and Acceptance (FCA).

2. All failed parts during the EW&M period shall be repaired or replaced without any cost to the OWNER including labor, material, and shipping charges.

3. Warrant all software, including layered software, supplied by the CONTRACTOR against any defect for a period of two (2) years after the FCA. Correct any defect in the software, without

charge, during the warranty period. If necessary, make the corrections and test the revised software on site without any charges to the OWNER during this period

1.05 Maintenance

A. Properly maintain operating equipment throughout the course of the EW&M without any charges to the OWNER.

B. Perform preventive maintenance in accordance with the manufacturer's recommendations. Include inspection, testing and calibration, cleaning, lubricating, and replacement of worn or defective parts.

C. Keep maintenance service records with the equipment and make them immediately available to the OWNER during the course of the EW&M.

D. Provide maintenance contracts that are renegotiable and expandable yearly, at the OWNER's option, for a minimum period of ten (10) years.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

****END OF SECTION****

SECTION 17510
FACTORY ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section describes the minimum requirements for Factory Acceptance Test (FAT).

B. Conduct a formal FAT prior to shipment of equipment to the project site. The purpose of the FAT is to verify compliance with the design specifications and correct deficiencies at the Contractor's facility to prevent extensive field tests.

C. The Contractor shall prepare a FAT Plan (FATP) for review and approval by the Engineer prior to scheduling the FAT. The Contractor shall dry run all tests prior to the FAT to expedite the process. All costs including test equipment, hardware and software of the FAT shall be included in the Contractor's original bid price.

D. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16120	Wire and Cables, 600 Volts and Below
Section 16130	Wiring Devices
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment

Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 16330	Variable Frequency Drives
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17512	Site Acceptance Tests
Section 17902	SCADA System Modifications
Section 17924	Control Strategies

1.02 System Description

A. The purpose of this test is to qualify each system, insofar as practical, as having met the functional, performance, and interface requirements. Verify the performance and functional integrity of the individual subsystems, including active interfaces between subsystems, and demonstrate the operation of the subsystems on an integrated system basis.

B. Supervise and assist in the tests. The Owner/Engineer shall be notified to actively participate in the tests.

C. Application software developed by the Plant Control System Integrator, including graphic displays, reports, control logic, database points will be installed on the system during FAT. The Plant Control System Integrator may add, modify and delete application software during testing to simulate normal operating conditions.

D. The Owner/Engineer reserves the right to test any specified function, whether or not explicitly stated in the test submittal.

E. Provide knowledgeable personnel capable of explaining procedures and test results to the understanding and satisfaction of the Owner/Engineer.

F. Meet the following criteria prior to the start of the tests:

1. Complete submittals and resolve disputes.
2. Have approved test procedure.
3. Set a test date that is agreeable to all.

1.03 Submittals

A. Test Plan Submittals

1. Prepare and submit FAT procedures to the Owner/Engineer for approval at least thirty (30) days prior to the scheduled test date.
2. Notify the Owner/Engineer at least fifteen (15) days prior to the scheduled start of the FAT. All Control Panels and SCADA equipment shall be, in the opinion of the Contractor, ready for the formal FAT prior to scheduling.
3. Submit dry run test results at least three (3) days prior to the scheduled start of the FAT.
4. Submit completed FAT procedures document with signatures, dates, test results, and notes.
   a. Factory Acceptance Test Procedures Document shall:

1) Include individual ID number, name, description and date of each test,
2) List the logical step by step procedure with expected response at each step and provide space for recording results,
3) Provide space for approval for each test,
4) Provide space for hand written comments,
5) Include checkpoints at critical points in logic,
6) Provide minimal reference to other documents,
7) Be written such that OWNER personnel can use it during site testing,
8) And describe steps necessary to simulate inputs required by the test.

b. Include the following in the FAT submittal:
1) Location of FAT,
2) FAT procedures,
3) A schedule of daily activities indicating that the FAT will be completed in the allotted time,
4) Configuration, cabling and wiring diagrams locating and identifying all equipment used for the test,
5) A hardware inventory including manufacturers, model numbers, serial numbers, and item descriptions,
6) A software inventory organized by computer on which it is installed including Contractor's names, software name and version, and
7) A list of documentation that will be on hand during testing including manufacturers' or Contractor's names, document descriptions and document numbers.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 Installation

A. Authorization to Ship
1. The Owner/Engineer will issue the Authorization to Ship (ATS) after successful completion of the FAT, and resolution of deficiencies. The ATS will list all known system deficiencies, and what modifications are required to allow shipment.
2. The Contractor shall agree to the conditions and schedule in the ATS and acknowledge this agreement with an authorized signature before the ATS will be issued.
3. No equipment will be accepted at the Owner's sites until an ATS has been issued.

B. Owner/Engineer Involvement
1. The Owner/Engineer shall witness all testing activities.

C. Expenses
1. Pay costs for (3) representatives from the Owner and (3) representatives from the Engineer to attend each test and retest if a test fails. Provide the following:

a. Meals

D. Testing Aids and Equipment

1. Provide the following documentation:

a. One copy of submittals applicable to the equipment to be tested.

b. One copy of the Drawings and Specifications together with addenda and change orders.

c. One master copy of the test procedure.

d. A complete inventory of the equipment to be tested and any special test equipment including make, model and serial number.

2. Provide the following support facilities:

a. Meeting room access

b. Copy machine access

c. Telephone for local and long distance service

d. FAX machine access

3. Provide the following test equipment:

a. Off line diagnostic and test programs.

b. Maintenance and test equipment including, but not limited to, serial data analyzer, electrician tool set, electrical continuity tester, analog loop amp meter.

E. Retest

1. If a test, or portion of a test, defined in the FAT procedures fails and needs to be rescheduled, pay expenses of Owner/Engineer personnel for retesting.

3.02 Field Quality Control

A. Conduct the FAT in accordance with plan and procedures documented in the submittal for this section.

B. Testing shall be conducted Monday through Friday for no more than 8 hours per day. Testing at other times requires the approval of the Owner/Engineer.

C. Provide simulation of the PLC network to duplicate loading to the SCADA system.

D. Programmable Logic Controller (PLC) Testing

1. Connect all PLCs to the SCADA system.

2. Download Vendor, Plant Control System Integrator supplied control strategies and execute. Test functionality and performance of all strategies.

3. Provide hardware and software required for simultaneously simulating all the inputs/outputs.

4. Perform the following functional tests:

a. Demonstrate proper operation of I/Os.

b. Demonstrate that analog points are within the specified accuracy when the inputs/outputs are at 25, 50, 75, and 100 percent of full scale. Demonstrate proper operation of analog inputs with the required signal levels.

c. Test operation under power failure conditions.

d. Demonstrate that the control strategies are functioning as specified.

e. Conduct other tests as required and directed by the Engineer.

E. Communication Test

1. Test the following communication functions from SCADA workstations to the Plant PLCs:

   a. Demonstrate operation of the control strategies from each workstation.

   b. Demonstrate that a control operation will override the normal scanning sequence and will show proper indication following selection and operation of the control point.

   c. Conduct a series of communication tests showing all message protocols and formats for which the equipment is designed to respond demonstrating proper function of error detection and error correction, and that the equipment does not respond to erroneous commands.

   d. Demonstrate uploading and downloading of PLC program and memory registers.

   e. Conduct other tests determined to be necessary by the Engineer.

F. System Factory Acceptance Test

1. The System Factory Acceptance Test includes, but is not limited to, the tests described in the following subsections.

   a. Test each hardware component individually.

   b. Verify inventory, model numbers and serial numbers.

   c. Run standard hardware diagnostic programs, plus all special diagnostic programs used by the Contractor to demonstrate that the hardware development is complete.

   d. Test include, but are not limited to, the following:

      1) Verify the correct functional operation of hardware and software.

      2) Verify scanning and data acquisition of all data points from the PLCs.

      3) Verify control operations to ensure that they result in the correct communication protocol and operation.

      4) Test operator interface functions.

      5) Verify on line programming of the PLCs.

      6) Verify the operation of historical data storage, displays, and trends.

      7) Test the behavior of the System in various failure modes, including I/O point failure, I/O module failure, communication channel failure, and peripheral and hardware component failures. Switch power off and on to hardware components. Reboot computers.

      8) Demonstrate that the spare capacity and expansion requirements have been met.

      9) Test on line display generation and modification functions.

      10) Test on line database editing functions.

      11) Verify that the System meets all the performance requirements, under simulated loading.

      12) Test custom software written specifically for this project.

      13) Perform backup and reload of operating system, SCADA software, historical data, and applications.

14) Test control strategy generation.

15)

16) Demonstrate the modification of logs, displays and database.

17) Test alarm conditions for analog and discrete points.

18) Conduct other tests as instructed by the Engineer.

3.03 Adjusting / Cleaning / Protection

A. Correction of Deficiencies

1. Document all discrepancies found during the Factory Acceptance Test and maintain in a record file. Describe subsequent corrections. The Owner/Engineer will verify proper operation.
2. Faulty or incorrect operation of major functions (i.e., major discrepancies) may be cause for suspension or restarting of the entire test, pending the correction of the problem. Minor discrepancies noted may be corrected and retested.
3. The system will not be shipped until the successful completion of the FAT certified by the Owner/Engineer. Delay in shipment of the system due to failure to pass FAT will not be considered an unavoidable delay and justification for later delivery.
4. System performance testing will not be started until approved by the Owner/Engineer

****END OF SECTION****

SECTION 17510
FACTORY ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 Summary

A. Scope: This section describes the minimum requirements for Factory Acceptance Test (FAT).

B. Conduct a formal FAT prior to shipment of equipment to the project site. The purpose of the FAT is to verify compliance with the design specifications and correct deficiencies at the Contractor's facility to prevent extensive field tests.

C. The Contractor shall prepare a FAT Plan (FATP) for review and approval by the Engineer prior to scheduling the FAT. The Contractor shall dry run all tests prior to the FAT to expedite the process. All costs including test equipment, hardware and software of the FAT shall be included in the Contractor's original bid price.

D. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01620	Protection of Materials and Equipment
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 11010	General Requirements for Equipment
Section 11060	Electric Motors
Section 16010	General Electrical Provisions
Section 16011	Protective Device Coordination Study and Arc Flash Analysis
Section 16120	Wire and Cables, 600 Volts and Below
Section 16130	Wiring Devices
Section 16155	Motor Starters
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16300	Electrical Service Equipment

Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 16330	Variable Frequency Drives
Section 16450	Grounding
Section 17010	General Requirements, Instrumentation
Section 17110	Instrumentation and Control Systems
Section 17201	Control Panels
Section 17512	Site Acceptance Tests
Section 17902	SCADA System Modifications
Section 17924	Control Strategies

1.02 System Description

A. The purpose of this test is to qualify each system, insofar as practical, as having met the functional, performance, and interface requirements. Verify the performance and functional integrity of the individual subsystems, including active interfaces between subsystems, and demonstrate the operation of the subsystems on an integrated system basis.

B. Supervise and assist in the tests. The Owner/Engineer shall be notified to actively participate in the tests.

C. Application software developed by the Plant Control System Integrator, including graphic displays, reports, control logic, database points will be installed on the system during FAT. The Plant Control System Integrator may add, modify and delete application software during testing to simulate normal operating conditions.

D. The Owner/Engineer reserves the right to test any specified function, whether or not explicitly stated in the test submittal.

E. Provide knowledgeable personnel capable of explaining procedures and test results to the understanding and satisfaction of the Owner/Engineer.

F. Meet the following criteria prior to the start of the tests:

1. Complete submittals and resolve disputes.
2. Have approved test procedure.
3. Set a test date that is agreeable to all.

1.03 Submittals

A. Test Plan Submittals

1. Prepare and submit FAT procedures to the Owner/Engineer for approval at least thirty (30) days prior to the scheduled test date.
2. Notify the Owner/Engineer at least fifteen (15) days prior to the scheduled start of the FAT. All Control Panels and SCADA equipment shall be, in the opinion of the Contractor, ready for the formal FAT prior to scheduling.
3. Submit dry run test results at least three (3) days prior to the scheduled start of the FAT.
4. Submit completed FAT procedures document with signatures, dates, test results, and notes.
   a. Factory Acceptance Test Procedures Document shall:

1) Include individual ID number, name, description and date of each test,
2) List the logical step by step procedure with expected response at each step and provide space for recording results,
3) Provide space for approval for each test,
4) Provide space for hand written comments,
5) Include checkpoints at critical points in logic,
6) Provide minimal reference to other documents,
7) Be written such that OWNER personnel can use it during site testing,
8) And describe steps necessary to simulate inputs required by the test.

b. Include the following in the FAT submittal:
1) Location of FAT,
2) FAT procedures,
3) A schedule of daily activities indicating that the FAT will be completed in the allotted time,
4) Configuration, cabling and wiring diagrams locating and identifying all equipment used for the test,
5) A hardware inventory including manufacturers, model numbers, serial numbers, and item descriptions,
6) A software inventory organized by computer on which it is installed including Contractor's names, software name and version, and
7) A list of documentation that will be on hand during testing including manufacturers' or Contractor's names, document descriptions and document numbers.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 Installation

A. Authorization to Ship
1. The Owner/Engineer will issue the Authorization to Ship (ATS) after successful completion of the FAT, and resolution of deficiencies. The ATS will list all known system deficiencies, and what modifications are required to allow shipment.
2. The Contractor shall agree to the conditions and schedule in the ATS and acknowledge this agreement with an authorized signature before the ATS will be issued.
3. No equipment will be accepted at the Owner's sites until an ATS has been issued.

B. Owner/Engineer Involvement
1. The Owner/Engineer shall witness all testing activities.

C. Expenses
1. Pay costs for (3) representatives from the Owner and (3) representatives from the Engineer to attend each test and retest if a test fails. Provide the following:

a. Meals

D. Testing Aids and Equipment

1. Provide the following documentation:

a. One copy of submittals applicable to the equipment to be tested.

b. One copy of the Drawings and Specifications together with addenda and change orders.

c. One master copy of the test procedure.

d. A complete inventory of the equipment to be tested and any special test equipment including make, model and serial number.

2. Provide the following support facilities:

a. Meeting room access

b. Copy machine access

c. Telephone for local and long distance service

d. FAX machine access

3. Provide the following test equipment:

a. Off line diagnostic and test programs.

b. Maintenance and test equipment including, but not limited to, serial data analyzer, electrician tool set, electrical continuity tester, analog loop amp meter.

E. Retest

1. If a test, or portion of a test, defined in the FAT procedures fails and needs to be rescheduled, pay expenses of Owner/Engineer personnel for retesting.

3.02 Field Quality Control

A. Conduct the FAT in accordance with plan and procedures documented in the submittal for this section.

B. Testing shall be conducted Monday through Friday for no more than 8 hours per day. Testing at other times requires the approval of the Owner/Engineer.

C. Provide simulation of the PLC network to duplicate loading to the SCADA system.

D. Programmable Logic Controller (PLC) Testing

1. Connect all PLCs to the SCADA system.

2. Download Vendor, Plant Control System Integrator supplied control strategies and execute. Test functionality and performance of all strategies.

3. Provide hardware and software required for simultaneously simulating all the inputs/outputs.

4. Perform the following functional tests:

a. Demonstrate proper operation of I/Os.

b. Demonstrate that analog points are within the specified accuracy when the inputs/outputs are at 25, 50, 75, and 100 percent of full scale. Demonstrate proper operation of analog inputs with the required signal levels.

c. Test operation under power failure conditions.

d. Demonstrate that the control strategies are functioning as specified.

e. Conduct other tests as required and directed by the Engineer.

E. Communication Test

1. Test the following communication functions from SCADA workstations to the Plant PLCs:

   a. Demonstrate operation of the control strategies from each workstation.

   b. Demonstrate that a control operation will override the normal scanning sequence and will show proper indication following selection and operation of the control point.

   c. Conduct a series of communication tests showing all message protocols and formats for which the equipment is designed to respond demonstrating proper function of error detection and error correction, and that the equipment does not respond to erroneous commands.

   d. Demonstrate uploading and downloading of PLC program and memory registers.

   e. Conduct other tests determined to be necessary by the Engineer.

F. System Factory Acceptance Test

1. The System Factory Acceptance Test includes, but is not limited to, the tests described in the following subsections.

   a. Test each hardware component individually.

   b. Verify inventory, model numbers and serial numbers.

   c. Run standard hardware diagnostic programs, plus all special diagnostic programs used by the Contractor to demonstrate that the hardware development is complete.

   d. Test include, but are not limited to, the following:

      1) Verify the correct functional operation of hardware and software.

      2) Verify scanning and data acquisition of all data points from the PLCs.

      3) Verify control operations to ensure that they result in the correct communication protocol and operation.

      4) Test operator interface functions.

      5) Verify on line programming of the PLCs.

      6) Verify the operation of historical data storage, displays, and trends.

      7) Test the behavior of the System in various failure modes, including I/O point failure, I/O module failure, communication channel failure, and peripheral and hardware component failures. Switch power off and on to hardware components. Reboot computers.

      8) Demonstrate that the spare capacity and expansion requirements have been met.

      9) Test on line display generation and modification functions.

      10) Test on line database editing functions.

      11) Verify that the System meets all the performance requirements, under simulated loading.

      12) Test custom software written specifically for this project.

      13) Perform backup and reload of operating system, SCADA software, historical data, and applications.

14) Test control strategy generation.

15)

16) Demonstrate the modification of logs, displays and database.

17) Test alarm conditions for analog and discrete points.

18) Conduct other tests as instructed by the Engineer.

3.03 Adjusting / Cleaning / Protection

A. Correction of Deficiencies

1. Document all discrepancies found during the Factory Acceptance Test and maintain in a record file. Describe subsequent corrections. The Owner/Engineer will verify proper operation.
2. Faulty or incorrect operation of major functions (i.e., major discrepancies) may be cause for suspension or restarting of the entire test, pending the correction of the problem. Minor discrepancies noted may be corrected and retested.
3. The system will not be shipped until the successful completion of the FAT certified by the Owner/Engineer. Delay in shipment of the system due to failure to pass FAT will not be considered an unavoidable delay and justification for later delivery.
4. System performance testing will not be started until approved by the Owner/Engineer

****END OF SECTION****

SECTION 17924
CONTROL STRATEGIES

PART 1 - GENERAL

1.01 Summary

A. Scope: This section provides functional descriptions of the PLC and SCADA computer software requirements for the Plant PLC based control system as indicated on the drawings and as described within.

B. Related Sections: The following list of related sections is provided for the convenience of the Contractor. It includes the commonly referenced sections that are in-general applicable to all equipment supplied. This list does not excuse the Contractor from any requirement given in sections not specifically listed below. Where there is a difference between this specification and any other specifications the conflict shall be resolved at the sole discretion of the Engineer.

Section	Title
Section 01300	Submittals
Section 01360	Operating and Maintenance Information
Section 01600	Material and Equipment Substitution
Section 01660	Testing and Startup
Section 01661	Instruction of Operations and Maintenance Personnel
Section 01720	Record Drawings
Section 11010	General Requirements for Equipment
Section 11050	Equipment Mounting
Section 11060	Electric Motors
Section 11345	Chemical Metering Pumps
Section 11800	Arsenic Filter System
Section 11810	In-Line Blender
Section 11820	Flow Meters
Section 16010	General Electrical Provisions
Section 16120	Wire and Cables, 600 Volts and Below
Section 16130	Wiring Devices
Section 16160	Pilot Devices
Section 16200	Overcurrent Protective Devices
Section 16250	Motor Control Center
Section 16261	Automatic Transfer Switch
Section 16320	Surge Protective Devices
Section 16324	Uninterruptible Power Supply
Section 17110	Instrumentation and Control Systems

Section 17201	Control Panels
Section 17506	Extended Warranty and Maintenance
Section 17510	Factory Acceptance Tests
Section 17512	Site Acceptance Tests

1.02 References

A. General: Instrumentation work, including connection to instrumentation and electrical equipment integral with mechanical equipment described elsewhere in these specifications, shall be performed in accordance with the latest published regulations of the following codes and standards.

Reference	Title
ANSI	American National Standard Institute
ASTM	American Society of Testing and Materials
ASME	American Society of Mechanical Engineers
IEEE	Institute of Electrical and Electronic Engineers
ISA	Instrument Society of America
JIC	Joint Industrial Council
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Administration
SAMA	Scientific Apparatus Makers Association
UL	Underwriter's Laboratories, Inc.
NPFA 70	National Electrical Code
NEMA ICS 1	General Standards for Industrial Control and Systems
NEMA ICS 1.1	Safety Guidelines for the Application, Installation, and Maintenance of Solid Station Control
NEMA/EIA 232-D	Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 Preparation

A. PLC and Operator Interface Terminal Strategies – General

1. Any software modifications to the City's existing SCADA system will be performed by City's Representative. Contractor shall coordinate with the City's Representative to demonstrate that the new control panel PLCs can communicate with the City's existing SCADA system via the expansion of the existing Ethernet network.

2. At each project site, the processes controlled by the new Control Panel PCP (i.e PCP 22 at Well 22 and PCP 26 at Well 26) shall be provided with both manual control of the various Well System PLC controlled systems and automatic control of the Well System PLC controlled systems.
3. At each project site, the packaged filter system PLC shall communicate with the new Control Panel PCP PLC via a network connection between the two PLCs. The network shall allow for the free exchange of information, control and alarms without the use of any external hard wiring input or output PLC modules.

B. SCADA System Control Strategies

1. The SCADA system is an existing City system that will monitor and control operations associated with the new PLCs provided under this contract and as define herein. The System Integrator will be responsible for providing the necessary PLC software program routines and hardware to allow the City's SCADA system to communicate with the PLCs. Any modifications to the existing SCADA system software will be provided by the City's representative.

3.02 Installation

A. Basic Operating Control Strategies

1. General: The following "Control Strategy" descriptions define the key features associated with the new process operations at Well 22 and Well 26. These control strategies provide the system integrator with an overview of the operation parameters that will be expected in each area. The system integrator will develop the PCP22 PLC,PCP 22 OIT, PCP 26 PLC and PCP 26 OIT programs for each of the PLCs based on the operating strategies described below, and in keeping with the basic function described below.
2. Motor: Where the P&IDs define that a motor load is controlled by a PLC, all of the status and alarm functions shall be available for display on SCADA and the OIT. Both a PLC automatic based control strategy and a manual overall control via the OIT or SCADA shall be provided for each motor. All set points shall be accessible and modifiable via the OIT and SCADA.
3. Valve: Where the P&IDs define that a valve is controlled by a PLC, all of the status and alarm functions shall be available for display on SCADA. Both a PLC automatic based control strategy and a manual overall control via the OIT and SCADA will be provided for each valve. All set points shall be accessible and modifiable via the OIT and SCADA.
4. Packaged System, Type 1: Where the P&IDs define that a package system equipped with a PLC, then PLC software routines shall be provided that will allow existing SCADA system to monitor all of the status, control and alarm functions that are accessible by the Packaged System's Operator Interface Terminal. These package systems include:
   a. Arsenic Filter System
5. Packaged System, Type 2: Where the P&IDs define that a package system that does not utilize a PLC or has limited functions that are monitored by the Control Panel, then there are no provision for future SCADA interface. These package systems include:
   a. Air Compressor
6. Instrumentation:
   a. Where the P&IDs define that an instrumentation device is monitored by a PLC, all status and alarm functions shall be displayed on the OIT and available for SCADA.
   b. All instrumentation having an analog value shall have a PLC based High-High, High, Low, and Low-Low alarms that can be monitored by the OIT and available to SCADA. Each

alarm shall have a PLC-based set point that can be adjusted via the OIT or SCADA. Each alarm shall have a means to be enabled or disabled via the OIT or SCADA.

B. Control Strategy – General

1. The Control Strategies listed below define the requirements for the PCP 22 PLC program, PCP 22 OIT program, PCP 26 PLC program and the PCP 26 OIT Program. Unless otherwise noted, the control strategies apply to control systems for both well 22 and well 26.
2. Based on these control strategies, the System Integrator shall develop a set of OIT screens that will meet the requirements of the Control Strategies and include these screens as part of the submittals. The City and Engineer shall review the screens as part of the submittal process.

C. Control Strategy – Well Pump 22

1. The Well Pump 22 system consists of a constant speed operated well pump, deep well control valve, pressure switches, flow meter and level based control via a remote storage tank.
2. Plant #1 Storage Tank Level: The level in a remote storage tank designated as Plant #1 Reservoir is used to control the on/off operation of Well Pump 22. A start/stop command from the Plant #1 PLC (via telemetry) will control the automatic operation of Well Pump 22,
3. Deep Well Control Valve:
   a. The Deep Well Control Valve is normally in the open position.
   b. The well pump motor starter controls will control the closing of the valve during pumping operations.
   c. The Deep Well Control Valve will include a solenoid operator that must be energized for the valve to be closed. The solenoid operator will be controlled by a time delay relay (user adjustable) that is energized when the pump motor starter is energized to run the pump.
   d. Two limit switches shall be provided to indicate when the well is in the full open position and the full closed position that will be monitored by the PCP 22 PLC and their status shall be displayed at SCADA and on the PCP 22 OIT.
4. Pressure Switches:
   a. The well pump discharge will be equipped with two pressure switches – high pressure alarm and low pressure alarm.
   b. The high pressure switch will provide alarm status and is interlocked into well pump controls. When a high pressure event occurs, the well pump will immediately stop. The high pressure switch will be monitored by the PCP 22 PLC and its status shall be displayed at SCADA and on the PCP22 OIT.
   c. The low pressure switch will provide alarm status only and is not interlocked into the well pump controls. The low pressure switch will be monitored by the PCP 22 PLC and its status shall be displayed at SCADA and on the PCP22 OIT.
5. Well Pump Operation: The Well Pump is equipped with a solid state reduced voltage starter that will allow the pump to run at full speed when activated. The solid state starter shall be equipped with a pump control feature to minimize pipeline surges.
   a. The well pump is equipped with a reduced voltage solid state starter to allow on/off operation of the pump and to minimum pipeline surges.
      1) Selector Switch – Hand/Off/Automatic: At the motor control center, plant personnel can select between Hand-Off-Automatic Operation via a selector switch.

a) When the selector switch is in the Hand Position, the pump will run at full speed.

b) When the selector switch is set in the Off Position, the pump will not run and is not available for automatic operation, manual operation, or level switch override operation.

c) When the selector switch is set in the Automatic Position, the pump is controlled by the PCP 22 PLC and the PCP 22 OIT.

2) Automatic Control: When the selector Switch is in the Automatic Position, the well pump will start and stop based on start/stop commands issued from the Plant #1 PLC via the telemetry radio link with PCP22 PLC or based on a start/stop command issued by the Filter Control Panel PLC for backwashing purposes.

b. Pump Alarm: Provide three separate alarms for the pump – Pump Failure to Start, Pump RVSS Failure, and Well Pump High Discharge. When any of these Pump Failure Alarms is issued from the motor control center to the PCP 22 PLC, a corresponding pump failure alarm will be generated for SCADA and at the PCP 22 OIT. In the event of this alarm, a remote alarm reset can be implemented from either SCADA or the PCP 22 OIT.

1) Pump Failure to Start:

a) If the PCP 22 PLC issues a command to start a pump and after a time delay, pump running contact fails to close then a failure to start alarm is issued to the OIT and SCADA.

b) Remote Reset to Pump RVSS, fails to allow pump start.

c) Remote Reset to either Pump High Temperature fails to allow pump to start.

2) Pump RVSS Failure: If the pump failure alarm is from the reduced voltage starter, then an alarm is sent to SCADA and the PCP 22 OIT. To reset the alarm, the operator will have to acknowledge the alarm at the motor control center and then cycle power at the RVSS.

3) .Well Pump High Discharge Pressure: When this alarm occurs, an alarm is sent to SCADA and the PCP 22 OIT.

c. Pump Running Status: The PCP 22 PLC shall provide SCADA and the PCP 22 OIT with the following information:

1) Daily Runtime for a 24-hour period

2) Total Runtime

3) Average Daily Runtime

4) Number of Pump Starts issue per day.

6. Control Panel PCP 22 Operator Interface Terminal

a. The following commands shall be provided:

1) None required.

b. The following set points shall be provided (adjustable by the operator):

1) All timer setpoints required for well pump control.

c. The following status points shall be provided:

1) Well Pump 22 in Hand

2) Well Pump 22 in Automatic

3) Well Pump 22 Not Available (OFF)
4) Well Pump 22 Running
5) Deep Well Control Valve Open
6) Deep Well Control Valve Closed.

d. The following alarms shall be provided:
1) Well Pump 22 Failure
2) Well 22 Discharge Pressure – High Alarm
3) Well 22 Discharge Pressure – Low Alarm
4) Deep Well Control Valve Failure to Close
5) Deep Well Control Valve Failure to Open

D. Control Strategy – Well Pump 26

1. The Well Pump 26 system consists of a variable speed control well pump with a bypass option to operate it as a constant speed well pump, deep well control valve, pressure switches, flow meter and pressure based control via a pressure transmitter..
2. Deep Well Control Valve:
   a. The Deep Well Control Valve is normally in the open position.
   b. The well pump motor VFD/starter controls will control the closing of the valve during pumping operations.
   c. The Deep Well Control Valve will include a solenoid operator that must be energized for the valve to be closed. The solenoid operator will be controlled by a time delay relay (user adjustable) that is energized when the pump motor starter is energized to run the pump. The Deep Well Control Valve will be open when Well Pump 26 is called to run. After the time delay relay times out, the Deep Well Control Valve will be energized to the closed position.
   d. Two limit switches shall be provided to indicate when the well is in the full open position and the full closed position that will be monitored by the PCP 26 PLC and their status shall be displayed at SCADA and on the PCP26 OIT.
3. Pressure Switches:
   a. The well pump discharge will be equipped with two pressure switches – high pressure alarm and low pressure alarm.
   b. The high pressure switch will provide alarm status (if the high pressure switch is made for 15 seconds) and is interlocked into well pump controls. When a high pressure event occurs (i.e. the high pressure switch is made for 15 seconds) , the well pump will immediately stop. The high pressure switch will be monitored by the PCP 26 PLC and its status shall be displayed at SCADA and on the PCP26 OIT.
   c. The low pressure switch will provide alarm status only and is not interlocked into the well pump controls. The low pressure switch will be monitored by the PCP 26 PLC and its status shall be displayed at SCADA and on the PCP26 OIT.
4. Well Pump Operation: The Well Pump is equipped with a variable frequency drive (VFD) that will allow the pump to run at variable speed when activated. The variable frequency drive will vary pump speed in a manner to maintain the pressure setpoint while minimizing pipeline

surges. The Well Pump will also have a bypass across-the-line starter that will allow the well pump to operate at full speed.

a. The well pump is equipped with a VFD to allow variable speed operation and a bypass across-the-line starter to allow on/off operation of the pump:

   1) Selector Switch – VFD/Bypass: At the motor control center, plant personel can select between VFD-Bypass Operation via a selector switch.

      a) When the selector switch is in the VFD position, the pump will run at variable speed control.

      b) When the selector switch is in the Bypass position, the pump will run at full speed.

   2) Selector Switch – Hand/Off/Automatic: At the motor control center, plant personnel can select between Hand-Off-Automatic Operation via a selector switch.

      a) When the selector switch is in the Hand Position, the pump will run at either variable speed or full speed depending on the position of the VFD/Bypass Selector Switch.

      b) When the selector switch is set in the Off Position, the pump will not run and is not available for automatic operation or manual operation.

      c) When the selector switch is set in the Automatic Position, the pump is controlled by the PCP26 PLC and the PCP26 OIT

   3) Automatic Control: When the selector Switch is in the Automatic Position, the well pump will start and stop based on one of the following:

      a) VFD Operation: When VFD Operation is selected, the VFD will vary the pump speed to maintain a pressure setpoint. A pressure transmitter located downstream of the Arsenic Filter system denoted as PT 300 and referred to as the System Distribution Pressure will serve as the process variable.

      b) .Full Speed Operation When Bypass Operation is selected the Well pump will operate at full speed only and will start and stop based on a set of pressure setpoints that are based on the System Distribution Pressure (PT 300)

         (i) Provide an alarm to the OIT and to SCADA when the maximum number of pump starts per hour is exceeded.

      c) Backwash Operation: When the Filter requires backwashing, the Well pump will start and stop as required for backwashing purposes. If the Well Pump is set for VFD operation, run the VFD based on a Backwash Filter Speed set point from the Filter Control Panel PLC. If the Well pump is set for Full Speed Operation, start/stop the well pump based on Filter backwashing.

b. Pump Alarm: Provide three separate alarms for the pump – Pump Failure to Start, Pump VFD Failure, and Well Pump High Discharge. When any of these Pump Failure Alarms is issued from the motor control center to the PLC, a corresponding pump failure alarm will be generated for SCADA and at the OIT. In the event of this alarm, a remote alarm reset can be implemented from either SCADA or the OIT.

   1) Pump Failure to Start:

      a) If the PLC issues a command to start a pump and after a time delay, pump running contact fails to close then a failure to start alarm is issued to the OIT and SCADA.

      b) Remote Reset to Pump RVSS, fails to allow pump start.

      c) Remote Reset to either Pump High Temperature fails to allow pump to start.

2) Pump VFD Failure: If the pump failure alarm is from the VFD, then an alarm is sent to SCADA and the OIT. To reset the alarm, the operator will have to acknowledge the alarm at the motor control center and then cycle power at the RVSS.

3) .Well Pump High Discharge Pressure: When this alarm occurs, an alarm is sent to SCADA and the OIT.

c. Pump Running Status: The PLC shall provide SCADA and the OIT with the following information:

1) VFD Operation, Daily Runtime for a 24-hour period

2) VFD Operation, Total Runtime

3) VFD Operation, Average Daily Runtime

4) VFD Operation, Number of Pump Starts issue per day.

5) Bypass Operation, Daily Runtime for a 24-hour period

6) Bypass Operation, Total Runtime

7) Bypass Operation, Average Daily Runtime

8) Bypass Operation, Number of Pump Starts issue per day

5. Control Panel Operator Interface Terminal

a. The following commands shall be provided:

1) None required.

b. The following set points shall be provided (adjustable by the operator):

1) VFD Operation – Pressure Setpoint to Start Pump

2) VFD Operation – Pressure Setpoint to Stop Pump

3) VFD Operation – Pressure Setpoint for VFD Continuous Operation

4) VFD Operation – PID Tuning Constant for Gain (Proportional)

5) VFD Operation – PID Tuning Constant for Reset (Integral)

6) VFD Operation – PID Tuning Constant for Rate (Derivative)

7) All Timer functions necessary for control.

8) Bypass Operation – Pressure Set point to Start Pump

9) Bypass Operation - Pressure Set point to Stop Pump

10) Bypass Operation - Maximum number of Pump Starts per Hour

c. The following status points shall be provided:

1) Well Pump 26 in VFD Mode

2) Well Pump 26 in Bypass Mode

3) Well Pump 26 in Hand

4) Well Pump 26 in Automatic

5) Well Pump 26 Not Available (OFF)

6) Well Pump 26 Running on VFD

7) Well Pump 26 Running on Bypass

8) Deep Well Control Valve Open
9) Deep Well Control Valve Closed.

d. The following alarms shall be provided:
1) Well 26 VFD Failure
2) Well 26 Pump fail to start
3) Well 22 Discharge Pressure – High Alarm
4) Well 22 Discharge Pressure – Low Alarm
5) Deep Well Control Valve Failure to Close
6) Deep Well Control Valve Failure to Open

E. Control Strategy – Well Pump 22 Flow Meter

1. Function: A turbine flow meter will monitor the discharge flow from Well Pump 22. The flow meter is hardwired to an analog input point in the filter control panel and flow meter data is provided to the PCP22 PLC via the network connection. This flow signal is for monitoring purposes only and not involved in the control operations of Well Pump 22. This flow signal will provide the following data and alarms that will be available via SCADA or via the PCP 22 OIT:
a. Discharge Flow
b. High-High Discharge Flow Alarm
c. High Discharge Flow Alarm
d. Low Discharge Flow Alarm
e. Low-Low Discharge Flow Alarm

2. Control Panel Operator Interface Terminal
a. The following commands shall be provided:
1) None required.
b. The following set points shall be provided (adjustable by the operator):
1) Well 22 High-High Discharge Flow Alarm
2) Well 22 High Discharge Flow Alarm
3) Well 22 Low Discharge Flow Alarm
4) Well 22 Low-Low Discharge Flow Alarm
c. The following status points shall be provided:
1) Well Pump 22 Discharge Flow
d. The following alarms shall be provided:
1) Well 22 High-High Discharge Flow Alarm
2) Well 22 High Discharge Flow Alarm
3) Well 22 Low Discharge Flow Alarm
4) Well 22 Low-Low Discharge Flow Alarm

F. Control Strategy – Well Pump 26 Flow Meter

1. Function: A turbine flow meter will monitor the discharge flow from Well Pump 26. This flow signal is not involved in the control operations of Well Pump 26 but does provide the flow pacing signal for the chemical feed systems. This flow signal will provide the following data and alarms that will be available via SCADA or via the PCP 26 OIT:
    a. Discharge Flow
    b. High-High Discharge Flow Alarm
    c. High Discharge Flow Alarm
    d. Low Discharge Flow Alarm
    e. Low-Low Discharge Flow Alarm
2. Control Panel Operator Interface Terminal
    a. The following commands shall be provided:
        1) None required.
    b. The following set points shall be provided (adjustable by the operator):
        1) Well 26 High-High Discharge Flow Alarm
        2) Well 26 High Discharge Flow Alarm
        3) Well 26 Low Discharge Flow Alarm
        4) Well 26 Low-Low Discharge Flow Alarm
    c. The following status points shall be provided:
        1) Well Pump 26 Discharge Flow
    d. The following alarms shall be provided:
        1) Well 26 High-High Discharge Flow Alarm
        2) Well 26 High Discharge Flow Alarm
        3) Well 26 Low Discharge Flow Alarm
        4) Well 26 Low-Low Discharge Flow Alarm

G. Control Strategy – Sulfuric Acid Chemical Feed System (Typical for Well 22 and for Well 26)

1. The Sulfuric Acid Chemical Feed System consists of a Sulfuric Acid Storage Tank, ultrasonic level transmitter, two Sulfuric Acid pumps and a packaged chemical feed system control panel.
2. Chemical Feed Control Panel – The packaged chemical feed system control panel will be provided the chemical feed system supplier. The Control Panel will provide power for each chemical feed pump and all wiring from the chemical feed pumps will terminate in the Packaged Chemical Feed Control Panel. All wiring from Control Panel PCP 22 will terminate in the packaged chemical feed system control panel:
    a. The following control components will be mounted on the outer door of the Packaged Control Panel:
        1) Chemical Feed Pump 1 – Hand-Off Automatic Selector Switch
        2) Chemical Feed Pump 1 – Speed Controller
        3) Chemical Feed Pump 1 – Alarm Pilot Light
        4) Chemical Feed Pump 2 – Hand-Off Automatic Selector Switch
        5) Chemical Feed Pump 2 – Speed Controller

6) Chemical Feed Pump 2 – Alarm Pilot Light

b. The following control signals will be provided from the Packaged Filter Control Panel to the Chemical Feed Pumps:

1) Speed Control of the Chemical Feed Pump 1
2) Chemical Feed Pump 1 Speed Feed Back
3) Chemical Feed Pump 1 Alarm
4) Speed Control of the Chemical Feed Pump 2
5) Chemical Feed Pump 2 Speed Feed Back
6) Chemical Feed Pump 2 Alarm

c. The following control signals will be provided from the Packaged Filter Control Panel to Control Panel PCP22 PLC:

1) Remote Speed Control of Chemical Feed Pump 1 (PLC Analog Output)
2) Remote Enable Control of Chemical Feed Pump 1 (PLC Discrete Output)
3) Chemical Feed Pump 1 Speed Feed Back (PLC Analog Input)
4) Chemical Feed Pump 1 Run Status (PLC Discrete Input)
5) Chemical Feed Pump 1 Alarm Status (PLC Discrete Input)
6) Chemical Feed Pump 1 Remote Control Status (PLC Discrete Input)
7) Remote Speed Control of Chemical Feed Pump 2 (PLC Analog Output)
8) Remote Enable Control of Chemical Feed Pump 2 (PLC Discrete Output)
9) Chemical Feed Pump 2 Speed Feed Back (PLC Analog Input)
10) Chemical Feed Pump 2 Run Status (PLC Discrete Input)
11) Chemical Feed Pump 2 Alarm Status (PLC Discrete Input)
12) Chemical Feed Pump 2 Remote Control Status (PLC Discrete Input)

3. Sulfuric Acid Storage Tank – The Sulfuric Acid Storage Tank level is monitored by the Control Panel PCP22 PLC. The Sulfuric Acid Storage Tank level will have operator adjustable set points for low-low level alarm, low alarm, high alarm and high-high alarm. If any of these alarms are activated they shall be displayed on the Control Panel PCP22 Operator Interface Terminal and shall be available for SCADA.

4. The two Sulfuric Acid feed pumps shall operate in a lead-standby alternating manner. When the Filter Run signal is activated from the Filter Control Panel, then the lead Sulfuric Acid pump will start, when the Filter Run signal is deactivated from the Filter Control Panel, then the lead Sulfuric Acid pump will stop and the lead pump will then be designated the standby pump. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manual designate which Sulfuric Acid pump is the lead pump.

5. If the lead pump fails then the standby pump will automatically start in its place.

6. Chemical Feed Pump Control Modes: The chemical feed pump shall have the following control modes that are selectable from the Operator Interface Terminal or from SCADA:

a. Manual Speed Control

1) When this control mode is selected, the chemical feed pump will run at a speed setting entered by the plant staff. The speed setting will be entered at the Operator Interface Panel or from SCADA.

2) The speed control range for the pump will be 0 to 100% speed.

b. Flow Pacing Dosing Control

1) When this control mode is selected, the chemical feed pump will run at a variable speed rate that delivers a constant feed rate proportional to well discharge flow.

2) The constant feed rate range shall be 0 to 10 mg/l. Note that the feed rate shall take into account the concentration strength of the chemical solution.

c. Automatic pH Control:

1) When this control mode is selected, the chemical feed pump will run at a variable speed rate to maintain a pH setpoint.

2) Provide PLC based Feed Forward/PID control for the chemical feed pump

3) The Chlorine Residual/pH Analyzer will provide the pH value as the process variable.

4) The Well Discharge Flow Meter will provide the flow valve as the Disturbance Value.

7. In the event that a low-low storage tank alarm occurs, an alarm shall be generated and the chemical pump will stop.

8. Control Panel PCP22 or PCP 26 Operator Interface Terminal

a. The following commands shall be provided:

1) Select automatic alternation

2) Select Sulfuric Acid pump 1 as lead

3) Select Sulfuric Acid pump 2 as lead

4) Alarm Reset

5) Select Manual Speed Control

6) Select Flow Dosing Pacing Control

7) Select Automatic pH Control

b. The following set points shall be provided (adjustable by the operator):

1) Sulfuric Acid Storage Tank High-High Level Alarm

2) Sulfuric Acid Storage Tank High Level Alarm

3) Sulfuric Acid Storage Tank Low Level Alarm

4) Sulfuric Acid Storage Tank Low-Low Level Alarm

5) Manual Mode, Speed Control: 0 to 100 %

6) Flow Pacing Dosing Control: (mg/l): 0 to 10

7) Automatic pH Control: 0 - 14

8) Automatic pH Control PID Tuning Constants

9) Sulfuric Acid Solution Concentration: 0 to 100 %

c. The following status points shall be provided:

1) Sulfuric Acid Chemical Storage Tank Level

2) Sulfuric Acid Pump 1 called to run
3) Sulfuric Acid Pump 2 called to run
4) Sulfuric Acid Pump 1 is Lead
5) Sulfuric Acid Pump 2 is Lead
6) Sulfuric Acid Pump 1 is running.
7) Sulfuric Acid Pump 2 is running.
8) Manual Speed Mode Selected
9) Flow Pacing Mode Selected
10) Automatic pH Control Mode Selected

d. The following alarms shall be provided:
1) Sulfuric Acid Storage Tank High-High Level Alarm
2) Sulfuric Acid Storage Tank High Level Alarm
3) Sulfuric Acid Storage Tank Low Level Alarm
4) Sulfuric Acid Storage Tank Low-Low Level Alarm
5) Sulfuric Acid Pump 1 has failed
6) Sulfuric Acid Pump 2 has failed

H. Control Strategy – Ferric Chloride Chemical Feed System (Typical for Well 22 and Well 26)

1. The Ferric Chloride Chemical Feed System consists of a Ferric Chloride Storage Tank, ultrasonic level transmitter, two Ferric Chloride pumps and a packaged chemical feed system control panel.
2. Chemical Feed Control Panel – The packaged chemical feed system control panel will be provided the chemical feed system supplier. The Control Panel will provide power for each chemical feed pump and all wiring from the chemical feed pumps will terminate in the Packaged Chemical Feed Control Panel. All wiring from Control Panel PCP22 will terminate in the packaged chemical feed system control panel:
a. The following control components will be mounted on the outer door of the Packaged Control Panel:
1) Chemical Feed Pump 1 – Hand-Off Automatic Selector Switch
2) Chemical Feed Pump 1 – Speed Controller
3) Chemical Feed Pump 1 – Alarm Pilot Light
4) Chemical Feed Pump 2 – Hand-Off Automatic Selector Switch
5) Chemical Feed Pump 2 – Speed Controller
6) Chemical Feed Pump 2 – Alarm Pilot Light
b. The following control signals will be provided from the Packaged Filter Control Panel to the Chemical Feed Pumps:
1) Speed Control of the Chemical Feed Pump 1
2) Chemical Feed Pump 1 Speed Feed Back
3) Chemical Feed Pump 1 Alarm

4) Speed Control of the Chemical Feed Pump 2
5) Chemical Feed Pump 2 Speed Feed Back
6) Chemical Feed Pump 2 Alarm

c. The following control signals will be provided from the Packaged Filter Control Panel to Control Panel PCP22 PLC:
1) Remote Speed Control of Chemical Feed Pump 1 (PLC Analog Output)
2) Remote Enable Control of Chemical Feed Pump 1 (PLC Discrete Output)
3) Chemical Feed Pump 1 Speed Feed Back (PLC Analog Input)
4) Chemical Feed Pump 1 Run Status (PLC Discrete Input)
5) Chemical Feed Pump 1 Alarm Status (PLC Discrete Input)
6) Chemical Feed Pump 1 Remote Control Status (PLC Discrete Input)
7) Remote Speed Control of Chemical Feed Pump 2 (PLC Analog Output)
8) Remote Enable Control of Chemical Feed Pump 2 (PLC Discrete Output)
9) Chemical Feed Pump 2 Speed Feed Back (PLC Analog Input)
10) Chemical Feed Pump 2 Run Status (PLC Discrete Input)
11) Chemical Feed Pump 2 Alarm Status (PLC Discrete Input)
12) Chemical Feed Pump 2 Remote Control Status (PLC Discrete Input)

3. Ferric Chloride Storage Tank – The Ferric Chloride Storage Tank level is monitored by the Control Panel PCP22 PLC. The Ferric Chloride Storage Tank level will have operator adjustable set points for low-low level alarm, low alarm, high alarm and high-high alarm. If any of these alarms are activated they shall be displayed on the Control Panel PCP22 Operator Interface Terminal and shall be available for SCADA.
4. The two Ferric Chloride feed pumps shall operate in a lead-standby alternating manner. When the Filter Run signal is activated from the Filter Control Panel, then the lead Ferric Chloride pump will start, when the Filter Run signal is deactivated from the Filter Control Panel, then the lead Ferric Chloride pump will stop and the lead pump will then be designated the standby pump. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manual designate which Ferric Chloride pump is the lead pump.
5. If the lead pump fails then the standby pump will automatically start in its place.
6. Chemical Feed Pump Control Modes: The chemical feed pump shall have the following control modes that are selectable from the Operator Interface Terminal or from SCADA:
   a. Manual Speed Control
      1) When this control mode is selected, the chemical feed pump will run at a speed setting entered by the plant staff. The speed setting will be entered at the Operator Interface Panel or from SCADA.
      2) The speed control range for the pump will be 0 to 100% speed.
   b. Flow Pacing Dosing Control
      1) When this control mode is selected, the chemical feed pump will run at a variable speed rate that delivers a constant feed rate proportional to well discharge flow.

2) The constant feed rate range shall be 0 to 10 mg/l. Note that the feed rate shall take into account the concentration strength of the chemical solution.

7. In the event that a low-low storage tank alarm occurs, an alarm shall be generated and the chemical pump will stop.
8. Control Panel PCP22 or PCP 26 Operator Interface Terminal
   a. The following commands shall be provided:
      1) Select automatic alternation
      2) Select Ferric Chloride pump 1 as lead
      3) Select Ferric Chloride pump 2 as lead
      4) Alarm Reset
      5) Select Manual Speed Control
      6) Select Flow Dosing Pacing Control
   b. The following set points shall be provided (adjustable by the operator):
      1) Ferric Chloride Storage Tank High-High Level Alarm
      2) Ferric Chloride Storage Tank High Level Alarm
      3) Ferric Chloride Storage Tank Low Level Alarm
      4) Ferric Chloride Storage Tank Low-Low Level Alarm
      5) Manual Mode, Speed Control: 0 to 100%
      6) Flow Pacing Dosing Control: 0 to 10 mg/l
      7) Ferric Chloride Solution Concentration: 0 to 100%
   c. The following status points shall be provided:
      1) Ferric Chloride Chemical Storage Tank Level
      2) Ferric Chloride Pump 1 called to run
      3) Ferric Chloride Pump 2 called to run
      4) Ferric Chloride Pump 1 is Lead
      5) Ferric Chloride Pump 2 is Lead
      6) Ferric Chloride Pump 1 is running.
      7) Ferric Chloride Pump 2 is running.
      8) Manual Speed Mode Selected
      9) Flow Pacing Mode Selected
   d. The following alarms shall be provided:
      1) Ferric Chloride Storage Tank High-High Level Alarm
      2) Ferric Chloride Storage Tank High Level Alarm
      3) Ferric Chloride Storage Tank Low Level Alarm
      4) Ferric Chloride Storage Tank Low-Low Level Alarm
      5) Ferric Chloride Pump 1 has failed

6) Ferric Chloride Pump 2 has failed

I. Control Strategy – Sodium Hypochlorite Chemical Feed System for Well 22

1. The Sodium Hypochlorite Chemical Feed System consists of a Sodium Hypochlorite Storage Tank, ultrasonic level transmitter, two Sodium Hypochlorite pumps and a packaged chemical feed system control panel.

2. Chemical Feed Control Panel – The packaged chemical feed system control panel will be provided the chemical feed system supplier. The Control Panel will provide power for each chemical feed pump and all wiring from the chemical feed pumps will terminate in the Packaged Chemical Feed Control Panel. All wiring from Control Panel PCP22 will terminate in the packaged chemical feed system control panel:

   a. The following control components will be mounted on the outer door of the Packaged Control Panel:

      1) Chemical Feed Pump 1 – Hand-Off Automatic Selector Switch
      2) Chemical Feed Pump 1 – Speed Controller
      3) Chemical Feed Pump 1 – Alarm Pilot Light
      4) Chemical Feed Pump 2 – Hand-Off Automatic Selector Switch
      5) Chemical Feed Pump 2 – Speed Controller
      6) Chemical Feed Pump 2 – Alarm Pilot Light

   b. The following control signals will be provided from the Packaged Filter Control Panel to the Chemical Feed Pumps:

      1) Speed Control of the Chemical Feed Pump 1
      2) Chemical Feed Pump 1 Speed Feed Back
      3) Chemical Feed Pump 1 Alarm
      4) Speed Control of the Chemical Feed Pump 2
      5) Chemical Feed Pump 2 Speed Feed Back
      6) Chemical Feed Pump 2 Alarm

   c. The following control signals will be provided from the Packaged Filter Control Panel to Control Panel PCP2 PLC:

      1) Remote Speed Control of Chemical Feed Pump 1 (PLC Analog Output)
      2) Remote Enable Control of Chemical Feed Pump 1 (PLC Discrete Output)
      3) Chemical Feed Pump 1 Speed Feed Back (PLC Analog Input)
      4) Chemical Feed Pump 1 Run Status (PLC Discrete Input)
      5) Chemical Feed Pump 1 Alarm Status (PLC Discrete Input)
      6) Chemical Feed Pump 1 Remote Control Status (PLC Discrete Input)
      7) Remote Speed Control of Chemical Feed Pump 2 (PLC Analog Output)
      8) Remote Enable Control of Chemical Feed Pump 2 (PLC Discrete Output)
      9) Chemical Feed Pump 2 Speed Feed Back (PLC Analog Input)
      10) Chemical Feed Pump 2 Run Status (PLC Discrete Input)
      11) Chemical Feed Pump 2 Alarm Status (PLC Discrete Input)

12) Chemical Feed Pump 2 Remote Control Status (PLC Discrete Input)

3. Sodium Hypochlorite Storage Tank – The Sodium Hypochlorite Storage Tank level is monitored by the Control Panel PCP22 PLC. The Sodium Hypochlorite Storage Tank level will have operator adjustable set points for low-low level alarm, low alarm, high alarm and high-high alarm. If any of these alarms are activated they shall be displayed on the Control Panel PCP22 Operator Interface Terminal and shall be available for SCADA.
4. The two Sodium Hypochlorite feed pumps shall operate in a lead-standby alternating manner. When the Filter Run signal is activated from the Filter Control Panel, then the lead Sodium Hypochlorite pump will start, when the Filter Run signal is deactivated from the Filter Control Panel, then the lead Sodium Hypochlorite pump will stop and the lead pump will then be designated the standby pump. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manual designate which Sodium Hypochlorite pump is the lead pump.
5. If the lead pump fails then the standby pump will automatically start in its place.
6. Chemical Feed Pump Control Modes: The chemical feed pump shall have the following control modes that are selectable from the Operator Interface Terminal or from SCADA:
   a. Manual Speed Control
      1) When this control mode is selected, the chemical feed pump will run at a speed setting entered by the plant staff. The speed setting will be entered at the Operator Interface Panel or from SCADA.
      2) The speed control range for the pump will be 0 to 100% speed.
   b. Flow Pacing Dosing Control
      1) When this control mode is selected, the chemical feed pump will run at a variable speed rate that delivers a constant feed rate proportional to well discharge flow.
      2) The constant feed rate range shall be 0 to 10 mg/l. Note that the feed rate shall take into account the concentration strength of the chemical solution.
   c. Automatic Residual Chlorine Control:
      1) When this control mode is selected, the chemical feed pump will run at a variable speed rate to maintain a Residual Chlorine setpoint.
      2) Provide PLC based Feed Forward/PID control for the chemical feed pump
      3) The Chlorine Residual/pH Analyzer will provide the Residual Chlorine value as the process variable.
      4) The Well Discharge Flow Meter will provide the flow valve as the Disturbance Value.
7. In the event that a low-low storage tank alarm occurs, an alarm shall be generated and the chemical pump will stop.
8. Control Panel PCP22 Operator Interface Terminal
   a. The following commands shall be provided:
      1) Select automatic alternation
      2) Select Sodium Hypochlorite pump 1 as lead
      3) Select Sodium Hypochlorite pump 2 as lead
      4) Alarm Reset

5) Select Manual Speed Control
6) Select Flow Dosing Pacing Control
7) Select Automatic pH Control

b. The following set points shall be provided (adjustable by the operator):
1) Sodium Hypochlorite Storage Tank High-High Level Alarm
2) Sodium Hypochlorite Storage Tank High Level Alarm
3) Sodium Hypochlorite Storage Tank Low Level Alarm
4) Sodium Hypochlorite Storage Tank Low-Low Level Alarm
5) Manual Mode, Speed Control: 0 to 100%
6) Flow Pacing Dosing Control: 0 to 10 mg/l
7) Automatic Residual Chlorine Control: 0.00 to 100.00 ppm
8) Automatic Control Tuning Constants
9) Sodium Hypochlorite Concentration Solution: 0 to 100%

c. The following status points shall be provided:
1) Sodium Hypochlorite Chemical Storage Tank Level
2) Sodium Hypochlorite Pump 1 called to run
3) Sodium Hypochlorite Pump 2 called to run
4) Sodium Hypochlorite Pump 1 is Lead
5) Sodium Hypochlorite Pump 2 is Lead
6) Sodium Hypochlorite Pump 1 is running.
7) Sodium Hypochlorite Pump 2 is running.
8) Manual Speed Mode Selected
9) Flow Pacing Mode Selected
10) Automatic pH Control Mode Selected

d. The following alarms shall be provided:
1) Sodium Hypochlorite Storage Tank High-High Level Alarm
2) Sodium Hypochlorite Storage Tank High Level Alarm
3) Sodium Hypochlorite Storage Tank Low Level Alarm
4) Sodium Hypochlorite Storage Tank Low-Low Level Alarm
5) Sodium Hypochlorite Pump 1 has failed
6) Sodium Hypochlorite Pump 2 has failed

J. Control Strategy – Sodium Hypochlorite Chemical Feed System for Well 26

1. The Sodium Hypochlorite Chemical Feed System consists of a Sodium Hypochlorite Storage Tank, ultrasonic level transmitter, a packaged dilution system, two Sodium Hypochlorite pumps and a packaged chemical feed system control panel.

2. Sodium Hypochlorite Dilution system: The packaged dilution system consists of a Feed Tank, Dilution Tank, Scale Platform, Dump Valve, Neat Chemical Pump, Water Valve, pressure

regulator, ball valve, overflow relay box and a dilution controller. The packaged dilution system will be provided by the chemical feed system supplier as described in section 11345. The Controller and overflow relay box will provide power and control for all of the electrical and instrumentation components provided on the Packaged Dilution Skid and all wiring from the chemical feed pumps will terminate in the Controller and the overflow relay box. All wiring from Control Panel PCP26 will terminate in the controller

a. The following control components will be mounted on the outer door of the Dilution System Controller:

   1) Operator Interface Panel that displays all control, status and alarms via a alphanumeric display and provide control via a series of preconfigured function keys.

b. The following control signals will be provided from the Dilution System Controller to Control Panel PCP26 PLC:

   1) Remaining Sodium Hypochlorite Dilute Remaining (PLC Analog Input)
   2) Remaining Sodium Hypochlorite Remaining (PLC Analog Input)
   3) Sodium Hypochlorite Dilution System Current Feed Rate (PLC Analog Input)
   4) Sodium Hypochlorite Dilution System Active (PLC Analog Input) where 4mA represents “Inactive” and 20mA represents “Active”.
   5) Sodium Hypochlorite Dilution System Alarm Status (PLC Discrete Input)

3. Chemical Feed Control Panel – The packaged chemical feed system control panel will be provided the chemical feed system supplier. The Control Panel will provide power for each chemical feed pump and all wiring from the chemical feed pumps will terminate in the Packaged Chemical Feed Control Panel. All wiring from Control Panel PCP26 will terminate in the packaged chemical feed system control panel:

   a. The following control components will be mounted on the outer door of the Packaged Control Panel:

      1) Chemical Feed Pump 1 – Hand-Off Automatic Selector Switch
      2) Chemical Feed Pump 1 – Speed Controller
      3) Chemical Feed Pump 1 – Alarm Pilot Light
      4) Chemical Feed Pump 2 – Hand-Off Automatic Selector Switch
      5) Chemical Feed Pump 2 – Speed Controller
      6) Chemical Feed Pump 2 – Alarm Pilot Light

   b. The following control signals will be provided from the Packaged Filter Control Panel to the Chemical Feed Pumps:

      1) Speed Control of the Chemical Feed Pump 1
      2) Chemical Feed Pump 1 Speed Feed Back
      3) Chemical Feed Pump 1 Alarm
      4) Speed Control of the Chemical Feed Pump 2
      5) Chemical Feed Pump 2 Speed Feed Back
      6) Chemical Feed Pump 2 Alarm

   c. The following control signals will be provided from the Packaged Filter Control Panel to Control Panel PCP26 PLC:

1) Remote Speed Control of Chemical Feed Pump 1 (PLC Analog Output)
2) Remote Enable Control of Chemical Feed Pump 1 (PLC Discrete Output)
3) Chemical Feed Pump 1 Speed Feed Back (PLC Analog Input)
4) Chemical Feed Pump 1 Run Status (PLC Discrete Input)
5) Chemical Feed Pump 1 Alarm Status (PLC Discrete Input)
6) Chemical Feed Pump 1 Remote Control Status (PLC Discrete Input)
7) Remote Speed Control of Chemical Feed Pump 2 (PLC Analog Output)
8) Remote Enable Control of Chemical Feed Pump 2 (PLC Discrete Output)
9) Chemical Feed Pump 2 Speed Feed Back (PLC Analog Input)
10) Chemical Feed Pump 2 Run Status (PLC Discrete Input)
11) Chemical Feed Pump 2 Alarm Status (PLC Discrete Input)
12) Chemical Feed Pump 2 Remote Control Status (PLC Discrete Input)

4. Sodium Hypochlorite Storage Tank – The Sodium Hypochlorite Storage Tank level is monitored by the Control Panel PCP2 PLC. The Sodium Hypochlorite Storage Tank level will have operator adjustable set points for low-low level alarm, low alarm, high alarm and high-high alarm. If any of these alarms are activated they shall be displayed on the Control Panel PCP2 Operator Interface Terminal and shall be available for SCADA.
5. The two Sodium Hypochlorite feed pumps shall operate in a lead-standby alternating manner. When the Filter Run signal is activated from the Filter Control Panel, then the lead Sodium Hypochlorite pump will start, when the Filter Run signal is deactivated from the Filter Control Panel, then the lead Sodium Hypochlorite pump will stop and the lead pump will then be designated the standby pump. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manual designate which Sodium Hypochlorite pump is the lead pump.
6. If the lead pump fails then the standby pump will automatically start in its place.
7. Chemical Feed Pump Control Modes: The chemical feed pump shall have the following control modes that are selectable from the Operator Interface Terminal or from SCADA:
   a. Manual Speed Control
      1) When this control mode is selected, the chemical feed pump will run at a speed setting entered by the plant staff. The speed setting will be entered at the Operator Interface Panel or from SCADA.
      2) The speed control range for the pump will be 0 to 100% speed.
   b. Flow Pacing Dosing Control
      1) When this control mode is selected, the chemical feed pump will run at a variable speed rate that delivers a constant feed rate proportional to well discharge flow.
      2) The constant feed rate range shall be 0 to 10 mg/l. Note that the feed rate shall take into account the concentration strength of the chemical solution.
   c. Automatic Residual Chlorine Control:
      1) When this control mode is selected, the chemical feed pump will run at a variable speed rate to maintain a Residual Chlorine setpoint.
      2) Provide PLC based Feed Forward/PID control for the chemical feed pump

3) The Chlorine Residual/pH Analyzer will provide the Residual Chlorine value as the process variable.
4) The Well Discharge Flow Meter will provide the flow valve as the Disturbance Value.

8. When the lead Sodium Hypochlorite Pump is called to run, the lead pump speed will run in a manner proportional (adjustable from the PCP26 OIT) to the well pump discharge flow.
9. In the event that a low-low storage tank alarm occurs or a failure of the dilution system occurs, an alarm shall be generated and the chemical pump will stop.
10. Control Panel PCP26 Operator Interface Terminal
    a. The following commands shall be provided:
        1) Select automatic alternation
        2) Select Sodium Hypochlorite pump 1 as lead
        3) Select Sodium Hypochlorite pump 2 as lead
        4) Alarm Reset
        5) Select Manual Speed Control
        6) Select Flow Dosing Pacing Control
        7) Select Automatic pH Control
    b. The following set points shall be provided (adjustable by the operator):
        1) Sodium Hypochlorite Storage Tank High-High Level Alarm
        2) Sodium Hypochlorite Storage Tank High Level Alarm
        3) Sodium Hypochlorite Storage Tank Low Level Alarm
        4) Sodium Hypochlorite Storage Tank Low-Low Level Alarm
        5) Manual Mode, Speed Control: 0 to 100%
        6) Flow Pacing Dosing Control: 0 to 10 mg/l
        7) Automatic Residual Chlorine Control: 0.00 to 100.00 ppm
        8) Automatic Control Tuning Constants
        9) Sodium Hypochlorite Concentration Solution: 0 to 100%
    c. The following status points shall be provided:
        1) Sodium Hypochlorite Chemical Storage Tank Level
        2) Remaining Dilute Sodium Hypochlorite Available
        3) Remaining Sodium Hypochlorite Available
        4) Dilution System – Current Feed Rate
        5) Dilution System is running
        6) Sodium Hypochlorite Pump 1 called to run
        7) Sodium Hypochlorite Pump 2 called to run
        8) Sodium Hypochlorite Pump 1 is Lead
        9) Sodium Hypochlorite Pump 2 is Lead
        10) Sodium Hypochlorite Pump 1 is running

11) Sodium Hypochlorite Pump 2 is running

12) Manual Speed Mode Selected

13) Flow Pacing Mode Selected

14) Automatic pH Control Mode Selected

d. The following alarms shall be provided:

1) Sodium Hypochlorite Storage Tank High-High Level Alarm

2) Sodium Hypochlorite Storage Tank High Level Alarm

3) Sodium Hypochlorite Storage Tank Low Level Alarm

4) Sodium Hypochlorite Storage Tank Low-Low Level Alarm

5) Sodium Hypochlorite Pump 1 has failed

6) Sodium Hypochlorite Pump 2 has failed

7) Sodium Hypochlorite Dilution System Common Failure

K. Control Strategy – Inline Blender (Typical of Well 22 and Well 26)

1. The Inline Blender is equipped with a Hand-Off-Automatic Selector Switch located in the Motor Control Center.

a. When the Selector Switch is in the Hand position, the inline blender will run continuously until the Selector Switch is placed in either the Off or Automatic position.

b. When the Selector Switch is in the Off position, the inline blender will not operate.

c. When the Selector Switch is in the Automatic position, the inline blender will start when the Filter is Filtering or when the Well Pump is Running. The Inline blender will stop when the Filter is not Filtering or when the Well Pump Stops. Provide a PCP PLC based start time delay of 0 to 999 seconds, initially set to 0 seconds. Provide a PCP PLC based stop time delay of 0 to 999 seconds, initially set to 0 seconds.

2. Control Panel PCP Operator Interface Terminal

a. The following commands shall be provided:

1) Alarm Reset.

b. The following set points shall be provided (adjustable by the operator):

1) Start Time Delay, initially set at 0 seconds.

2) Stop Time Delay, initially set to 0 seconds.

c. The following status points shall be provided:

1) Inline Blender Selector Switch in the Hand Position.

2) Inline Blender Selector Switch in the Off Position.

3) Inline Blender Selector Switch in the Automatic Position.

4) Inline Blender Running

d. The following alarms shall be provided:

1) Inline Blender Failure

L. Control Strategy – Surface Wash Booster System (Typical of Well 22 and Well 26)

1. The Surface Wash Booster Pump System consists of two Surface Wash Booster Pumps,

2. The two Surface Wash Booster Pumps shall operate in a lead-standby alternating manner. When the Filter Control Panel issues a Surface Wash Required signal then the lead Surface Wash Booster pump will start, when the Surface Wash Required signal is deactivated from the Filter Control Panel, then the lead Surface Wash Booster pump will stop and the lead pump will then be designated the standby pump. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manually designate which Surface Wash Booster Pump is the lead pump
3. Each Surface Wash Booster Pump is equipped with a Hand-Off-Automatic Selector Switch located in the Motor Control Center.
    a. When the Selector Switch is in the Hand position, the associated Surface Wash Booster Pump will run continuously until the Selector Switch is placed in either the Off or Automatic position.
    b. When the Selector Switch is in the Off position, the associated Surface Wash Booster Pump will not operate.
4. When the Selector Switch is in the Automatic position, associated Surface Wash Booster Pump will start when the Filter Control Panel issues a surface wash required signal and the pump is designated as the lead pump. The lead pump will stop when the Filter Control Panel PLC indicates that a surface wash is no longer required. Provide a PLC based start time delay of 0 to 999 seconds, initially set to 0 seconds. Provide a PLC based stop time delay of 0 to 999 seconds, initially set to 0 seconds.
    a. If the pump designated as Lead Pump fails, then the standby pump shall start and then stop when a surface wash is no longer required. Provide a PLC based start time delay of 0 to 999 seconds, initially set to 0 seconds. Provide a PLC based stop time delay of 0 to 999 seconds, initially set to 0 seconds.
5. Control Panel PCP Operator Interface Terminal
    a. The following commands shall be provided:
        1) Select automatic alternation
        2) Select Pump 1 as Lead
        3) Select Pump 2 as Lead
    b. The following set points shall be provided (adjustable by the operator):
        1) Lead pump start delay
        2) Lead pump stop delay
        3) Standby pump start delay
        4) Standby pump stop delay
    c. The following status points shall be provided:
        1) Surface Wash Pump 1 Running
        2) Surface Wash Pump 1 in Hand
        3) Surface Wash Pump 1 in Off
        4) Surface Wash Pump 1 in Automatic
        5) Surface Wash Pump 2 Running
        6) Surface Wash Pump 2 in Hand

7) Surface Wash Pump 2 in Off

8) Surface Wash Pump 2 in Automatic

d. The following alarms shall be provided:

1) Surface Wash Pump 1 Failure

2) Surface Wash Pump 2 Failure

M. Control Strategy – Arsenic Filter System (Typical of Well 22 and Well 26)

1. The Arsenic Filter System is a package system for control strategy requirements refer to Section 11050.

2. The Arsenic Filter System will consist of the Filter System, Control Panel with PLC based control and an OIT. The Filter System PLC will communicate with the PCP PLC via an Ethernet connection. The system integrator shall confirm that data transfer to and from the PCP PLC and the Filter System PLC is functioning properly:

3. The following commands shall be issue from the Filter PLC to the PCP PLC:

a. Start Surface Wash Pump

b. Stop Surface Wash Pump

c. Start Backwash Pump

d. Stop Backwash Pump

e. Start Well Pump for Backwashing

f. Stop Well Pump for Backwashing

g. Backwash VFD speed set point for Well Pump

4. The following status information shall be issued from Filter PLC to the PCP PLC.

a. Arsenic Filter Status: Filtering

b. Arsenic Filter Status: Backwash

c. Arsenic Filter Status: Surface Wash

5. The following alarms shall be issued from the Filter PLC to the PCP PLC:

a. Arsenic Filter Alarm – Filter Failure

N. Control Strategy – Backwash Recycle System (Typical of Well 22 and Well 26)

1. The Backwash Recycle System consists of a Filter Backwash Return Flow Meter, Backwash Tank, and two Backwash Recycle Pumps. The Backwash Recycle Pumps will pump water from the Backwash Tank to a point upstream of the inline blender to allow the water to be processed by the Arsenic Filter System.

2. The Filter Backwash Return Flow Meter will monitor the flow from the Arsenic Filter during a backwash filter operation. The PCP PLC shall provide actual flow rate and totalized flow values for the day and month.

3. The Backwash Tank will be equipped with a level transmitter. The PCP PLC shall provide actual tank level and tank level set points for High-High Alarm, High Alarm, Low Alarm and Low-Low Alarm.

4. Backwash Tank Settling Timer – The PCP PLC shall have a timer that will allow settling of any solids in the water delivered to the Backwash Tank after a backwash operation. The Backwash Tank Settling Timer, operator adjustable via the PCP OIT, shall have a range of 0

to 999 minutes. Note that any Backwash Recycle Pump operations shall be delayed until the Backwash Tank Settling Timer has timed out.

5. The two Backwash Recycle Pumps shall operate in a lead-standby alternating manner. Provided that the Backwash Tank Settling Timer has timed out, the lead pump will pump when the level in the tank is above the low level set point. The lead pump will then stop when the Backwash Tank Level drops to the Backwash Tank Low-Low Level set point. The lead-standby alternator shall operate automatically or may be bypassed at the Operator Interface Panel to manual designate which Backwash Recycle Pump is the lead pump
6. Each Backwash Recycle Pump is equipped with a Hand-Off-Automatic Selector Switch located in the Motor Control Center.
    a. When the Selector Switch is in the Hand position, the associated Backwash Recycle Pump will run continuously until the Selector Switch is placed in either the Off or Automatic position.
    b. When the Selector Switch is in the Off position, the associated Backwash Recycle Pump will not operate.
7. When the Selector Switch is in the Automatic position, associated Backwash Recycle Pump will start and stop if the PCP PLC designates it as the lead pump. Provide a PCP PLC based start time delay of 0 to 999 seconds, initially set to 0 seconds. Provide a PCP PLC based stop time delay of 0 to 999 seconds, initially set to 0 seconds.
    a. If the pump designated as Lead Pump fails, then the standby pump shall start and then stop in its place. Provide a PCP PLC based start time delay of 0 to 999 seconds, initially set to 0 seconds. Provide a PCP PLC based stop time delay of 0 to 999 seconds, initially set to 0 seconds.
8. Control Panel PCP Operator Interface Terminal
    a. The following commands shall be provided:
        1) Select automatic alternation
        2) Select Pump 1 as Lead
        3) Select Pump 2 as Lead
    b. The following set points shall be provided (adjustable by the operator):
        1) Backwash Tank High-High Level Alarm
        2) Backwash Tank High Level Alarm
        3) Backwash Tank Low Level Alarm
        4) Backwash Tank Low-Low Level Alarm
        5) Lead pump start delay
        6) Lead pump stop delay
        7) Standby pump start delay
        8) Standby pump stop delay
    c. The following status points shall be provided:
        1) Backwash Return Flow
        2) Backwash Return Daily Flow Total
        3) Backwash Return Monthly Flow Total

4) Backwash Tank Level
5) Backwash Recycle Pump 1 Running
6) Backwash Recycle Pump 1 in Hand
7) Backwash Recycle Pump 1 in Off
8) Backwash Recycle Pump 1 in Automatic
9) Backwash Recycle Pump 2 Running
10) Backwash Recycle Pump 2 in Hand
11) Backwash Recycle Pump 2 in Off
12) Backwash Recycle Pump 2 in Automatic

d. The following alarms shall be provided:
   1) Backwash Tank High-High Level Alarm
   2) Backwash Tank High Level Alarm
   3) Backwash Recycle Pump 1 Failure

e. Backwash Recycle Pump 2 Failure

O. Residual Chlorine and pH Monitor/Controller (Typical of Well 22 and Well 26):

1. Function: The Residual Chlorine and pH Monitor/Controller will monitored the residual chlorine and pH at a point downstream of the new arsenic filter as shown on the contract drawings. The Residual Chlorine value will be used in the automatic control mode of the sodium hypochlorite chemical feed systems. The pH value will be used in the automatic control mode of the sulfuric acid chemical feed system. This monitor controller will provide the following data and alarms that will be available via SCDA or via the PCP OIT:
   a. Residual Chlorine
   b. Residual Chlorine High-High Alarm
   c. Residual Chlorine High Alarm
   d. Residual Chlorine Low Alarm
   e. Residual Chlorine Low-Low Alarm
   f. pH
   g. pH High-High Alarm
   h. pH High Alarm
   i. pH Low Alarm
   j. pH Low-Low Alarm
2. Control Panel Operator Interface Terminal
   a. The following commands shall be provided:
      1) Refer to the sodium hypochlorite and sulfuric acid chemical feed control strategies..
   b. The following set points shall be provided (adjustable by the operator):
      1) Residual Chlorine High-High Alarm
      2) Residual Chlorine High Alarm

3) Residual Chlorine Low Alarm
4) Residual Chlorine Low-Low Alarm
5) Residual Chlorine Setpoint for Sodium Hypochlorite Feed System
6) pH High-High Alarm
7) pH High Alarm
8) pH Low Alarm
9) pH Low-Low Alarm
10) pH Setpoint for the Sulfuric Acid Chemical Feed System

c. The following status points shall be provided:
   1) Residual Chlorine
   2) pH

d. The following alarms shall be provided:
   1) Residual Chlorine High-High Alarm
   2) Residual Chlorine High Alarm
   3) Residual Chlorine Low Alarm
   4) Residual Chlorine Low-Low Alarm
   5) pH High-High Alarm
   6) pH High Alarm
   7) pH Low Alarm
   8) pH Low-Low Alarm

P. Control Strategy – Power and Security (Typical of Well 22 and Well 26)

1. The SCADA system shall monitor the various alarm status conditions:
   a. UPS power failure at each UPS unit.
   b. Control Power AC Failure at each Control Panel
   c. Utility Service Failure at the Plant Control Panel, and the Motor Control Center
2. Intrusion alarm at each building door

****END OF SECTION****

County of San Mateo
Department of Public Works

Pescadero Community Water System (*County Service Area No. 11)*

Public Meeting

Pescadero Elementary School
October 19, 2011
6:30 PM

1. History & Operations of CSA-11

- Funding for the construction of the CSA-11 water system ($1.3 Million):
  - California Dept. of Water Resources (DWR) Grant of $400,000
  - DWR loan:
    - $296,100 loan for 20 years
    - Approximately $20,475 paid annually
    - Will be paid off by October 2012
  - County General Fund loan
  - Property owner assessments

1. History & Operations of CSA-11

- Well and pump systems constructed and put in operation in 1992:
  - Storage tank – 140,000 gallon capacity
  - Well #1 – Production well; Drilled and developed in 1992; Pump rate ~ 60 gpm
  - Well #2 – Standby/emergency well; Drilled in 1983; Developed in 1992; Pump rate ~ 30 gpm
  - Alarm and telemetry system
  - Cathodic protection for storage tank to prevent corrosion
  - Chlorination building

2. August 2011 Water Outage

- Costs of water outage:
  - New pump for Well #1 – $5,952.
  - Contractor to remove failed pump and install new pump – $4,300.
  - Bottled water supply and delivery – $1,996.
  - Portable restrooms – $842.
  - Bacteriological sampling – $240.
  - County staff labor and equipment costs – $17,087.
  - Total costs of event - $30,420 (not including potential payments for claims).

3. Findings

- Well #1:
  - Pump failed due to declining water surface elevation.
- Well #2:
  - Pump rate was 5-7 gpm – below its rated capacity of 30 gpm.

3. Findings

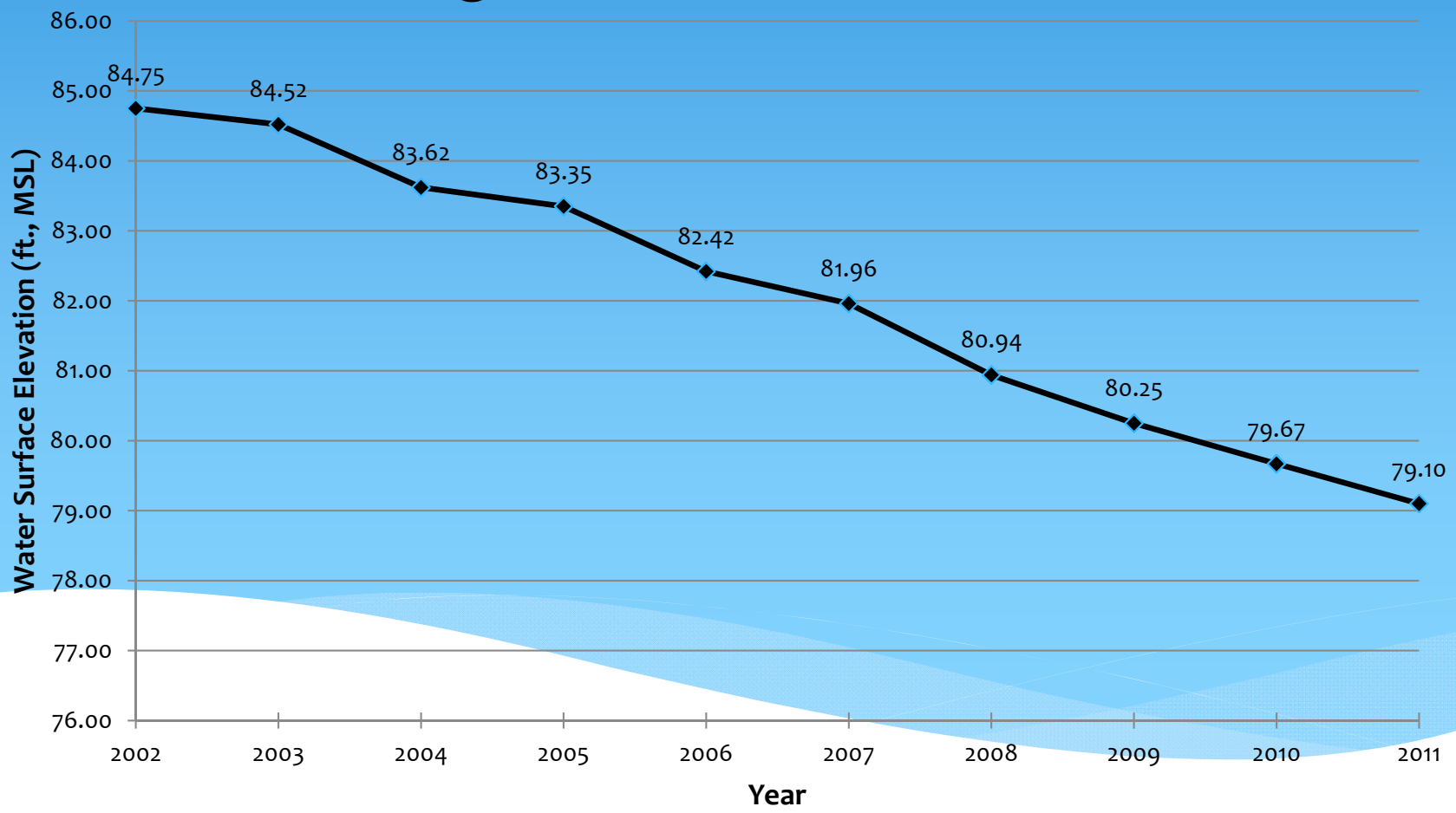
- Alarm System:
  - Originally equipped to dial a pre-programmed phone # when:
    - ✓ Storage tank reached a low or high level (adjustable levels).
    - ✓ Power outage.
  - Deactivated for several years as it routinely issued false alarms:
    - ✓ More frequent physical inspections were done instead.
    - ✓ Did not work as intended during power outages when the phone line lost power.

3. Findings

- Recommended Actions:
  - Video inspect both wells to determine actual depths – Approx. cost $17,000.
  - Place pumps at proper depths, based on actual well & water surface depths (as part of video inspection work).
  - Alarm re-activated to monitor power outage and low and high tank levels.

County of San Mateo
Department of Public Works

Well #1 Water Surface Elevation Changes from 2002-2011



5. Financial State of CSA-11

- Independent entity with own separate budget.
- Receives no property taxes because CSA-11 was formed after implementation of Proposition 13.
- Only source of funding is from revenue generated by water sales and monthly service fees.
- Current rates do not support required operation and maintenance activities.

5. Financial State of CSA-11

- Fund balance as of 6/30/2011 – $43,512.
- Revenue - $46,500 annual average.
- Average annual expenditures (5-yr avg.)
  - $66,000 ($20,475 for loan repayment)
- Cost of August 2011 water outage event:
  - $30,420 (potential payments for claims not included)

County of San Mateo
Department of Public Works

6. Water Rates

	CSA - 11		Other Water Agency Rates		
No. of Customers	99		6,583	12,412	1,656
	Current Rate	Proposed Tiered Rates	Coastside County Water	North Coast County Water	Montara Water & Sanitary
5/8" x 3/4" Meter Monthly Service Charge	$22	$28	$15.36	$24.94	$20.84
1-1/2" Meter Monthly Service Charge	$33	$42	$74.32	$44.95	$37.51
Tier 1 Water Rate (0-8 HCF)	$1.38	$2.69	$5.02	2.53 (0-5 HCF)	6.54 (0-6 HCF)
Tier 2 Water Rate (9-25 HCF)	-	$4.04	$5.53	5.62 (6-16 HCF)	8.72 (7-13 HCF)
Tier 3 Water Rate (26-40 HCF)	-	$5.45	$7.19	8.04 (17-28 HCF)	10.9 (14-27 HCF)
Tier 4 Water Rate (> 40 HCF)	-	$7.36	$8.88	14.75 (> 28 HCF)	15.26 (> 27 HCF)

Pescadero Community Water System – County Service Area No. 11 (CSA11)

August 2011 Water Outage Report

<u>Sequence of Events Leading to Water Outage, Actions Taken, and Recommendations</u>

Monday, August 22, 2011

At approximately 3:30 p.m. CSA11 staff began receiving calls from CSA11 customers stating that they had little water pressure or no water. Thomas Sipp (Thomas), a County Department of Public Works (DPW) Stationary Engineer, familiar with the water system, was informed immediately of the possible water outage. Thomas arrived at the CSA11 tank location at about 4:45 p.m. and found the pump in the Production Well (Well #1) not operating and the storage tank level at 0.7 feet. He turned the pump back on at 5:30 p.m. and observed a continuous pumping rate of approximately 57 gallons per minute (gpm). He remained at the site until 9:30 p.m. At that time, the pump was running properly and filling the storage tank. CSA11 customers had water before Thomas left and staff did not receive additional calls that night regarding water issues.

Tuesday, August 23, 2011

Gary Webb (Gary), a DPW Supervising Stationary Engineer, received a text message at approximately 6:30 a.m. from a relative of a CSA11 customer stating that there was no water. Gary notified Thomas, who left the County's Tower Road complex in San Mateo for CSA11 at 6:40 a.m. Gary followed Thomas shortly thereafter to CSA11. They discovered that the Well #1 three phase pump had failed and two of the three legs of the pump had shorted to ground. It was determined at this point that a replacement pump was necessary. The pump in the Standby Well (Well #2) was immediately put into operation and although it pumped continuously, it was only delivering on average 5-7 gallons of water per minute. This is well below the 60 gpm production rate that the pump is rated to produce.

To secure a replacement pump for Well #1, Gary contacted local contractors to inquire about the availability of a compatible pump and labor/equipment to remove the failed pump and install the new pump. Contractors indicated that they did not have a compatible pump in stock and that crews would not be available to perform the repair work until Wednesday, August 24, 2011 at the earliest. At that point, DPW began contacting pump suppliers to locate a replacement pump that could be installed the same day.

The State Department of Public Health (DPH) was informed of the situation and after having a discussion via telephone with Gary and office staff (Mark Chow and America Sanchez), DPH determined that pressure in the distribution system had been lost and required CSA11 to issue Boil Water Notices to its customers. DPW went door-to-door providing Boil Water Notices on August 23, 2011 and posted the Boil Water Notice on the DPW website. DPH also required CSA11 to collect water samples at 287 Stage Road and the pump house by the storage tank to test for bacteria in the distribution system as Well #2 was inactive for a period of time and not flushed prior to delivering water to the CSA11 system. Test results from these samples reported to DPW on August 24, 2011 were negative for bacteria.

DPW delivered 3,500 gallons of water to the California Department of Forestry at approximately 11:30 a.m. to ensure water was available for fire-fighting purposes.

The County of San Mateo Environmental Health Division was notified by DPH of the Boil Water Notice and ordered the closure of businesses that sold foods that were not exclusively prepackaged. This closure affected four businesses.

DPW discussed with DPH strategies for providing potable water and replenishing the storage tank, including the hauling of water by certified haulers to a location where customers could obtain drinking water or fill the CSA11 storage tank. However, after multiple discussions it was concluded that due to the location/elevation of the tank and the amount of water that could be hauled by approved water companies (4,000 gallons per truck load which is not a significant amount compared to the storage tank capacity of 140,000 gallons), hauling water to fill the tank was determined not to be feasible. Hauling water would not solve the water outage, customers would still be under a Boil Water Notice, and the introduction of trucked water could potentially compromise the integrity of the system by introducing contaminants into the CSA11 water system. Water trucking companies also would not park their filled trucks for CSA11 customers to draw water from. DPW provided potable water to its customers by delivering 900 gallons of bottled drinking water to Pescadero at approximately 5:00 p.m.. Customers were informed to take 2 gallons per person (as recommended by County of San Mateo Environmental Health Division for potable water provisions per day during emergency water outages). DPW staff assisted by hand delivering drinking water to those customers who could not stop by to pick-up their supply of water on their own. DPW arranged for the delivery of four portable restrooms to a lot adjacent to the intersection of Stage Road and Pescadero Creek Road.

While some DPW staff worked to arrange for potentially hauling water and the delivery of bottled water, others worked on locating and contacting companies that sell, install, and repair pumps. Specialized contractors were contacted as the existing pump had to be lifted out of the well from a depth of over 200 feet underground and a new pump reinstalled at or below the original depth. A contractor was located and authorized to mobilize to the site at 12:30 p.m. once a new pump was located in Salinas. The new pump arrived at the site at 6:51 p.m. and was installed by approximately 12:00 a.m. on Wednesday, August 24, 2011. The pump was lowered an additional 37' into the well after reviewing well sounding data to verify the static water surface elevation in the well. DPW staff remained at the site until 4:30 a.m. to ensure that the new pump was functioning properly and the water supply in the tank was being replenished.

Wednesday, August 24, 2011 through Friday, August 26, 2011

Chlorine was injected into the water supply system during the morning of Wednesday, August 24, 2011 for disinfection purposes due to the loss of pressure in the distribution system. The hydrants at the end of the CSA11 pipes were opened (flushed) to ensure that chlorine was distributed throughout the system for proper disinfection. DPH required at least 1.5 parts per million (ppm) of chlorine concentration throughout the system. Staff sampled the chlorine

concentration at 5 locations on August 24, 25, and 26 to ensure the disinfection requirements were met and reported the values to DPH.

DPH also required that bacteriological samples be taken approximately 24 hours apart on August 24 and 25 from the same 5 locations from which chlorine concentrations were analyzed. Two consecutive sets of sample results needed to be free of bacteria in order for DPH to cancel the Boil Water Notice. Staff collected the samples on said dates and the results were negative for bacteria. The Boil Water Notice was cancelled on August 26 at 2:01 p.m.. Staff notified CSA11 customers via email, telephone, and hand delivery of the cancellation notice (in English and Spanish) door-to-door. The cancellation notice was also posted on the DPW website.

Findings

According to CSA11 records, the pump in Well # 1 was replaced in 2009 and was not expected to fail in such a short timeframe as we believe it was installed to the appropriate depth as indicated on the record drawings. According to the record drawings, the depth of the Well #1 is 260 feet. However, when the pump was removed on August 23, 2011 a 300 foot long metal tape was lowered into the well and it was reported to not reach the bottom of the well. If this measurement is accurate and based on prior well soundings performed by CSA11, it may indicate that the pump was not fully submerged in water and may have been pumping water and air causing premature pump failure. A decision was made when installing the new pump to add an additional 37 feet of 2” galvanized pipe that was available at the time to the intake line. The top of the new pump is currently at 225 feet below the surface elevation of the well but the actual depth and condition of the Well #1 need to be determined.

The pump at Well #2 was only pumping at a rate of 5-7 gallons per minute while it was used during the incident. The pump and condition of Well #2 will require further investigation.

Recommended Actions and Timeline for Future Work

Item No.	Actions	Timeline
1.	Continue monitoring the storage tank level and associated measurement devices	- Each weekday (8/29/11 to 9/9/11) - 2-times per week thereafter
2.	Test existing alarm system and investigate methods to improve alarm system’s reliability	Re-programmed existing alarm system on 9/7/11
3.	Obtain contractor proposals to investigate Well #2 pump and condition of well, confirm record drawing information (well depth and screen depth)	October 2011
4.	Obtain contractor proposals to investigate condition of Well #1 (confirm record drawing information – well depth and screen depth) and replace temporary 2” galvanized intake pipe with 3” galvanized pipe	October 2011
5.	Complete cost accounting of water outage	October 2011

Item No.	Actions	Timeline
	expenditures to determine impact on CSA11 Fund Balance	
6.	Public meeting with CSA11 customers to discuss water outage, operations moving forward, and future water rates	October 19, 2011
7.	Select contractor(s) for work items #3 & #4 above	November 2011
8.	Conduct water rate setting process	October to December 2011
9.	Investigate feasibility of potential modifications to current operations: a. Need to determine through working with DPH whether existing permit could be amended to allow lead/lag setup for both pumps b. Verify that existing cathodic protection for storage tank is adequate c. Verify that existing electric circuits for 3-phase pumping is appropriate d. Verify the need to reconfigure existing settings for motor saver e. Increase capacity of the pump in Well #2 to provide adequate supply volume in the event of failure of the pump in Well #1 f. Work with DPH to allow periodic use of Well #2 g. Retain spare pumps	Nov. 2011 to Jan. 2012

COUNTY OF SAN MATEO
Inter-Departmental Correspondence
Department of Public Works

DATE: May 30, 2012
BOARD MEETING DATE: June 26, 2012
SPECIAL NOTICE/HEARING: Complied with Required Notification
VOTE REQUIRED: Majority

TO: Honorable Board of Supervisors

FROM: James C. Porter, Director of Public Works

SUBJECT: Adoption of Water Rates and Charges for County Service Area No. 11, Pescadero Area

RECOMMENDATION:
Acting as the Governing Board of County Service Area No. 11, and after conducting the public hearing, adopt a Resolution adopting the water rates and meter service charges for County Service Area No. 11.

BACKGROUND:
On September 9, 2003, your Board adopted Resolution No. 066229, adopting the current water service rates and meter service charges for County Service Area No. 11 (CSA 11). Revenue generated from these rates is not sufficient to adequately operate, maintain, and administer CSA 11.

On May 8, 2012, your Board adopted Resolution No. 071932, which set 9:00 a.m. on June 26, 2012, in your Chambers as the time and place for a public hearing to consider the proposed water rates and meter service charges for CSA 11 and directed the Director of Public Works to send the necessary notices for said hearing.

The process to be followed for adopting the water service rates includes:

1. Hold a public hearing and receive testimony on the proposed water rates and meter service charges.

2. After considering all written and oral objections to the proposed water rates and meter service charges, close the public hearing and determine if there is a majority protest to the proposed water rates and meter service charges.

3. If there is a majority protest, terminate consideration of adopting the proposed water rates and meter service charges.

4. If there is not a majority protest, adopt the Resolution and set the water rates and meter service charges effective July 1, 2012.

DISCUSSION:

CSA 11 provides quality drinking water in compliance with State and Federal Regulations to a population of approximately 450 residents in the Pescadero community. The Department provides staff to CSA 11 to perform routine operation and maintenance, 24-hour emergency response, billing and other administrative services, as well as, the purchase and installation of necessary equipment upgrades. The revenue to provide these services to CSA 11 customers is generated by water rates and meter service charges.

The May 8, 2012 Board Report (copy attached) explained the need for the water rates and meter service charges to be increased and recommended the water rates be based on a tiered rate structure. Notices were sent to CSA 11 property owners and tenants (approximately 170 mailing addresses), informing them of the proposed rate structure and increases, the reasons for the increases, and the time, place, and date when your Board would consider the proposed rates and charges. The purpose of the public hearing is to allow your Board to hear and consider any objections and written protests of the proposed water rates and meter service charges.

Public Input Process

The Department has sent letters to all property owners and customers in CSA 11, provided information relative to the proposed water service rates and community meetings to discuss proposed rates, and sought their input regarding the proposed rates. Staff conducted meetings with customers, property owners, the Pescadero Municipal Advisory Council, and a “Ratepayers Group” to discuss the proposed rates and the revenue requirements to adequately support CSA 11 operations. The input received was used to help determine the proposed rates.

After the Board meeting on May 8, 2012, the Department sent a letter which provided property owners and customers with the proposed rates and information about the time and place of the public hearing. This notice complied with Article XIIIC and XIIID of the State Constitution (Proposition 218) by individually noticing each property owner and customer of record of the proposed water service increase and a mechanism for rejecting the proposed rates via a “majority protest” at the public hearing.

At the time this report was prepared, the Department had not received any written protests to the proposed water rates and meter service charges. We will report to your Board on any written protests that are received up to and including the date of the public hearing.

Alternates to Consider

After the close of the hearing, if there is not a majority protest, your Board can adopt the proposed water rates and meter service charges or reduce the water rates and meter service charges as you may determine appropriate. However, reducing the proposed rates would require identifying a source of funding, such as a loan, to support CSA 11

operations as the rates would not be sufficient to adequately support CSA 11 expenditures. Additional impacts to CSA 11 could include reduced maintenance; deferred capital improvements; or CSA 11 not meeting State and Federal water quality requirements that could result in possible fines against CSA 11.

We believe the recommended water rates and meter service charges are appropriate as they have been calculated to provide the funding necessary to maintain the water supply and distribution system of CSA 11 and meet current State and Federal requirements.

County Counsel has reviewed and approved the Resolution as to form, and we will provide an alternate form of resolution if there is a majority protest in CSA 11.

Your Board's adoption of the water rates and meter service charges contributes to the Shared Vision 2025 outcome of a Healthy Community by providing revenue to CSA 11 and allowing for uninterrupted potable water service to CSA 11 customers.

FISCAL IMPACT:
The following are the current and proposed water service rates for CSA11:

Water Service Description	Current Rates	Proposed Rates
5/8" x 3/4" Meter Monthly Service Charge	$22.00	$28.00
1-1/2" Meter Monthly Service Charge	$33.00	$42.00
Tier 1 Water Rate (0-11 HCF)	$1.38	$2.69
Tier 2 Water Rate (12-25 HCF)	-	$4.04
Tier 3 Water Rate (26-40 HCF)	-	$5.45
Tier 4 Water Rate (> 40 HCF)	-	$7.36

Other associated CSA 11 charges are described in Exhibit A of the Resolution.

There is no direct impact to the General Fund. However, water service charges are levied on properties that are either leased or owned by the County and provided water by CSA 11, such as the County Fire Station Number 59 located on Pescadero Creek Road.

Attachment : May 8, 2012 Board Report

HydroScience
Strategic Water Solutions

HydroScience Engineers, Inc.
741 Allson Way
Sacramento, CA 94710
T: 510.540.7100
F: 510.540.7106

November 8, 2012 (updated 12/18/12)

Edelzar Garcia, P.E.
Senior Civil Engineer
County of San Mateo Department of Public Works
555 County Center, 5th Floor
Redwood City, CA 94063-1665

Subject: Proposal for Engineering Services – CSA 11 Water Supply Project

Dear Ed:

Pursuant to our contract for San Mateo County 2012 General Engineering Services and your request for a proposal to provide assistance in pursuing grant funding, planning and design services for a water well, water storage tank, and appurtenances for the County Service Area No. 11 (CSA 11) Water Supply Project in Pescadero, CA, HydroScience Engineers, Inc. (HSe) is pleased to submit the following proposal.

PROJECT UNDERSTANDING

The CSA 11 water system is a public water system with a production well, standby well, storage tank, pump house and distribution system serving approximately 100 customers. The County of San Mateo Department of Public Works (County) operates and maintains the water system. The CSA 11's water source is an underground aquifer located in the Pigeon Point Formation, about one mile west of the Town of Pescadero on the top of a northwest trending ridge, and adjacent to the Pacific Ocean.

The system is supplied by two groundwater wells, 1 and 2, which had estimated capacities of 50 gpm and 80 gpm respectively (Todd, 2002). The production well is 260 feet deep with a 10" diameter casing and a 50-foot cement grout sanitary seal. The standby well is 247 feet deep with a 6" diameter casing. System demands are approximately 16 gpm on an annual average basis. Both wells pump to a water storage tank located on a hill, which supplies the service area by gravity.

Due to the declining water table and corresponding drop in capacity, a hydrogeologic report has been prepared to provide recommendations to augment the two wells. The report recommended the installation of deep wells (100 feet below MSL, TD 400 feet) to take advantage of overlying potable groundwater supplies which has been estimated to yield capacities ranging from 200 gpm to 300 gpm. The new well would be located in the vicinity of the existing water storage tank.

In addition to a new water well an additional 140,000 gallon welded steel water storage tank has also been proposed.

SCOPE OF WORK

To address the water supply issues associated with the existing facilities in CSA 11, the County has elected to move forward with the construction of one new well and an additional 140,000 gallon welded steel water storage tank, and has requested assistance with the following:

1. An update of the previously prepared groundwater supply investigation report (Todd, 2002);

2. The preparation of IRWMP Implementation grant funding applications to finance the project, and;
3. The preparation of design plans and specifications for a new well and storage tank.

We have prepared the following scope of work arranged in three major task items corresponding to the three project elements.

Task 1 – Update to the Groundwater Supply Investigation Report

- HSe will review the report entitled "Assessment of Source Water for the Pescadero Water System – CSA 11 prepared by Todd Engineers in March, 2002.

- HSe will provide a supplement to the 2002 Todd Report in a Technical Memorandum format, which will address updated and/or new items, referencing the original report. Specific items to be included in this update include:

    - Current groundwater elevation readings in wells 1 and 2, and selected surrounding wells. HSe would work with local private well owners to secure permission to sample their private wells, and get level readings and other relevant water well information from up to three nearby wells.
    - The potential for a system outage should the project not be constructed
    - Fire flow capacity based on California Title 22 requirements, and current system capacity and storage. This analysis would be limited to the water supply, and not the potable water distribution system within the CSA 11 distribution system.
    - Known alternate water sources, such as historic abandoned wells, surface water impoundments and potential agency interconnections
    - Current water demands
    - Current water rates
    - An updated timeframe for failure and/or inability to meet current demands for the existing wells
    - Recommended well depth, casing size, and target production value.
    - Recommended size, type and configuration of an additional storage reservoir.
    - The original design and current configurations of wells, pumps, electrical systems, alarm systems, etc will be compared and document any modifications made

Task 1 Deliverables:
- Draft and final TM format supplemental report

Task 2 – Grant Application Assistance

The Integrated Regional Water Management (IRWM) Grant Program consists of three program components: IRWM Planning Grants, IRWM Implementation Grants, and Stormwater Flood Management (SWFM) Grants. As part of this project, the County is interested in pursuing funding through the IRWM Implementation Grants program. This project is included in the 2013 Update to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) and will be eligible for funding through the Implementation Grant Program with the adoption of the 2013 BAIRWM Plan by September 2013.

The grant application will include the prescribed grant application form as well as a series of attachments. As part of this proposal, HSe will prepare the following documents for submittal with the application.

- Work Plan
- Budget
- Schedule
- Monitoring, Assessment, and Performance Measures
- Technical Justification of Project Physical Benefits
- Benefits and Cost Analysis
- Program Preferences

The detailed requirements for each of the documents are described in the DRAFT Proposal Solicitation Package Proposition 84 – Implementation, Round 2 (July 2012, DWR). It is assumed that the County will prepare, compile, and submit the application form and package as well as all other application attachments, including, but not limited to, the following forms and/or attachments:

- Authorization and Eligibility Requirements
- Adopted Plan and Proof of Formal Adoption
- Disadvantaged Community Assistance
- Groundwater Management Plan: Of note, CSA 11 is included within the Bay Area IRWMP which went through a regional acceptance process (RAP) from DWR. Thus, HSe believes that a separate GWMP is not required at this time, since Bay Area IRWMP will be the recipient of the grant. If a GWMP is required, HSe can provide a scope to provide this service as part of a separate authorization.
- AB1420 Compliance Forms
- Water Meter Compliance Forms
- Environmental Permitting documentation (CEQA/NEPA)
- Consent Form
- IRWMP Plan

HSe will prepare the following components of the application:

Work Plan – The Work Plan will include a detailed description of the project along with a complete list of tasks that are necessary to complete the project and the associated deliverables to track and assure project progress. The objective is to demonstrate that the project is ready for implementation. The Work Plan will include an introduction section and section detailing the proposed work.

Budget – A budget must be included with the application package and must include a detailed cost estimate. The Budget will include the various costs including land acquisition, project planning and design, environmental compliance and documentation, construction costs and construction contingency as well as detailed information about the funding match, subject to DWR approval, representing a minimum of 25%, unless the County pursues a waiver as a disadvantaged community (DAC). It is understood that this waiver is being pursued by the County.

Schedule – The schedule will present the sequence and timing of the various tasks proposed for the project. The schedule will be in Gantt chart format and will include task start and finish dates as well as any milestones. The chart will indicate which tasks, if any, are linked to indicate critical path dependencies.

Monitoring, Assessment, and Performance Measures – The application package must include a description of the measurements that will be used to verify project performance with respect to the benefits and objectives. A monitoring plan will be developed and will describe how to assess the projects performance and which parameters to monitor and measure to indicate level of performance and goal achievement.

Technical Justification of Project Physical Benefits – The appropriate technical justification must be provided for the project. The technical justification may be in the form of technical reports, feasibility studies, expert opinion or local knowledge, journals, etc. It is expected that the previously completed Todd Engineering Report as well as the HSe update to the Todd Engineering Report will be provided as the technical justification for the project. The justification must clearly address the physical benefits such as the amount of water supply produced.

Benefits and Cost Analysis – As part of the application package, a benefits and costs analysis must be completed and submitted. There are two methods that can be used to complete the analysis: the RWMG Method and the DWR Method. The DWR method consists of four benefit analysis options to select from. The RWG Method is a method that is comparable to the DWR method and submitted in lieu of the DWR Method analysis. DWR provides guidance for using the various methods of analyses. HSe will recommend a method and complete the analysis upon the County's approval of the recommended method.

Program Preferences – The application package will include a technical memorandum (TM) describing how the project will meet the program preferences as described in the 2012 IRWM Grant Program Guidelines. The TM will discuss the breadth and level at which the project will meet the program preferences and statewide priorities.

Task 2 Deliverables

- Work Plan
- Detailed Budget and Summary Tables 7 & 8
- Gantt chart format schedule
- Monitoring, Assessment, and Performance Measures Tables
- Technical Justification of Project Physical Benefits TM and Summary Table 9
- Benefits and Cost Analysis TM and summary Tables 19 & 20
- Program Preferences TM
- Draft and final permit package (plan set to be included)

Task 3 – Well and Water Storage Tank Design

- **Well Drilling Specifications** – HSe will prepare a set of specifications for the drilling of a water production well by a C57 licensed contractor. It is anticipated that the completed depth of the well will be as low as four hundred feet below ground surface, and it is anticipated that the capacity will be approximately 200 gpm to 300 gpm. It is anticipated that the Engineer will provide services during construction to determine the well location, final completed depth,

screening intervals, and gravel pack size based on the physical strata logs and electronic logs. Drilling specifications will address the following:

- Well casing materials and thicknesses
- Screen materials
- Gravel pack, surface seal and intermediate seal materials
- Base bid quantities for completed depth, screened interval lengths, surface and intermediate seal lengths, and sounding tube depths
- Drilling procedures and methods (rotary mud or reverse rotary)
- Test hole, reamed production hole, casing and screen diameters
- Strata sampling, collection and logging requirements
- Test hole logging requirements for electronic logs and caliper logs
- Final borehole reaming procedures
- Casing and screen installation procedures
- Gravel pack and surface seal placement procedures
- Disinfection procedures
- Well development equipment, procedures and base bid quantities
- Pump testing procedures for step drawdown and constant rate aquifer tests
- Site restoration and environmental compliance requirements

- **Well Mechanical and Tank Plans and Specifications** – HSe will prepare as set of construction plans and specifications for the well pump, discharge piping, electrical and controls, yard piping, water storage tank, and interconnection piping with the existing tank. It is assumed that the new tank will be installed at the same hydraulic gradient as the existing tank. The plans would be bid to a Class A licensed General Contractor following the completion and testing of the well, or, alternately the drilling specifications could be included and bid as one package to an appropriately licensed contractor. It is anticipated that the Engineer will provide limited services during bidding and construction to include requests for information (RFIs) and submittal review. Day to day inspection and inspection of the coating on the steel reservoir shall be the County's responsibility. Plans and specifications will address the following:

  - Civil design – Civil sheets will be prepared including a site plan, piping and trenching details, a grading plan, drainage details and fencing details.
  - Geotechnical investigation – Carlton will perform a field investigation in accordance with the 2010 CBC and San Mateo County requirements. An exploratory boring of approximately 50 feet in depth will be located at the proposed water tank site to assess the foundation and subgrade. Samples from the boring will be collected and analyzed in the laboratory for the purposes of collecting data suitable to provide the basis for the geotechnical investigation and subsequent detailed design. A geotechnical report will be prepared that provides conclusions and recommendations to serve as the geotechnical basis of design for the project.
  - Supplemental geotechnical investigation (optional) – Two additional 20-foot deep borings can be performed to gather additional information about the tank foundation and backfill requirements. These additional borings will only be performed if the base geotechnical investigation requires collection of additional information to confirm design requirements.
  - Seismic Studies - Carlton will conduct a CBC Seismic Study to provide seismic design information in accordance with Chapters 16 and 18 of the 2010 CBC in sufficient detail to support seismic class "D" for design work. The ground motion shall be based on the geologic, tectonic, seismic recurrence information, and foundation material properties

associated with the specific site. The design ground motion shall be 10 percent probability of being exceeded in 50 years.

- Mechanical Design – Mechanical sheets will be prepared for the wellhead improvements, pump and discharge piping installation, blow off piping assemblies, pump control valve assemblies, and chlorination equipment and housing details. It is assumed that chlorination equipment will consist of liquid sodium hypochlorite metering pumps and double containment storage inside of a prefabricated chlorination building. Plans for a new welded or bolted steel tank will be prepared.
- Structural design – Structural sheets will be prepared, if required, for the tank foundation.
- Electrical and Instrumentation Design – Electrical sheets will be prepared for an electrical site plan, conduit routing schedules, motor control center elevations, control logic diagrams, PLC block diagrams and electrical trenching and other miscellaneous details.
- Specifications – Technical specifications as required for final design (Divisions 00 through 17 in CSI format), notice inviting bids, instructions to bidders, bid schedule and supplementary general conditions based on County Standards will be prepared. The County will provide contract documents, general conditions, and general requirements in Caltrans format electronically (Microsoft Word) to HSe. HSe will review, revise and integrate the County documents within the technical specifications.

The base scope of service will allow HSe to bring the design to the 75% level and submit it with the funding application. HSe can bring the design to completion as an optional service that can be executed at a later date.

- **Permitting Assistance** (optional task for inclusion in final design package) – HSe will assist the County in the CDP and CEQA permitting process by providing project descriptions and figures as necessary. HSe will prepare the Water Supply Permit Amendment application for County approval and submittal to CDPH and will attend one scoping meeting with CDPH

Task 3 Deliverables:

- Draft well specifications – 3 copies
- Final well specifications – 1 reproducible copy, PDF copy, Word files
- 75% mechanical plans and specifications – 3 copies, half size drawings
- Final mechanical plans and specifications – 1 full size and half size reproducible copy of plans, 1 set of reproducible specifications, PDF plans and specifications, AutoCAD and Word files.
- Project descriptions and figures as required for environmental permitting.
- Completed Water Supply Permit Amendment application form.

Task 4 - Topographic Surveying (Optional)

Carlton will provide the necessary field staff to complete a topographic survey of the site affected by this project. This data will be returned to the office for post processing and completion of the deliverable. Work to be completed as part of this optional task will include:

1. Complete project pre-planning in the office.
2. Complete the field survey of the affected area as indicated on Figure 3 – Site Map provided by the County to HSe. (approximately 100' x 100')
3. Locate site on California Coordinate System utilizing GPS.
4. Post processing of all field data.
5. Draft completed topographic survey with 1' contour Interval and at 1"=10' scale. (or other as agreed upon by HSe and Carlton)

ASSUMPTIONS

- The County will provide CEQA and CDP permitting with support from HSe as identified in the scope of work.
- The County will provide topographic surveying services. HSe can provide those services as an optional task.
- Bidding and construction services are not included. The drilling construction phase will require some level of effort from the design engineer to complete the well design after the initial pilot hole and logging has been completed.

PROJECT TEAM

HSe has selected the most qualified members of our organization chart from our Statement of Qualifications. It is anticipated that this team will be led by Mary Hoang as our Principal-in-Charge, with Walter Sadler as Project Manager. David Dauwalder will be the Project Engineer. Carlton Engineering will provide the geotechnical engineering services and, optionally, the topographic surveying services. Detailed resumes for each individual can be made available to the County upon request.

PROJECT SCHEDULE

We understand that time is of the essence for this work. Our intent will be to complete the Task 1, 2, 4 (optional) and Task 3 work through 75% design by February 21, 2013. This schedule will allow the County enough time to review submit the grant application, Groundwater Supply Investigation Report, and 75% Design in advance of the March 2013 deadline. The schedule for completion of the detailed design work will be coordinated with the County.

PROPOSED FEE

We propose to perform the above services for a fee not to exceed **$96,960** to complete the base scope of services. A scope and fee for the optional services, including topographic surveying, additional geotechnical investigation, final design, and CDPH permitting assistance, are also included for County consideration. All charges will be invoiced monthly to the County based on HSe's standard rate schedule in effect when the services are performed. Invoices will be submitted monthly and will include a bulleted list of work performed during the invoice period, identify any deviations between the work performed and the contract scope, and identify any key unresolved issues.

Should you have any questions regarding this proposal, please contact me at (510) 540-7100 x12. We thank you for the opportunity to submit this proposal, and look forward to working with you on this project.

Sincerely yours,
HYDROSCIENCE ENGINEERS, INC.

Curtis Lam, P.E.
Principal

Attachment

HydroScience Engineers, Inc. **County of San Mateo/CSA 11 Water Supply Project** November 8, 2012

Item	Description	Principal	Project Manager	Senior Engineer II	Project Engineer	Senior CAD Designer	Admin.	HSe Hours	HSe Fee	Travel, Repro., and ODCs	Carlton Engineers	Direct Charges Markup @ 10%	Expense Subtotal	Total Fee
	Hourly Rate	$175	$160	$130	$120	$90	$65							
Base Scope of Services														
1	Source Water Assessment Report Update													
	Report Review	4	8					12	**$1,980**			$0	**$0**	**$1,980**
	Report Update	8	24		32		4	68	**$9,340**	$250		$25	**$275**	**$9,615**
2	Grant Assistance													
	PSP Preparation	8	40		24		4	76	**$10,940**	$150		$15	**$165**	**$11,105**
3	Water Well and Water Tank Design													
	Well Drilling Specifications	48	16		60	24	8	156	**$20,840**	$1,000		$100	**$1,100**	**$21,940**
	75% Mechanical Design	8	96		160	24	12	300	**$38,900**	$2,500	$9,700	$1,220	**$13,420**	**$52,320**
Total - Base Scope of Services		**76**	**184**	**0**	**276**	**48**	**28**	**612**	**$82,000**	**$3,900**	**$9,700**	**$1,360**	**$14,960**	**$96,960**
Optional Tasks														
3	Water Well and Water Tank Design													
	Supplemental Geotechnical Investigation							0	**$0**		$1,600	$160	**$1,760**	**$1,760**
	Final Mechanical Design	4	40		60	8	4	116	**$15,280**	$500		$50	**$550**	**$15,830**
	CDPH Permitting Assistance	4	16					20	**$3,260**			$0	**$0**	**$3,260**
4	Topographic Surveying													
	Topographic Surveying							0	**$0**		$3,300	$330	**$3,630**	**$3,630**
Total - Optional Services		**8**	**56**	**0**	**60**	**8**	**4**	**136**	**$18,540**	**$500**	**$4,900**	**$540**	**$5,940**	**$24,480**
Overall Total - Base & Optional Services		**84**	**240**	**0**	**336**	**56**	**32**	**748**	**$100,540**	**$4,400**	**$14,600**	**$1,900**	**$20,900**	**$121,440**

Technical Memorandum

HydroScience
Strategic Water Solutions

REGISTERED PROFESSIONAL ENGINEER
CURTIS M. LAM
No. C 59049
Exp. 06/30/13
CIVIL
STATE OF CALIFORNIA

To: Edelzar Garcia, P.E.
From: Walter Sadler, P.E.
Reviewed By: Curtis Lam, P.E.
Subject: TM #1: Water Supply Reliability
Date: March 19, 2013

Purpose

San Mateo County, County Service Area No. 11 (CSA 11) is a public water system with a production well, standby well, welded steel storage tank, pump house, and distribution system that provides water for domestic use and fire flow to approximately 100 customers in Pescadero, CA. CSA 11's water source is an aquifer located in the Pigeon Point Formation approximately one mile west of unincorporated Pescadero area on the top of a northwest trending ridge adjacent to the Pacific Ocean. Due to the physical location and characteristics of both wells, the long-term sustainability of groundwater has been a concern for the County.

To comply with conditions of approval in the Coastal Development Permit No. 90-62 (CDP 90-62) issued in 1990 for construction of the existing well, the County of San Mateo commissioned an investigation of the groundwater supply by Todd Engineers in 2002, with the intent to identify issues associated with the source water and potential solutions to address those issues. This investigation of the groundwater basin was very thorough and presented a variety of recommendations, one of which was to drill a new and deeper well adjacent to the existing storage reservoir. The purpose of this Technical Memorandum (TM) is to review the existing water supply conditions and provide a recommendation for water supply improvements.

History

The unincorporated area of Pescadero has a history of identifying and studying alternative water supplies for a community water system. One of the first studies to evaluate the use of both groundwater and surface water as a reliable source of supply was the *Community Water Plan for the Town of Pescadero, County of San Mateo* (Koretsky King Associates, September 1976). In this study, aquifers in bedrock and in the alluvium of Pescadero Creek were evaluated. It was determined that the bedrock formations would be marginal in yield and adequate only for small domestic demands and therefore were unsuitable for development as a source of supply for a municipal system. Groundwater aquifers in the valley of Pescadero Creek are extensively pumped for both agriculture and domestic uses. While the hydraulic characteristics of these aquifers are excellent, it was determined that their low storage capacity due to their shallow nature presented problems with regard to developing a long-term and continuous supply. In addition, water quality was a major concern due to the potential for contamination by agricultural practices and septic tank leachate in the basin.

As a result, it was determined that groundwater from the main valley of Pescadero Creek was not a viable long-term source of supply. While other sources including several wells along Butano Creek were also evaluated, the overall conclusion was that groundwater within the creek alluvium was not sufficient to be considered a reliable source of supply for a municipal system.

Several alternatives for diversion and storage of surface water together with required reservoir capacities were considered for Pescadero Creek, Butano Creek, and Little Butano Creek. In addition, issues regarding water rights for existing diverters on the streams were also considered and cost estimates for a surface water project were developed. The project was not advanced to completion due to funding issues. Other studies evaluating the potential for development of groundwater as a source of supply were completed in the early 1980s. These studies are further described below.

The report, *The Water System for Pescadero Rural Service Center, County of San Mateo*, Kennedy/Jenks/Chilton, August 1986, evaluated four water supply alternatives. Alternative A was for surface water only, Alternative B was a conjunctive use project (groundwater and surface water), and Alternatives C and D were based on groundwater only. The report was inconclusive as to a recommendation, although Alternative D assumed that a groundwater supply could be identified that would only need to address iron and manganese removal. As a result of this assumption, Alternative D was by far the least cost alternative for the development of a municipal water supply. The projected monthly cost per residential user was approximately half that of the next less costly alternative.

In a subsequent amendment to the study in 1987, Alternative E was identified that assumed the source of supply to be a new well in the vicinity of an existing 6-inch well, which served as a test well and was named the Warheit Well. This well is located to the southwest of unincorporated Pescadero, in a geographical location that had not been previously considered, on top of a ridge, adjacent to the Pacific Ocean. Further analysis determined that this well had the required capacity and water quality. However, a second well was necessary for redundancy in the event of failure of the first well or pump. Cost estimates for this alternative were even lower per residential user than Alternative D of the original study.

In 1992, the second well (Well No. 1) was constructed approximately 300 feet north of the Warheit Well. The Warheit Well was also developed as a standby well in 1992 and is designated as Well No. 2. Completion details for the two wells are slightly different with Well No. 2 being screened at depths from 215 feet to 249 feet at which point the well is filled with bentonite and sand. Well No. 1 was completed to the depth of 260 feet and is screened at depths from 210 to 250 feet. Both wells were constructed with PVC casing and slotted screen with a gravel envelope. Following the completion of the 140,000 gallon steel storage reservoir, the system was put into operation as the sole source of supply for domestic and fire flow water for CSA 11.

Both Wells No. 1 and 2 are situated in the Pigeon Point formation. When Wells No. 1 and 2 were completed, this formation at this location was saturated from approximately 110 feet above Mean Sea Level (MSL) to well below MSL. Well depths in the Pigeon Point formation extend to well over 500 feet below MSL, suggesting that Wells No. 1 and 2 are not taking full advantage of the full saturated thickness (i.e. storage availability) of the formation.

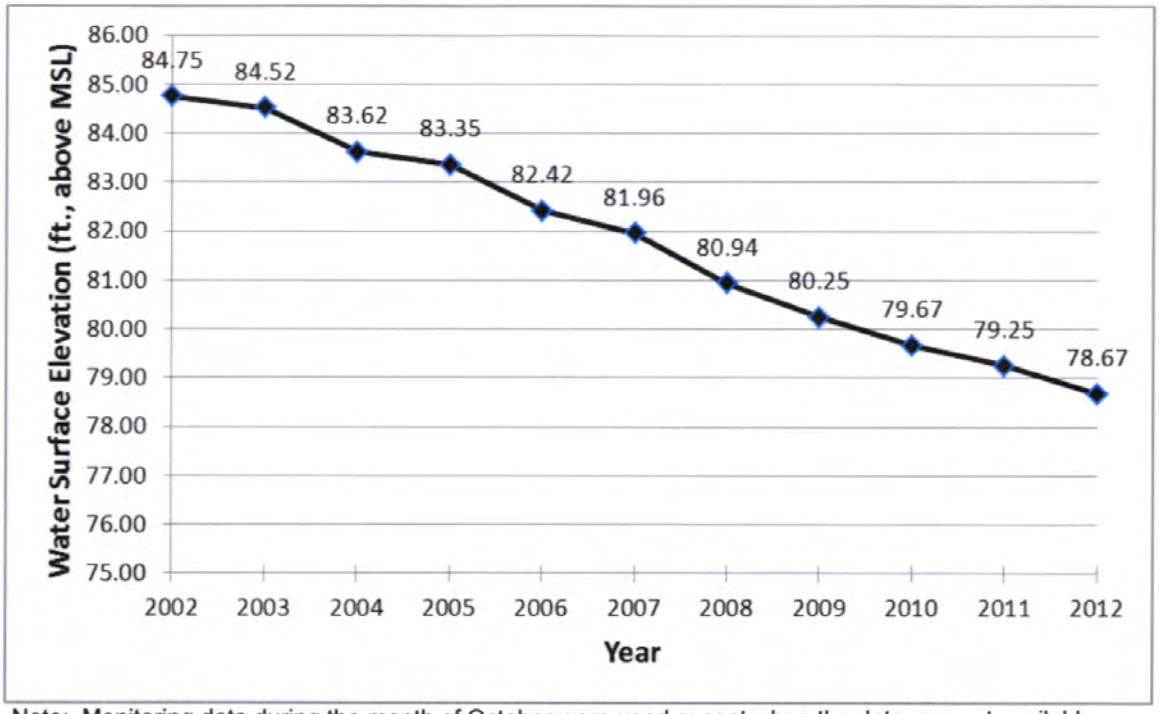
When initially constructed, the static water level in the wells was approximately 106 feet above MSL, whereas by 2002 the level had dropped to approximately 90 feet above MSL (a drop of 16 feet), with the top of the screens for Well No. 1 (the production well) and Well No. 2 (the standby well) at 66 and 70 feet above MSL, respectively. As a result, the County of San Mateo retained Todd Engineers to perform an assessment of the source water for the wells, which was summarized in the *Assessment of Source Water for the Pescadero Water System – CSA 11* ,Todd Engineers, March 2002. In the 2002 study by Todd Engineers (Todd Report), the Warheit Well is referred to as Well No. 1, and the production well is referred as Well No. 2. At some point after the

Todd Report was prepared, the well numbering system was reversed so that the production well became Well No. 1 and the Warheit or standby well became Well No. 2.

The Todd Report identified the rate of decline of the static water level and made a projection of the number of years each well will have before the pumping water level would encroach into the well screen area, thus causing cascading water. This study also presented some physical and operational changes for the water system, including monthly monitoring of static and pumping water levels. It was also recommended that a new production well be constructed at a depth of 100 feet below MSL so that storage in the aquifer can be more fully utilized and remain as the sole source of water supply for CSA 11.

In response to the Todd Report and to comply with Condition No. 4 of CDP 90-62, a monitoring program for water levels was established. Results of the water level monitoring from 2002 to 2012 are presented in Figure 1, below.

Figure 1. Static Water Levels in Well No. 1



Note: Monitoring data during the month of October were used except when the data was not available.

Current Conditions

The current static water surface elevation in Well No. 1 is projected to be approximately 78.5 feet above MSL. This projection is based on the assumption that the water level is continuing to fall at the same rate since the establishment of the monitoring program, as the level could not be measured at the time of this study. During a field visit on January 8, 2013, it was documented that the County's water level recording device had become stuck in the plastic pipe attached to the side of the metal drop pipe and its position precluded inserting another device in the plastic pipe to measure the water level. The projected level demonstrates a significant decline from the original static level of 106 feet above MSL in 1992. The downward trend in water surface elevations, as

shown in Figure 1, demonstrates that the static groundwater level will continue to decline in the long-term in response to pumping.

The significant issue regarding the water surface elevation during pumping is its proximity to the screens. If, during pumping, there is a significant difference between the water level in the well and that in the adjacent aquifer and the screens are exposed, air entrainment can occur. This difference in elevation can cause water to cascade into the well, which in turn will entrain air and cause the pump to cavitate and lose capacity. Ultimately, cavitation can destroy the pump, or the air entrainment will cause the pump to lose prime and cease pumping. While the Todd Report made note of the static water level and the height above the screens, the more significant issue now with the continuing decline in static water levels is the pumping water level.

Currently, Well No. 2 is operating as a standby well in conformance with Condition No. 2 of CDP 09-62. Therefore, to utilize this well, Operations Staff must notify the California Department of Public Health (CDPH) and perform the necessary water quality testing. It was noted that during an emergency condition on August 23, 2011, the pumping rate from Well No. 2 had declined significantly from its historical value of approximately 60 gpm to 6 gpm. This decrease in the production could be due to a variety of factors, such as decreased well efficiency which is reflected in a decrease in the specific capacity of the well (gpm/ft) during draw down. Thus, this increase in draw down will create a higher pumping head which will reduce the output of the pump. In addition, based on the decline in the static level, the pumping water level will be in the screened area of the well which can cause cascading water and thus entrained air and lower pumping rates. This lower pumping level may be responsible for the change in water quality (higher nitrate) as water is being drawn into the well from a different water bearing zone in the formation.

Well No. 1 has a reported specific capacity of approximately 5.4 gpm/ft of draw down, which based on current static water levels of approximately 78.5 feet above MSL and a pump rate of 100 gpm, would put the pumping water level at approximately 60 feet MSL or just below the top of the screens at 66 feet above MSL. If the efficiency of the well has changed over time due to formation or screen fouling, then the pumping water level would be lower and thus further into the well screen. There have been two occasions when the pump for this well needed to be replaced within the last few years, the first occurring in 2009 and the other in August 2011. During the August 2011 failure, CSA 11 had to resort to providing bottled water and other measures to address the short-term water supply needs until the pump could be replaced. Also, upon replacing the well pump in 2011, the pump was set at a deeper depth to address a concern regarding pumping water level and submergence of the well pump.

Water demand during 2012, was estimated to be approximately 24 acre-ft, which is consistent with the historical annual demand. Demand management measures such as low flush toilets, low flow shower heads, and high efficiency washers will reduce demand.

Conclusions

CSA 11 water system's Wells No. 1 and 2 were constructed in the portion of the Pigeon Point formation that is located above MSL. This formation is specific to this location and the saturated portion of the formation is at least 700 feet thick; however, only the portion of the formation that is above MSL is available to Wells No. 1 and 2. Current pumping exceeds the amount of recharge as evidenced by the declining water surface elevation. Continual declines in the water surface elevation will expose more of the screen during pumping and exacerbate the cascading water and associated cavitational impacts on the pumps in both wells It is estimated that at the current rate of water level decline, replacement of the pump will occur much more frequently until the water surface is at a level that it cannot be pumped from the well. It is currently estimated that this condition and thus failure of the well will occur within the next 5 to 7 years at the most.

To alleviate this situation, a new well with the screens located well below MSL will provide for adequate draw down of the pumping water level well above the new screen location. By design, the new well will have the screens located approximately 100 feet below MSL and well below the existing screens in Wells No. 1 and 2. Therefore, the screens in this new well would be well below the current pumping water level. In addition, locating the screens at this depth will allow the well to take advantage of more storage volume within the formation. Assuming the current level of water use and rate of decline of the water surface elevation, it is estimated that this new well will have a longevity of well in excess of 50 years. Reductions in demand due to water conservation together with potential for additional recharge by local stream flow will only lengthen the estimated life of the well.

To further improve the hydraulic performance of Well No. 1, it is proposed to locate the new well approximately 800 feet to the north of Well No. 1, thereby minimizing the mutual interference between the two wells. This greater separation, together with operating the wells in an alternating lead lag scenario, will provide more time for groundwater levels in the vicinity of Well No. 1 to recover.

Well No. 2 has limited capacity and cannot provide the average daily demands for the CSA 11 water system. Rehabilitation of Well No. 2 using standard chemical and physical methods to restore its hydraulic capacity would be difficult if not impossible as PVC casing can be easily damaged or destroyed by these techniques. Therefore, the CSA 11's water supply system does not have the redundancy requirements for supply, as required by CDPH for municipal systems, which at a minimum would require that each well be able to address the maximum daily demands of approximately 20,000 gallons.

In the Memorandum titled, *Pescadero Fire Flow Analysis*, Winzler & Kelly, May 2009, a deficiency in available water storage was identified. The current storage reservoir with a working capacity of 140,000 gallons does not have the capacity required to address fire flow requirements of 1,500 gpm for 2 hours, 180,000 gallons, plus operational and emergency demands. While the exact amount of emergency storage is Agency-specified, it should be well over 100% of Maximum Daily Demand as there is no backup power for the system. Therefore, adding additional storage in the amount of 140,000 gallons for a total of 280,000 gallons is reasonable as demonstrated by the recent failure of Well No. 1 in August 2011. CSA 11 did not have any redundancy of supply and therefore had to resort to bottled water for domestic consumption. In addition there was no fire flow storage.

Recommendations

Based on the review of historical and current information presented above, HydroScience recommends the following to address the long-term water supply reliability for the CSA 11 water system.

1. A new gravel packed well with a 12-inch diameter casing should be drilled adjacent to the existing storage reservoir to provide for maximum separation from the existing Well No. 1 and No. 2. This well should be completed to a depth of at least 100 feet below MSL, total depth approximately 300 feet, with the screens placed at the bottom of the well. This well would take advantage of the overlying storage in the formation and potential recharge from the local creeks in addition to the direct rainfall. Drilling the new well will provide CSA 11 with the redundancy required by CDP 90-62 and CDPH, and a more sustainable water supply.

2. The new well should be constructed to current well construction standards with a steel casing to facilitate any future rehabilitation efforts, a deeper sanitary seal and appropriate pump pedestal and site drainage facilities constructed to CDPH Standards. In addition, downhole pressure transducers should be installed to facilitate the collection of static and pumping water level data to provide for a better understanding of well performance.

3. It is recommended that this well have a steel casing of 12-inch diameter minimum to facilitate future downhole rehabilitation using mechanical and chemical methods, and pump installation with a sounding well attached to the pump column. This well should be designed for a capacity of approximately 100-150 gpm to allow for pumping during non-peak power usage times to reduce operational costs.

4. The pump control system should be configured to allow for the new well and Well No. 1 to alternate back and forth as the sources of supply for the storage reservoir, with Well No. 2 remaining as the emergency standby well. This new pump control system should allow for collection of the various system operational data such as water levels in the wells and reservoirs, flow rates, etc. and transmittal of that data or alarm settings to an appropriate operations center.

5. A second storage reservoir, to be constructed in proximity to the existing storage reservoir, is needed to provide for the additional storage requirements previously identified for operational requirements, fire flow and emergency demands. Both tanks should be hydraulically connected to enhance system operation.

Project Description
Water System for the Pescadero Rural Service Center

County of San Mateo

K/J/C 6515
August 1986

Kennedy Jenks Chilton

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Plate 3 - Alternative "C" and "D"

INCLUDES 78 RESIDENTIALLY ZONED PARCELS AND 32 COMMERCIALLY ZONED PARCELS OF WHICH 71 RESIDENTIAL AND 25 COMMERCIAL PARCELS ARE DEVELOPED. SOME COMMERCIAL PARCELS ARE USED FOR RESIDENCE AND SOME RESIDENTIAL PARCELS HAVE MORE THAN ONE RESIDENCE SUCH THAT

Presently, the community contains about 130 residences, 16 commercial establishments, several churches and an elementary school of about 150 students.

ALTERNATIVE "E" - WARHEIT WELL

This alternative assumes as its source the development of a well, or wells, in the vicinity of an existing 6" well called the "Warheit Well" to the southwest of the community.

On the basis of preliminary water quality tests made on water from this well, treatment would be limited to corrosion control, chlorination, and, optionally, fluoridation.

A preliminary well test shows that this well is likely to have the capacity required to supply the community. Furthermore a system using the well as a source appears to be the most economical, with an average monthly bill of approximately $24 for the average residential user.

This alternative is shown on Plate 4. Alternative E assumes as its source a well, or wells, in the vicinity of the test well drilled in April of 1985. The purpose of the 1985 test well was to develop a source for a proposed low income housing development proposed at that time.

. further testing shows that a well at the Warheit site has the required capacity, then a water system with this as a source has the potential for being the most economical of the alternatives, costing an average of approximately $25/month for the average residential user.

Although the existing well seems likely to have the necessary capacity, a second well should be drilled and equipped to provide redundancy for this vital feature. The second well would be available in case of the failure of the first, and for planned maintenance. As stated before, because the source is in the southwest rather than the northeast, the distribution system is somewhat different than the other four.

The results of preliminary water quality testing indicate that the only water treatment required would be chlorination, treatment for corrosion, and possibly flouridation for a well at this site. The distribution piping to provide for consumptive demand will be 6" in diameter and the probable tank site will be on a hill to the south of Pescadero.

An alternate tank site might be to the north of the community, depending on the availibility and cost of land and relative suitability of the two tank sites. If fire flows are to be provided, one line would increase in size to 10" in diameter in order to provide for fire flows in the business area. Cost estimates assume 6" diameter pipes.

The tank, if sized for consumption demand only, would be approximately 30,000 gallons; if for fire flows, 330,000 gallons. Cost estimates assume a 30,000 gallon tank.

TABLE 7

Preliminary Estimate
Alternative "E" - Potable Quality Water, Warheit Location

Item	Unit	Unit Cost	Quantity	Total	
Well	Each	10,000	2	20,000	
12' x 12' Bldg,	Each	15,000	1	15,000	27,000 W.T.P.
Misc Piping, and Chlorination					
Paving and Site Work	Each	5,000		5,000	
Generator Set	Each	7,000	1	7,000	
Pipeline, 6" PVC	Lin. Ft.	15.00	13,000	195,000	
Temporary Paving	Lin. Ft.	1.50	7,600	11,400	
Pavement	Lin. Ft.	7.50	5,600	42,000	
Treated Water Storage	Gal.	1.00	30,000	30,000	
Gate Valve	Each	800	5	4,000	
Services-Near Side	Each	300	74	22,200	
Services-Far Side	Each	400	74	29,600	

SUBTOTAL:	$ 381,200
17% ENGR, CONSTR. MGMT, FINANCIAL ADMIN.:	64,804
10% CONTINGENCY:	44,600
TOTAL:	490,604

INCREASED COST FOR FIRE PROTECTION

Increased Storage Cost	$180,000 gal @ 30¢/gal	$54,000
Inceased Pipeline Costs		
3000' of pipeline increased from 6" to 10"	5400 ft as an increase of $5.34/ft	28,836
30 Fire hydrants @ $1200		36,000
	SUBTOTAL:	$118,836
	17%, ENGR. MGMT, FINANCIAL ADMIN:	20,202
	10% CONTINGENCY:	13,904
	SUBTOTAL:	$152,942

CHAPTER 1
EXECUTIVE SUMMARY

This report is intended to provide a project description and preliminary design of a Water System to serve the Community of Pescadero and to provide other ancillary information that will be helpful for funding, public information, and final water system design.

Another consultant will prepare an EIR for the project. This report is to be used by the EIR consultant for the Project Description portion of the EIR.

GENERAL

The Community of Pescadero is located in San Mateo County about 40 miles south of San Francisco and about 2 miles inland (east) from the Pacific Ocean. It is designated as a Rural Service Center in the San Mateo County General Plan.

Currently water is being supplied by private wells. These wells are shallow and it is well documentated that most are delivering water with excessive nitrates and bacteria. Most of Pescadero's residents and businesses buy bottled water for drinking. One business, a restaurant, reports a bottled water bill of over $200/month.

Presently the community contains about 130 residences, 16 commercial establishments, several churches and an elementary school of about 150 students.

WATER SYSTEM ALTERNATIVES

There are four alternative water systems described in this report. These alternatives are identified as Alternative A (Honsinger Creek), Alternative B (Conjunctive Supply), Alternative C (Brackish Well) and Alternative D (Potable Quality Well). Each alternative varies by its source of water, raw water storage provided and treatment required.

The three alternatives which appear to be most economical each require an underground water supply, which is yet to be confirmed. Since the potential cost savings of these alternatives are very large, and because of the likelihood of success, it is recommended that a test well program to confirm an underground source be undertaken as soon as possible. The results of this program will be used to determine the most economically feasible alternative, and will be useful in developing the final design of the system. The final design may incorporate parts of several alternatives, depending on the results of the test well program.

Each of the four alternatives has the same treated water distribution system. The likely site for the treatment plant is the same for each alternative, although as stated earlier, the type of treatment will vary, depending on the source. The four alternatives are described below and are shown on Plates 1, 2 and 3 in the Appendix.

ALTERNATIVE "A" - HONSINGER CREEK

This alternative uses Honsinger Creek as its source. Hydrologic studies show that approximately 100 ac-ft. of raw water storage is required to provide a reasonably reliable supply. Because of the large volume of raw water storage, this alternative is the most expensive of the four and may not be affordable. It would only be selected if the recommended well testing program were a failure and an underground water source could not be found. The cost for this alternative is estimated to be approximately $70/month for the average resident.

ALTERNATIVE "B" - CONJUNCTIVE SUPPLY

This alternative uses Honsinger Creek as a source during wet weather when flows are high and a well as a second source during dry periods. The raw water storage needed for this alternative is approximately 5 ac-ft. It is probable that the water produced from the well will be brackish requiring reverse osmosis (R.O.) treatment during the time the well supplies the water. The unit cost of water treated by R.O. is very high, but since the well will only supply water during dry periods, only 10% to 15% of the water served will require R.O. treatment, making this alternative relatively economical. The average residential water bill under this alternative is estimated to be approximately $45/month.

A unique advantage of this alternative is the additional reliability afforded because of source redundancy.

ALTERNATIVE "C" - WELL SOURCE PRODUCING BRACKISH WATER

The water source for this alternative is a well producing brackish water requiring R.O. treatment. In this case the unit cost of water treatment is very high. On the other hand, the capital costs are relatively low so this alternative is about the same cost as alternative "B". The monthly water bill is estimated to be approximately $47/month for the average residential user.

ALTERNATIVE "D" - POTABLE QUALITY WELL

This alternative assumes that the water source will be a well producing potable (drinking) quality water, water not requiring R.O. treatment. Finding such a well is the best possible result of the well testing program.

In this case water treatment will be conventional with iron and manganese removal the only unusual feature. Unit water treatment costs will be reasonable and capital costs are the least of all the alternatives. The result is that this alternative is the most economical of the four. The water bill for the average residential user is estimated to be $28/month.

COMMUNITY WATER PLAN FOR THE TOWN OF PESCADERO

COUNTY OF SAN MATEO

SEPTEMBER 1976

This report was funded by Federal Community Development Block Grant Program funds.

Koretsky King Associates, Inc.
A Subsidiary Of ANDERSON-NICHOLS Co.
1485 Bayshore Boulevard
San Francisco, California 94124

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SUMMARY

The primary objective of this study is to develop preliminary engineering design, cost estimates and implementation requirements for a Community Water Supply to serve the Town of Pescadero and the proposed Farm Worker Housing Development. We have investigated the potential for a combined Water Supply System to serve both the Town and Farm Worker Housing and the potential for independent supplies. We have evaluated groundwater, surface water or a combination for the water source.

WATER NEED

Population projections were furnished by the County Planning Department (see Appendix A). The projections indicate the Farm Worker Housing Development would have a population of 250 persons. A Pescadero Water Service Area was defined with community participation. The minimum population (includes Farm Worker Housing) for sizing the distribution system was set at 1200 persons, and for water source facilities at 2000 persons.

Water demand for Farm Worker Housing is 25,000 gallons per day (28 acre-feet per year) based upon a population of 250 people with an average daily demand of 100 gallons per person. The water demand for a Pescadero Water Service Area is 288,000 gallons per day (322 acre-feet per year) which is based upon a projected population of 2000 persons. Average daily demand of 150 gallons per person is used for all areas other than Farm Worker Housing.

WATER SOURCE

The need for 322 acre-feet of water per year to supply the Town of Pescadero Water Service Area will require substantial transmission, treatment and distribution facilities. One does not design such facilities to tap an uncertain or marginal water supply. A reliable water supply is a prime requirement.

We have investigated both surface water and groundwater as potential sources for water supply. After extensive investigation, we can state categorically that no local groundwater source can supply unallocated water yields of sufficient reliability to serve as a starting point for the formulation of a water plan. In fact, it is doubtful that even marginal, temporary or uncertain supplies of adequate quantity and quality can be developed either for the Pescadero Water Service Area or for an independent Farm Worker Housing supply.

The opposite is true for surface water. The average annual flow past the Pescadero gage just east of the Town is 30,200 acre-feet. Approximately 75 percent (22,650 acre-feet) of this flow occurs during the period December through March. A majority of this winter flow is currently wasted to the ocean. A similar condition exists in Butano Creek which has approximately half the quantity of flow as Pescadero Creek.

Based upon these findings, a surface water supply is recommended to serve the combined needs of the Town of Pescadero and Farm Worker Housing. This will require a storage reservoir of sufficient size to provide a reliable firm yield of 322 acre-feet of required demand during the most critical dry period (water years 1959-60, 61 and 62).

A search of available literature, field engineering and geological reconnaissance, and a comparison of available alternatives, led to the selection of an off-stream storage reservoir in the Arroyo de los Frijoles canyon with diversion of winter flow from Butano Creek (currently wasted to the ocean).

APPARENT BEST PROJECT

The Apparent Best Project Facilities are shown in plan view in Figure 1. They consist of a zoned rockfill and earthfill dam (maximum height of 44 feet above streambed) in Arroyo de los Frijoles. This will impound a reservoir with 1000 acre-feet of storage capacity. A 400 horsepower pumping station and 18-inch diameter pipeline will divert waterflow from Butano Creek to the reservoir. An 8-inch diameter transmission line and a 50 HP pump station will take water from the outlet works of the dam and deliver to a modular-type treatment plant. Treated water will be delivered by gravity to a ground storage tank located above the Town. A distribution system will deliver water to individual users and is sized to provide the required fire flow. Distribution would be provided to any Farm Worker Housing site with a 35 HP fire flow pump. An investigation of phasing the Apparent Best Project Facilities indicates no advantage can be gained; therefore, it is recommended to initiate the project in its entirety from the beginning.

COMBINATION AGRICULTURAL - DOMESTIC STORAGE

The economic, cultural and environmental setting of the Town and the proposed Farm Worker Housing Development is founded on the surrounding agriculture (and, to a much lesser extent, on tourism). Thus, the health of the region's agri-industry is vital to the well-being of the domestic community. Yet agriculture in the area suffers from a deficient and uncertain water supply.

IMPLEMENTATION

The 'near-term' organizational structure to carry forward toward project implementation (until the permanent operating entity is formed) is suggested as being best achieved by the 'concensus' process used so effectively up to now. This structure would consist of four interacting components:

1. The County of San Mateo (Public Works Department as Lead Group, Environmental Health and Planning Departments)
2. The South Coast Water Committee
3. The Peninsula Water Agency
4. The South Coast Council

Should a domestic/agricultural project be decided upon for initial development, farmer respresentation should be added to the South Coast Water Committee.

Immediate implementation steps and actions required are:

1. Processing of this report
2. Initial water rights application filing
3. Funding application filings
4. Conditional agreements for property and easements
5. Environmental Impact Report
6. Assess the viability of a domestic/agricultural initial system
7. Decide upon the desired permanent operating institutional entity and initiate steps toward its formation
8. Initiate filings for several required permits and approvals
9. Develop and carry-out program for ongoing communication

Certain required follow-on actions and steps are described.

hour demands are generally expressed as a percentage of the average demand. The following demand rates are proposed for this system:

Maximum Month	160% of Average
Maximum Day	200% of Average
Maximum Hour	400% of Average

Using the above average demands, the water required to supply 2000 people will be 294 acre-feet per year for the Town plus 28 acre-feet per year for the Farm Worker Housing, a total of 322 acre-feet/year.

Fire flow within the water service area will be 1000 gpm for five hours with a residual pressure of 20 psi. The Farm Worker Housing will have a fire flow of not less than 500 gpm with a residual pressure of 20 psi.

SURFACE WATER

CONCLUSIONS

There is no possibility of finding a groundwater source of sufficient reliability to use as the basis of a design for a water plan. This is consistent with the findings of previous studies and of investigations elsewhere along the San Mateo coastside.

HYDROLOGY

Three streams were studied as potential sources of surface water supply - Pescadero Creek, Butano Creek and Little Butano Creek. Continuous stream gage records on Pescadero Creek (1951-52 through 1973-74) and Butano Creek (1962-63 through 1973-74) provide a sound basis for evaluating these sources.

As indicated in Bulletin 138, the critical period of dry years for determining the firm yield of relatively small reservoirs is confirmed to be the water years 1958-59, 60, 61 and 62. For Pescadero Creek, the average flow in this 4-year period (10,000 AF/year) is only 32 percent of the overall average flow in the 23-year period of record (31,000 AF/year). However, this dry period is both preceded and succeeded by years of substantially greater than normal flow.

For Butano Creek and its southerly tributary, Little Butano Creek, unrecorded runoff during the dry period was estimated using two basic hydrologic methods. First, the 12 years of concurrent runoff records for Pescadero and Butano Creeks were compared. From these concurrent records, the average annual runoff from the Butano Creek watershed is a factor of about 50 percent of the runoff from the Pescadero Creek watershed. The annual flows for Butano Creek during the dry period are based on this factor. Second, the product of drainage area and weighted mean annual precipitation for Butano and Little Butano Creeks were compared as a constant ratio. Assuming similar runoff characteristics for these watersheds, the annual flows for Little Butano Creek are based on Butano Creek flows using this area-precipitation ratio.

The recorded and derived annual flows and runoff characteristics for Pescadero, Butano and Little Butano Creeks are shown in Table 3-1.

As discussed subsequently, streamflow from Butano Creek diverted to storage in Arroyo de la Frijoles is the most attractive surface water scheme. Using the daily flow records of Pescadero Creek for the period 1957-58 through 1961-62 and of Butano Creek for

The critical period of dry years for determining the firm yield is the water years 1958-59, 60, 61 and 62. A daily reservoir operation study was performed using an operating diversion capacity of 7.5 cfs. A total reservoir capacity of 1000 acre-feet is required to provide a firm water supply yield of 322 acre-feet per year. The storage allocation would be 240 acre-feet for sedimentation and 760 acre-feet for active storage.

OUTLET CAPACITY

The reservoir in Arroyo de la Frijoles must be capable of passing the required amount of agricultural water between the Bean Hollow and Lake Lucerne reservoirs. An outlet riser would be provided with separate parts for demand releases and sediment sluicing. A 30-inch outlet pipe would provide about 80 cfs capacity which would drain the entire active storage of 760 acre-feet in 5 days.

The outlet pipe would be valved to pass only the required agricultural releases. Also, a separate takeoff from the outlet pipe would be used for the municipal supply. This takeoff would be sized for about 2 times the average daily demand. It will consist of a pump station and pipeline to the treatment plant on the hill above the reservoir.

COST ESTIMATE
FARM WORKER HOUSING DEVELOPMENT
SEPARATE WATER SUPPLY
(Population 200 - Fire Flows Included)

1.	Well, complete	$ 10,000
2.	Treatment Plant, complete	75,000
3.	Pumping Plant and Appurtenances	5,000
4.	Transmission Line	50,000
5.	Distribution Facilities (including Storage Tank)	70,000
	Subtotal	$210,000
	Engineering, Administration, etc. @ 25%	53,000
	Total Capital Cost	$263,000
	Annual Cost - Including Reverse Osmosis	$10,000

COST ESTIMATE
APPARENT BEST PROJECT FACILITIES

1.	Diversion Facilities	$110,000
2.	Dam, Spillway and Outlet	216,000
3.	Transmission and Treatment Facilities	227,000
4.	Distribution Facilities	253,000
*5.	Farm Worker Housing	48,000
	Subtotal	$854,000
	Engineering, Administration, etc. @ 25%	211,000
	Total Capital Cost	$1,065,000
	Annual Cost - Operation, Maintenance, Energy, and Administration	$20,000

*For this estimate the Phase II Farm Worker Housing site was priced. If either of the other two sites are used the cost will be somewhat less.

NOTE: Costs are present day costs. Allowance for inflation is not included.

C. Rights of overlying owners

The owners of land overlying a groundwater basin have correlative rights to the use of water from the basin. Like the riparian rights, the overlying rights have no priority as among themselves based upon time of use. In the event that the total demand of overlying owners exceeds the safe annual yield, the yield must be apportioned among the overlying owners. Presumably the same factors considered in apportioning water among riparian owners will be applicable to apportionment here.

The right of the overlying owner is restricted to the use of water on the overlying land.

D. Appropriative rights

To the extent that the safe annual yield is not exhausted by the overlying owners, the surplus is available for appropriation. Water withdrawn pursuant to an appropriative right may be used on nonoverlying lands. The priority of appropriative rights is determined on the basis of priority in time of use.

Unlike the appropriative rights to watercourses, there is no administrative control over the acquisition of appropriative rights to percolating groundwater.

Table 7-3 and Figure 7-4 portray existing water rights related to the proposed project.

TABLE 7-3

EXISTING WATER RIGHTS RELATED TO PROPOSED PROJECT

App. No.	Date Filed	Applicant	Creek	Season	Q	Use	Status
3433	5/22/23	Emma D. Muzzi	Little Butano	11/1- 3/31	480AF	I	L
5671	8/29/27	Butano Land & Development Company	unnamed	1/1-12/31	25^{k}G/day (12AF)	D	L
9112	9/10/37	Emma D. Muzzi	Little Butano	11/1- 5/1	310AF	I	L
17198	7/24/56	Rita Giannini	Butano Creek	3/1- 6/30	5.2AF	I	L
17590	5/09/57	Oku Inc.	Butano Creek	12/1- 4/1	40AF	I	L
17740	7/25/57	SF Bay G.S.C.	Girl Scout Creek	1/1-12/31	6.25^{k}G/day (3AF)	D	L
19551	7/14/60	Maurice Oppenheimer	Butano Creek	5/1- 4/30	0.32cfs (4AF)	D, I	L
20711	4/05/62	Thelma A. Keyes	Butano Creek	12/1- 6/1	40AF	I	L
					895AF		

Refer to Figure 7-4

All above are upstream of Proposed Project Diversion.

I	=	Irrigation
D	=	Domestic
L	=	License
AF	=	Acre Feet
G/day	=	Gallons per day
k	=	1,000
Q	=	Quantity
cfs	=	cubic feet per second

Flume - Little Butano Creek to Upper Bean Hollow

There appear to be no recorded filings appropriating the flow in the Arroyo de los Frijoles. A flume connecting the Little Butano Creek with the Arroyo de Los Frijoles upstream of the Bean Hollow Lakes exists, but is in an advanced state of disrepair. It apparently was used to divert water to storage in those Lakes (in the past) from diversion points of Licenses 3433 and 9112, but has obviously not been used for several years, nor is it functional now.

The proposed project diversion point lies downstream of any recorded water rights or on any creek or stream tributary to it. Thus, there are no recorded water rights below (i.e., downstream) the proposed project diversion point.

Recorded water rights total 895 acre-feet annually on a year-round basis. 790 acre-feet, or more than 88%, resides in two Licenses, 3433 and 9112, both with the same point of diversion on Little Butano Creek. License 3433 has a limiting rate of 5.26 cubic feet per second diversion to storage, which is equivalent to 326.12 acre-feet per month. Similarly License 9112 is limited to a rate of 9.2 cubic feet per second, which is equivalent to 480.4 cubic feet per month. But since this latter license is also limited to a diversion of 310 acre-feet per annum, its monthly maximum is, therefore, 310 acre-feet per annum.

There thus appears to be no reason that the proposed project cannot successfully file for and perfect its required water rights. An application to divert winter flows from Butano Creek at the proposed project diversion point, at rates and in quantities set forth earlier in this investigation, should be filed promptly. Follow-on discussions with existing upstream license holders would be in order.

PROPERTY AND RIGHTS-OF-WAY

Wherever possible, proposed project facilities should be located on public - preferrably County - property. For example, insofar as is feasible, pipelines should be located within County road easement limits.

Where this cannot be done, a definition of required rights-of-way should be developed and a program of discussion and negotiations with private landholders undertaken. Frequently their objections, if any, can be overcome by facility relocations which do not materially affect the operation or cost of the proposed project. The exercise of eminent domain or inverse condemnation should be used only as a measure of last resort.

1 - Primary direction by the County of San Mateo (Public Works, as lead Department, Environmental Health, and Planning)

2 - South Coast Water Committee

3 - Peninsula Water Agency

4 - South Coast Council

Finally, reference is made later to the exploration of a domestic/agricultural potential. Should this eventuate, farmer representation will need to be added - possibly by inclusion in the South Coast Water Committee:

STEPS AND ACTIONS REQUIRED

All steps and actions should be programmed and reviewed through the process described above.

I - Immediate:

a)	This Report	Circulate for comments to: County Departments, South Coast Water Agency, Peninsula Water Agency. Evaluate comments. Print Final Report with comments appended at back. Circulate Final Report to all involved and interested agencies, entities and individuals.
b)	Water Rights	File initial Water Rights Application without exhibits - which can be submitted up to six months later. Point of diversion and storage can be changed, if necessary, when exhibits are submitted. Copies of Final Report should accompany initial application and an information copy transmitted to the State Division of Dam Safety.
c)	Farmers Home Administration (FHA)	Copies of Final Report should be transmitted to, and reviewed with, FHA--Morgan Hill followed by FHA--Woodland.

Pescadero Municipal Advisory Council
September 13th, 2011
Pescadero Community Church Social Hall

I. Roll Call
Present: Darius Dunlap, Catherine Peery, Kate Haas, Donald McDermott, Rob Talbot, Greg Bonaparte, Rob Skinner, Jake Bowman, Recording Sec'y.
Excused absence: Carolyn Shade, get well soon!

II. Swearing in Ken Pesso

III. Clara Murphy, Youth Commissioner appointed.
A. She will serve until May
B. A documentary film of her experience will be screened in June.
C. Clara's first assignment will be this coming Saturday to count the fish in the estuary.

IV. Lt. Lisa Williams, Sheriff of Coastside Sector
A. With 26 years experience, she assumed post 9 mos. ago
B. Now her responsibilities include HMB
C. Coastside zone from Skyline, Pacifica to S. Cruz county line.
D. Mike Smeizer & Alfredo Gardino are assigned to Pescadero
1. They're working with schools, hold movie night
2. Citizens' Police Academy en español serves a need for communication with the Spanish-speaking community on issues, such as 911 dispatch, drugs & gangs.

V. Dept. of Public Works Director Jim Porter
A. Ann Stillman, Deputy Dir. of Engineering & Resource Protection
B. Gave county's version of events leading to CSA11 water crisis
C. Will go into further detail at CSA11 ratepayers meeting
1. To be held sometime mid-October, still scheduling room
2. Gave basic overview of well and pump site
D. Reviewed the order of events from the nonoperation of the pump
E. Focused on State Dept. of Health's boil order requirements
-multiple lab tests required, expedited by county officials
F. Emergency water supplies, fire protection, other measures taken
G. Decided not to haul more water as replacement pump installed
H. Pump failure most probably due to setting pump too high in the water column, which resulted in the pump sucking air.
I. Time was needed to distribute Chlorine evenly through pipes.
J. Alarm system was disabled because it never worked, false alarms.
K. Some possible next steps forward include:
1. Reviewing the maintenance schedule
2. The second well should be made fully functional.
3. A lead lag set up to exercise both wells and both pumps.
4. New, improved alarm system installed
L. The well will be televised to investigate aquifer level and position of screens.
-level has declined an estimated 0.7 ft./year
M. Pipe will also need to be replaced.
N. Comments and questions included:
1. Responsiveness of county officials appreciated.

2. Maintenance seemed lax, employees not knowledgeable
-Recent employee turnover possibly lead to this situation.
3. Failure to replace or repair the alarm system was oversight.
4. Previous failure in 1996 may also have been due to inappropriate pump depth location
5. Pescadero (CSA11), La Honda (CSA7) and Memorial Park are the only water systems under direct county management, so the county lacks scale and depth of organization committed to operating water systems.
6. Other options should be explored, from independent Community Service District to privatization as a Municipal Water Co.
7. Engineering should be at least double-safe
8. Permits for well, tank expire in 2012
9. Who takes responsibility for emergency maintenance, liability for incompetence? Who audits and analyzes current system?
-A committee of ratepayers will be appointed to work with county to approve repairs and find way forward.
10. The County will not oppose a local takeover of the system.
11. Fireflow pressure could be provided by booster pump.
12. No additional repairs will be made before the ratepayers' meeting
13. Water quality is excellent, no additives necessary
14. State assumed direct regulation this year, unclear how state authority will proceed to regulate a system such as CSA11.
15. LAFCo meeting Sept. 21st best forum to address this.

VI. The County Board of Supervisors approves new PMAC Bylaws
A. Presented by Don Horsley
B. Don will also be holding office hours Thursday 9/15 at the Farmers' Market in Pescadero
C. He appreciates the resilience of the community in the face of the water crisis and particularly the contribution of individuals such as Steve Simms, Dante Silvestri, Frank Muzzi and Rob Talbott.
D. He invites comment about the new jail.
E. Arata Farm will be moving the maze off of prime ag land.
F. Redistricting means that he will also be covering Belmont.

(10 min. break)

VII. Capt. Mike Maskarich, CHP Area Commander
A. extends greetings to community from CHP command
B. explains CHP presence at big bike ride this Saturday

VIII. PMAC and the assembled community wish Carolyn Shade well.

IX. Reviewing August minutes
A. LAFCo meeting coming up Wed. 9/21 to be held at Social Hall
B. Presentations available online PescaderoCouncil.org
1. Kellyx's RCD preso posted
2. Transfer Station info
3. Greg's flood preso to be posted soon
C. Town sign a success at PAFF unveiling
D. AT&T follow-up continues, led by Rob T.
E. Traffic study will be completed next month

F. Capping the landfill is ongoing
G. Joe Simitian's office is being pursued.

X. Transfer Station Business Plan Analysis
A. Presented by Catherine Peery & Greg Bonaparte
B. Assumptions include mobile compactor, reducing labor overhead
C. Conclusion is that the station is viable, break-even or profitable
D. Missing mos. of data and some minor discrepancies exist
E. There is no outside market research included
F. No permit changes are assumed.
G. Community will need to learn to run the station
1. Talking to haulers for rates
2. Real costs of hiring labor explored
3. Rate structure can then be adjusted
H. Opportunities for reform exist, example:
It costs $3 to dump mattresses here vs. $30 at Ox Mt.
I. Next step is a meeting with Rob S., Jake B., Dante S. & Frank M.
Note: Lou Heine also expressed interest in community solid waste issues.
J. Potential "landmine" issues need to be uncovered
K. Desirable subcontractors should be identified.
L. Dept. of Public Works has granted an extension until Nov.
M. Karen McBride, Rural Community Assistance Corp. a resource
N. This could be a community asset that creates local jobs
O. Questions and discussion:
1. Will we have to pay rent? Jim Porter: negotiable.
-County wants to partner to reduce subsidy
2. What about recyclable pick-up in town?
-Dealing with Recology or Republic Services for local pick-up is different situation entirely.
3. What about liability? Business plan projection includes cost of liability insurance
4. Will there be more community input about progress?
5. Could we put the KPDO antenna up there? Maybe.
"Trash Talk" would make a great radio program!
6. There is no possibility of relocating the dump right now.
XI. Public Works Committee looks into painting the hydrants
A. Presented by Rob T. with input from CalFire
B. Rita is the only person in town who has painted her hydrant.
C. Saturday Oct. 1st is planned for wire-brush de-rusting, priming, and official color application. Caps must correspond to proper pressure.
D. Puente volunteers and CalFire personnel will accompany Rob T.
E. Questions and discussion included:
1. Can we paint the hydrants artistically?
-Rob will need to check with proper authorities for guidelines
2. Lou H. will check with art project at high school

XII. Darius D. unveils new PescaderoCouncil.org website design
A. It's a Wordpress implementation
B. CMS = Content Management System
C. Communications Committee will regulate content, user accts.
D. Google Group will still exist to disseminate announcements
E. Google Apps will provide Council members and helpers with specific functionality

regarding drafting documents.

F. Questions and discussion:

1. Agendas will be posted on the main page of the site.
2. The menus will be reworked to make it easier to locate audio recordings of the meetings as well as minutes.
3. The best way to find something is to use the search bar.

XIII. Officer Reports

A. Corresponding Secretary, Catherine Peery

1. Appointed to board of KPDO
2. High school “media arts” curriculum
3. KPDO is purchasing red truck for mobile studio
4. PMAC will draft letter of support
   -Rob S. moved, Jake B. seconded
5. Youth broadcast journalism with Puente
6. Board update: Celeste resigned, Daniel removed
7. Station Manager Shannon Bowman-Sarkisian introduces herself, extends offer of service to community, commends volunteers.
8. Linda Parnassus still involved, hired by Pacific Coast TV
9. Thanks to summer interns

B. Treasurer, Kate Haas

[Insert Treasurer’s Report Statement Here]
-Budget allocation from the County received.

C. Communications Committee Chair, Rob Skinner

1. Informal business survey on bicycle traffic finds 100% downtown businesses are in favor of continued bicycle tourism.
2. Bicycle parking needs signage to be organized.

D. Don McDermott, School Board Report

1. Thanks to donors:
   a. Denise Bettencourt for Athletic Equipment
   b. TomKat Ranch for 110 lbs. grass-fed beef
2. School improvement grant in question
   a. Need to document increased learning time
   b. Correction actions are in place
   c. Early morning, summer school and Saturday sessions
   d. Must reapply to Federal Dept. of Education
3. STAR tests are in!
   a. Pescadero Elementary improved.
   b. La Honda Elementary declined in score.

IX. Adjourn

Pescadero Municipal Advisory Council
December 11, 2012
Pescadero Community Church Social Hall

I.Reception: 6:30 to 7:00 PM

II. Call to Order – 7:00 PM Greg Bonaparte

Roll Call:
Darius Dunlap, Mike Polacek, Carolyn Shade, Donald McDermott, Rob Talbot, Greg Bonaparte, Rob Skinner, Ken Pesso

Absent with Permission: Kate Haas

III. Greg Bonaparte opens discussion on "Major Event". The County has passed resolution funding $542,000 to address the flooding and water issues in Pescadero. Greg reads the talking points: Short Term goals which are safety, message boards. Mid Term goals which are Dredging of the Butano creek at the Pescadero Road Bridge within the 100 ft wide County Right of Way. Long Term goals which are Flood Protection, Resource Protection and to that end, requesting support of the RCD.

Additionally to request funding for water system. Greg mentions that requesting $700,000 for new well and holding tank would yield 30 more years of dependable water supply.

IV. Carolyn Shade is called upon to announce the nominations for PMAC Officers. The following were her recommendations:

Chair-Ken Pesso; Vice Chair-Carolyn Shade; Recording Secretary – Darius Dunlap and Rob Talbot; Treasurer- Don McDermott; Corresponding Secretary-Rob Skinner

Without much discussion, Carolyn Shade made a motion to elect the designates and Greg Bonaparte seconded. All members voted AYE. No Nays. So moved

V. Digital meeting recorder. Carolyn Shade made motion to approve the purchase and spending limit of $200.00 Greg Bonaparte seconded the motion. All Votes AYE. So moved

VI: 7:15 PM Guest Speaker Karen McBride to discuss CSA 11 water survey. However, prior to her speaking at length, some audience inputs:

Steve Simms comments upon the needed corrections to the pump failure .

Outstanding issues with the fact a larger pump (10 HP) was installed rather than a 7.5 HP , no low water cutoff, due to oversized pump, the water level pumped down too rapidly, pump sucked air and twice the pump burned out. This is not pump failure but incorrect sizing of pump. There are no depth soundings being taken and we are currently out of compliance with State Requirements. Well water testing.. Will the County be doing this?

Dante Silvestri comments that the Community needs a breakdown of how the $150,000 will be spent.

Steve Simms comments that the repairs need to be made to the water system. Need to have continual soundings of the Aquifer. Don't want monies wasted on more studies. Need repairs not studies. The County's sounder is still stuck in the well and never removed. Steve states that we have gone over the issues time and again and still not resolved.

Mike Polacek: Emphasis message to the County and need point person on the water system

Karen McBride from RCAC .. Karen first talks briefly about what the RCAC is and how it is funded by Federal Government and private organizations. Also funded by Non-Profits and have been working on local issues for years.

Proposition 84 Funds. Full application is due March 2013. There is a pre application in right now as a holder.
Would be better if Pescadero were deemed Disadvantaged. That means Pescadero would have to come in at under $48,000 which is 80% of the State Wide Medium income.

Discussion on the upcoming CSA11 Survey.

Previous survey done in 2001

Currently 86 households in CSA 11. The Survey will require an 80% rate of return

1. The first letter is sent out. Customer notification letter for the survey. Why, who and contact information.
2. One week after the first letter, the first survey is sent out and comes with a self stamped return envelope
3. Two weeks after the first survey, a 2nd survey is sent out
4. If low CSA11 response, a 3rd survey is done door to door

The survey process must follow specific guidelines. There must be two mailings and the door to door surveying can only be done by the RCAC.

Once the surveys are returned, data is logged on a spread sheet. The information is downloaded and these surveys are not public documents. Timeline is that the surveys will be sent out in bulk mail. First survey will go out after the first of the year (2013) and it typically takes 4-6 weeks to process. They will stop taking surveys once they reach an 80% rate of return.

VII: Flooding Initiative 8:02 PM

Mike Polacek discusses the $342,000 for the initiative. He supports the action. Spoke about the engineering studies.
His followup with the County on the status of the permits. County has not moved forward on the permits for two reasons: No MONEY and working with the RCD on developing a plan.. Mike closes with the comment that this will not be a short term process

VIII: Open Committee and Public Discussion

Dante Silvestri- What local lands does the County of SM own? How does the County plan on using these lands? What is the total acerage.. Number of Parcels.. could the lands to leased out to organic farmers and put to good use rather than being locked up.

It was mentioned that a new person may be appointed by the County to attend PMAC meetings after the first of the year (2013)

Emergency Generator over at the High School. Who maintains the new generator. Who is trained to operate and who is designated in an emergency to operate it.. We want to ensure that there are backups to the backups in case of an emergency

There is a Marsh account set up for people to make donations and under the name, Pescadero Marsh Rescue.

It was mentioned that we need to reach out to the County about the safety of Stage Road. When that road is used as a bypass to Hwy 1 and Pescadero Road during flooding or slides, Stage Road can be abit scary since it does not have double lines . Should recommend to the County that this road be striped at specific locations (blind corners).

There was quick discussion on a previous discussion about a possible memorial to accident victim Angela Mozart who was killed on Hwy 1. Rob Skinner had thought of a memorial plaque on Pescadero Road however there was some audience disention that we were honoring someone so new

to Pescadero and how about all the farmers and ranchers over the years like Eddie Nunes and Noel Diaz that deserve such an honor. After that interaction, no further action on Angela's memorial

IX: Don McDermott's report on the School District. Don reports that under the latest State budget, there are no cuts planned to school personell. Currently the school has a surplus of $140,000 .. Don concluded that the school district has finally settled the lawsuit over the school improvements for about $2.2 million

X: Move to Adjourn at 9:18 PM.. So moved

Rural Community Assistance Corporation

March 15, 2013

Carole Foster
County of San Mateo
Department of Public Works and Parks
555 County Center, 5th Floor
Redwood City, CA 94063

Subject: Pescadero (CSA 11) Community Median Household Income Survey Results

Dear Carole:

The County of San Mateo requested that Rural Community Assistance Corporation (RCAC) perform an income survey of the CSA 11Area/Pescadero Community in Pescadero, California. The purpose of this survey is to establish a median household income (MHI) level for grant and loan funding programs and sources.

The MHI for CSA 11 Area/Pescadero Community is **$44,325** based on a response rate of **61 percent.**

There are a total of 107 parcels within the project area. Five (5) parcels were vacant, 18 commercial, two (2) were vacation, leaving 82 parcels to survey. Of the 82 residences, 50 responded to the survey; 32 did not respond or refused to participate. State and Federal guidelines established by USDA-RD states that households in a universe from 78 – 99 requires a sample size of 80 percent.

As stated, RCAC conducted two mailings, two door to door site visits, and two community outreach efforts with the assistance of Supervisor Horsley's office, as well as Puente Community Center. RCAC staff concluded all efforts to gather the additional surveys would not be achievable and ran the survey results with amount received. This conclusion was also discussed with the Dept. of Water Resources.

The survey was designed and conducted per State and Federal guidelines established for the USDA-RD.

Sincerely,

Karen D. McBride
Rural Development Specialist-Environmental

Median Household Income (MHI) Data
For CSA 11 Area/Pescadero Community

Survey Ascending order	Survey Number	# of People in Residence	Primary Residence	Annual Income Dollars	Survey Date
1	PES-107	3	Yes	$8,400	02/16/13
2	PES-101	5	Yes	$9,000	01/26/13
3	PES-050	2	Yes	$14,400	02/16/13
4	PES-010	3	Yes	$15,000	02/15/13
5	PES-001	2	Yes	$18,000	02/15/13
6	PES-093	1	Yes	$18,216	01/17/13
7	PES-022	1	Yes	$19,000	02/15/13
8	PES-032	2	Yes	$19,921	01/26/13
9	PES-080	2	Yes	$20,000	02/16/13
10	PES-062	3	Yes	$22,000	01/29/13
11	PES-020	3	Yes	$23,113	01/29/13
12	PES-104	4	Yes	$25,000	02/25/13
13	PES-092	1	Yes	$26,000	02/15/13
14	PES-096	5	Yes	$29,980	02/05/13
15	PES-078	2	Yes	$34,106	01/17/13
16	PES-033	2	Yes	$35,000	02/15/13
17	PES-057	5	Yes	$35,000	02/08/13
18	PES-086	2	Yes	$35,000	01/23/13
19	PES-105	3	Yes	$35,000	02/15/13
20	PES-106	5	Yes	$36,000	02/15/13
21	PES-031	7	Yes	$38,000	02/06/13

22	PES-090	2	Yes	$38,000	8/24/12
23	PES-025	6	Yes	$40,000	9/2/12
24	PES-097	4	Yes	$40,000	8/21/12
25	PES-091	7	Yes	$44,052	11/1/12
26	PES-028	3	Yes	$44,597	9/15/12
27	PES-012	9	Yes	$45,000	9/24/12
28	PES-102	4	Yes	$45,000	10/11/12
29	PES-011	1	Yes	$46,000	02/16/13
30	PES-023	1	Yes	$48,000	02/15/13
31	PES-042	4	Yes	$49,500	02/01/13
32	PES-055	4	Yes	$49,536	02/20/13
33	PES-038	5	Yes	$50,000	02/15/13
34	PES-056	1	Yes	$50,000	01/15/13
35	PES-067	2	Yes	$50,000	01/18/13
36	PES-006	3	Yes	$53,625	02/10/13
37	PES-103	3	Yes	$57,900	02/08/13
38	PES-052	1	Yes	$58,000	02/10/13
39	PES-021	1	Yes	$60,000	02/15/13
40	PES-026	4	Yes	$60,000	01/31/13
41	PES-015	6	Yes	$80,000	02/06/13
42	PES-098	6	Yes	$80,000	01/17/13
43	PES-048	2	Yes	$85,000	02/16/13
44	PES-035	3	Yes	$87,000	01/28/13
45	PES-003	2	Yes	$90,000	01/21/13
46	PES-044	2	Yes	$100,000	01/25/13

47	PES-071	3	Yes	$100,000	02/15/13
48	PES-085	2	Yes	$170,000	01/19/13
49	PES-008	5	Yes	$208,000	01/29/13
50	PES-075	2	Yes	$224,000	01/29/13
The MHI for CSA11 Area/Pescadero is $44,325; the average of survey numbers PES-091 and PES-028, on ascending line order numbers 25 and 26 with income levels of $44,052 and $44,597 ($44,052 + $44,597 = $88,649; divided by 2 = $44,325) = the Median Household Income level.					

HEALTH DEPARTMENT

RECEIVED
JUL 10 2006
DIVISION OF
FINANCIAL ASSISTANCE

July 6, 2006

Dave Kirn, P.E., Program Manager
Small Community Grants Program
Division of Financial Assistance
State Water Resources Control Board
1001 I Street, 16th Floor
Sacramento, CA 95814

SUBJECT: COMMUNITY OF PESCADERO, PESCADERO SEWER PROJECT INCOME SURVEY RESULTS AND REQUEST FOR ELIGIBILITY DETERMINATION, SCG No. 959

Dear Mr. Kirn:

The Community of Pescadero's Wastewater Treatment Project is currently ranked as a Class B project on the Small Community Grants (SCG) priority list. Because Pescadero's boundary does not coincide with a 2000 Census tract boundary, Pescadero was required to complete an income survey in order to determine the community's median household income (MHI) and associated SCG eligibility. In order to achieve compliance an income survey form, provided by the Division of Financial Assistance, was mailed to all residents within the proposed area (County Service Area 11). San Mateo County Environmental Health (Health) has completed the income survey, which shows that Pescadero's 2000 MHI is $23,384, and has an SCG eligibility rate of 90 percent.

Pescadero has 109 lots within the proposed service area. Out of the 109 lots, 10 lots are vacant, and 20 of the properties are commercial (e.g. restaurants, a post office, gas station, grocery store, grade school). This leaves 79 residential services that could provide MHI data. Out of the 79 residential properties that were polled, 52 responses were received. Although this is less than the 75% (59 responses in this case) normally required for a MHI survey, the MHI currently determined is low enough that even if all seven of the additional survey responses required to reach a 75% level were over the maximum income range this project would remain eligible.

Health has summarized all of the income survey information received to date (Attachment 1) and has provided a copy of all income surveys that were returned (Attachment 2). A statistical analysis of this information (adding 7 responses in the top MHI category) yields a 2006 MHI of $34,500.

The Federal Reserve Bank of Minneapolis reports the consumer price index from 2000 to 2006 to be:

PUBLIC HEALTH AND ENVIRONMENTAL PROTECTION DIVISION

Board of Supervisors: Mark Church • Rose Jacobs Gibson • Richard S. Gordon • Jerry Hill • Adrienne Tissier • **Health Director:** Charlene Silva

455 County Center • Redwood City, CA 94063 • PHONE 650.363.4305 • TDD 650.573.3206 • FAX 650.363.7882
http://www.smhealth.org

Year	Annual Average	Annual Percent Change (Rate of Inflation)
2000	172.2	3.4
2001	177.0	2.8
2002	179.9	1.6
2003	184.0	2.3
2004	188.9	2.7
2005	195.3	3.4
2006*	202.5	3.7

http://woodrow.mpls.frb.fed.us/Research/data/us/calc/hist1913.cfm

Utilizing the Federal Reserve Bank consumer price index, to convert Pescadero's 2006 MHI to correspond with the 2000 Census MHI, Pescadero's MHI based upon 2000 dollars is about $28,384. Furthermore, utilizing the eligibility formula on page 12 of the SCG Program Guidelines document, Pescadero's grant eligibility percentage is 90% and up to $2 million.

Based upon this analysis, we are applying for a SCG Planning Grant, to pay for an engineer to begin the planning work for our wastewater project. After you have had a chance to review this information, please notify me in writing whether or not this analysis and information is correct.

Thank you in advance for your consideration of this supplemental information and please feel free to contact me at shartsell@co.sanmateo.ca.us or (650) 363-4798, if you have any questions regarding the project, income survey, or MHI analysis. I look forward to working with you and your staff over the next year to achieve full funding of this very important project that will improve both water quality and public health.

Sincerely,

Steven R. Hartsell, REHS
Program Supervisor

10

Water Supply

Background ▪ Issues

WATER SUPPLY BACKGROUND

I. INTRODUCTION

A. SCOPE AND ROLE

Perhaps no other aspect of infrastructure is more vital to public health and welfare than an adequate and potable supply of water. Without it life cannot be sustained. Since the beginning of concentrated settlements, water has been a necessary resource and an important factor in determining the location and intensity of land uses. The need to provide an adequate supply to meet the demands of growing populations is a primary planning concern.

This Chapter of the General Plan describes water supply sources and water quality, inventories water suppliers, analyzes relevant issues affecting the supply and, finally, provides policies to guide the actions of decision-makers concerning water supply management.

B. STATE PLANNING LAW

Section 65302(d) of the California Government Code requires the development of "a conservation element for the conservation, development and utilization of natural resources including water and its hydraulic force . . ." Section 65302(d) goes on to say, "that portion of the conservation element including waters shall be developed in coordination with any countywide water agency and with all district and city agencies which have developed, served, controlled or conserved water for any purpose for the county or city for which the plan is prepared."

C. RELATION TO OTHER GENERAL PLAN DOCUMENTS

1. Existing General Plan Documents

a. Conservation and Open Space Element (1973)

The 1973 Conservation and Open Space Element of the General Plan discussed water primarily as a natural resource, although there is also a limited discussion of the supply of water. The background data and issue statements applicable to water supply provided information used in compiling this Chapter. The goals and objectives of this Element have been examined and, where relevant, incorporated into this Chapter. This Chapter, when approved, will replace the Water Supply portion of the Conservation and Open Space Element.

b. Area Plans

The San Bruno Mountain General Plan Amendment, the Montara-Moss Beach-El Granada Community Plan, the Emerald Lake Hills Community

Plan, the Local Coastal Program, and the Skyline General Plan Amendment each contain particular water supply policies. The Water Supply Chapter is more generalized and applies to the entire County. Section 65300.5 of the Government Code requires that these distinct portions of the General Plan be consistent.

2. Other Sections of the Updated General Plan

While this Chapter discusses the supply and distribution of water for various purposes, it does not discuss the ecological importance of water (see the Vegetation, Water, Fish and Wildlife Resources Chapter). Further, this Chapter does not discuss the management and disposal of sewage (see the Wastewater Chapter).

D. RELATION TO OTHER COUNTY PLANS

The San Mateo County Comprehensive Water Resources Management Plan was developed in response to State legislation requiring San Mateo County to prepare a plan for coordinating and managing the supply and distribution of water, and for coordinating and managing the treatment and disposal of wastewater from all sources. Its preparation was managed by the Peninsula Water Agency through a steering committee comprised of many representatives with an interest in water management. In 1978, the Comprehensive Water Resources Management Plan was adopted by the Board of Supervisors, and staff was directed to incorporate the policies contained therein into the General Plan. Much of the information contained in the Plan provided background data for use in preparing this Chapter.

E. DEFINITIONS AND WATER MEASUREMENTS

Terms used in this Chapter which require explanation are listed below:

ACRE-FOOT - A standard measurement of volume equivalent to the amount of water required to cover one acre one foot deep. One acre-foot is equivalent to 325,851 gallons.

AQUIFER - Any geologic formation of sufficient porosity and permeability to store, transmit and yield water to springs and wells.

POTABLE - Water which is suitable, safe or prepared for drinking purposes.

MILLION GALLONS/DAY(mgd) - A rate of flow of water.

ONE MILLION GALLONS - 3.0689 acre-feet.

(b) Scenic River Designation of Tuolumne River

The Tuolumne River is being considered for designation as a Wild and Scenic River, a designation given by Congress to free flowing rivers with extraordinary scenic, recreational, fishing or wildlife values. Because this river supplies the Hetch-Hetchy Reservoir, it is possible that a scenic designation would adversely affect its use as a major source of potable water. At this writing, the designation issue is under discussion.

(2) Availability of Water Service to Serve Future Development

Water service in urban areas is generally available and suppliers can accommodate present and future service connections. However, water service in the Mid-Coast area is limited. The Coastside County Water District cannot provide new water connections and has a sizable waiting list. In addition, the City of Burlingame indicates that it can accommodate new connections but future demand will exceed supply because of increased industrial demand for water. For additional information on the availability of water service, see Table 10.4.

B. RURAL AREAS

1. Sources of Water

Almost all of the water in the rural South Coast area is provided by streams, creeks and groundwater. These sources are entirely dependent upon rainfall for replenishment, although many of the watersheds yield a constant flow throughout the year. The mean annual streamflow for watersheds in the area is indicated in Table 10.5. Water from these streams and creeks is often diverted at many points by private property owners and water companies for domestic, agricultural and livestock use. Farmers and ranchers in the area have been developing small storage reservoirs for irrigation and stock watering purposes for many years. Eight such reservoirs, formed by dams large enough to require regulation by the State, have a total storage capacity of 2,602 acre-feet. Table 10.6 illustrates these reservoirs.

Other small reservoirs in the area and their storage capacities are indicated by affected watersheds in Table 10.7. Private water companies in the area providing at least 100 connections also use small surface reservoirs. Skylonda Mutual Water Company and Cuesta La Honda Guild each maintain small reservoirs. Skylonda maintains one reservoir and four storage tanks with a combined capacity of over 20 acre-feet. The Guild maintains a 15 acre-feet reservoir. Recoverable groundwater in the area is generally confined to the lower alluvial valleys of streams such as Pescadero and San Gregorio Creeks.[14]

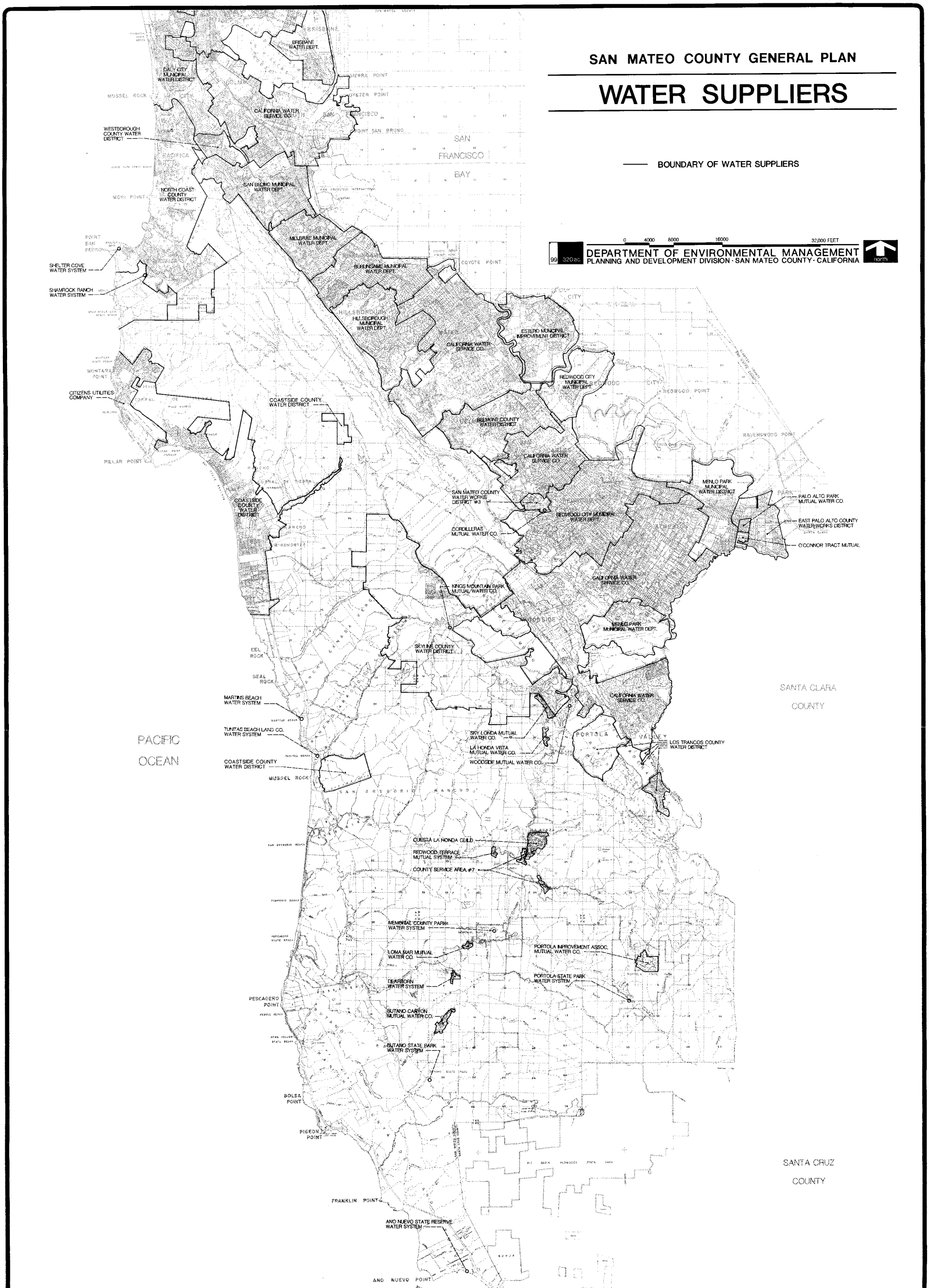
SAN MATEO COUNTY GENERAL PLAN
WATER SUPPLIERS
BOUNDARY OF WATER SUPPLIERS
0 4000 8000 16000 32,000 FEET
99 320ac.
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
PLANNING AND DEVELOPMENT DIVISION · SAN MATEO COUNTY · CALIFORNIA
north
SAN FRANCISCO BAY
PACIFIC OCEAN
SANTA CLARA COUNTY
SANTA CRUZ COUNTY
BRISBANE WATER DEPT.
DALY CITY MUNICIPAL WATER DISTRICT
CALIFORNIA WATER SERVICE CO.
WESTBOROUGH COUNTY WATER DISTRICT
NORTH COAST COUNTY WATER DISTRICT
SAN BRUNO MUNICIPAL WATER DEPT.
MILLBRAE MUNICIPAL WATER DEPT.
BURLINGAME MUNICIPAL WATER DEPT.
HILLSBOROUGH MUNICIPAL WATER DEPT.
SHELTER COVE WATER SYSTEM
SHAMROCK RANCH WATER SYSTEM
ESTERO MUNICIPAL IMPROVEMENT DISTRICT
REDWOOD CITY MUNICIPAL WATER DEPT.
CITIZENS UTILITIES COMPANY
COASTSIDE COUNTY WATER DISTRICT
BELMONT COUNTY WATER DISTRICT
MENLO PARK MUNICIPAL WATER DISTRICT
PALO ALTO PARK MUTUAL WATER CO.
EAST PALO ALTO COUNTY WATERWORKS DISTRICT
O'CONNOR TRACT MUTUAL
SAN MATEO COUNTY WATER WORKS DISTRICT #3
CORDILLERAS MUTUAL WATER CO.
KINGS MOUNTAIN PARK MUTUAL WATER CO.
SKYLINE COUNTY WATER DISTRICT
MARTINS BEACH WATER SYSTEM
TUNITAS BEACH LAND CO. WATER SYSTEM
SKY LONDA MUTUAL WATER CO.
LA HONDA VISTA MUTUAL WATER CO.
WOODSIDE MUTUAL WATER CO.
LOS TRANCOS COUNTY WATER DISTRICT
CUESTA LA HONDA GUILD
REDWOOD TERRACE MUTUAL SYSTEM
COUNTY SERVICE AREA #7
MEMORIAL COUNTY PARK WATER SYSTEM
LOMA MAR MUTUAL WATER CO.
PORTOLA IMPROVEMENT ASSOC. MUTUAL WATER CO.
DEARBORN WATER SYSTEM
PORTOLA STATE PARK WATER SYSTEM
BUTANO CANYON MUTUAL WATER CO.
BUTANO STATE PARK WATER SYSTEM
ANO NUEVO STATE RESERVE WATER SYSTEM

TABLE 10.5

MEAN ANNUAL STREAMFLOW BY WATERSHED
1970 - 1980

WATERSHED	MEAN ANNUAL FLOW (Acre-Feet Per Year)
Purisima-Tunitas	9,880
San Gregorio	22,410
Pomponio	2,430
Pescadero	25,600
Butano	7,650
Gazos	4,440

Source: Skyline-Santa Cruz Mountains study.

TABLE 10.6

MAJOR DAMS IN SOUTH COAST AREA

DAM	WATERSHED	STORAGE CAPACITY (Acre-Feet)
Johnson	Arroyo de Leon	30
Pomponio Ranch	Pomponio Creek	256
Lake Lucerne	Arroyo de los Frijoles	455
Bean Hollow No. 2	Arroyo do los Frijoles	900
Bean Hollow No. 3	Arroyo de los Frijoles	461
Green Oaks No. 1	Green Oaks Creek	287
Lake Elizabeth	Green Oaks Creek	113
Coastways	Ano Nuevo Creek	100
TOTAL		2,602

Source: Comprehensive Water Resources Management Plan.

TABLE 10.7

SMALL RESERVOIRS BY WATERSHED

WATERSHED	NUMBER OF SMALL RESERVOIRS OR STOCKPONDS	TOTAL STORAGE (Acre-Feet)
Purisima	4	103
Lobitos	3	80
Tunitas	1	4
La Honda/San Gregorio	21	463
Pomponio	4	276
Pescadero	13	405
Butano	14	1,549
Gazos	6	382
TOTAL	66	3,262

Source: Skyline-Santa Cruz Mountains Area Study, 1982.

These valleys offer little permeability and can support only a limited number of domestic and stock watering wells. Firm estimates of groundwater production are unavailable, yet the amount available is known to be minor when compared with the quantity of water obtained by stream diversion.[15] The town of Pescadero, some of the small mutual water systems, and some recreational uses obtain supplies from wells.

2. Water Quality

The quality of surface waters in the South Coast area is generally satisfactory for domestic and agricultural uses.[16] Water in many of the creeks is excessively hard and it may be necessary to soften these supplies for domestic use. These waters are also high in sodium. Table 10.8 illustrates a chemical analysis of surface waters in this area.

Groundwater quality in the vicinity of the Skyline-Santa Cruz Mountains is considered high in dissolved minerals, such as manganese and iron, which causes a metallic taste and brown color.[17] Groundwater quality around the town of Pescadero is quite poor and has been a problem for some time. Over 60% of the wells have been contaminated by fecal coliform bacteria as a result of septic system failure, a high water table and heavy clay soils.[18] The Pescadero groundwater also has high concentrations of nitrates, a known cause of methemoglobinemia or "blue-baby" disorder affecting infants under six months old.[19]

3. Water Suppliers

a. Administrative Organization

Water suppliers in rural areas include the same administrative organizations as suppliers in urban areas and, in addition, the following types of entities:

(1) County Service Area

A county service area, authorized by Section 25210.1 et seq. of the County Government Code, is a special district governed by the Board of Supervisors. Services provided can include water service, supply and distribution systems, police and fire protection, refuse and garbage collection, library services, lighting, and several other activities.[20] In addition, the service area can include all or any part of a city when legislative approval is given. Finally, a service area can issue bonds, charge fees and levy assessments.[21]

(2) Mutual Water Company

A mutual or cooperative water company, organized under the nonprofit corporation law of California, is a private entity organized primarily to sell, distribute, supply, or deliver water for domestic or irrigation purposes to its shareholders.

TABLE 10.8

WATER QUALITY OF SOUTH COAST STREAMS

SOUTH COAST STREAMS	TOTAL DISSOLVED SOLIDS (mg/l)	HARDNESS (mg/l)	ALKALINITY (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	IRON (mg/l)	MANGANESE (mg/l)	SODIUM (mg/l)
Butano Creek	238	133	118	34.2	11.5	.93	.05	27.1
San Gregorio Creek	592	312	216	73.1	31.4	.07	.05	65.0
Purisima Creek	498	306	244	84.6	23.0	.16	.05	48.5
Gazos Creek	218	106	80	24.2	11.2	.20	.03	26.8
Pescadero Creek	422	225	184	59.1	18.8	.33	.05	51.0
Pomponio Creek	549	222	110	36.5	32.0	.88	.10	81.8
Tunitas Creek	728	322	219	82.1	43.3	.19	.05	108.0
Domestic Water Quality Standards	500[1]	---[2]	---	---	---	.30	.05	20.0[3]

	POTASSIUM (mg/l)	CHLORIDES (mg/l)	SULFATES (mg/l)	FLOURIDES (mg/l)	NITRATES (mg/l)	ACIDITY (pH units)	TURBIDITY (units)	COLOR (units)
Butano Creek	2.6	28	32.9	.20	.10	8.0	8.5	45
San Gregorio Creek	4.8	82	131.0	.40	.02	8.2	0.5	15
Purisima Creek	5.0	53	85.5	.30	.02	8.3	1.7	15
Gazos Creek	2.8	32	42.7	.20	.10	7.9	2.1	15
Pescadero Creek	4.4	51	81.2	.20	.04	8.0	2.3	15
Pomponio Creek	5.6	100	159.0	.10	3.60	7.5	16.0	80
Tunitas Creek	4.4	156	140.0	.30	.02	8.1	2.3	20
Domestic Water Quality Standards	---	250[1]	250.0[1]	1.40-2.40	45.00	6.0-9.0	5.0	15

Notes:
1. Maximum contaminant levels recommended by California Department of Public Health. Higher levels may be tolerable.
2. Hardness: 0-60 = soft; 61-120 = moderately soft; 121-180 = hard; 181+ = very hard.
3. Maximum level suggested by the Environmental Protection Agency to accommodate limited sodium intake diets.

Sources: California Department of Public Health, "1977 California Domestic Water Quality and Monitoring Regulations."

San Francisco Water Department, "Annual Mineral Analysis, " 1981, for Crystal Springs Reservoir, San Andreas and Pilarcitos Lakes

Leeds, Hill, and Jewett, Inc., Comprehensive Water Resources Management Plan, San Mateo County, January 1978, Table IX-3; for Lake Lucerne and South Coast Streams.

b. Inventory of Suppliers

Table 10.9 provides an inventory of water suppliers in the rural areas. Because of the vast number of mutual and private water companies in operation, only suppliers with at least ten connections have been included.

c. Availability of Water Service for Future Development

Water service in rural areas is limited and the majority of suppliers cannot accommodate a significant number of additional service connections. However, Skyline County Water District can accommodate roughly twice the current number of connections. Similarly, Los Trancos County Water District can accommodate a modest number of new connections but has no plans for expansion. Additional information on the availability of water service by water supplier appears in Table 10.10.

C. WATER DEMAND

1. Domestic Water Demand

Water demand in the County is expected to increase moderately by the year 2000 for most geographical subareas. Demand in the Mid-Coast area is expected to more than double from 1.5 mgd in 1980 to 3.2 mgd in 2000. Demand in the South Central Bayside is expected to increase from 1980 levels of 16.3 mgd to 18.3 mgd by 2000. For information on demand in specific geographical areas, see Table 10.11.

Present and future demands for residential and commercial use were calculated by multiplying per capita water use values by population statistics. Water use values were determined from "weighted historic values of per capita water use modified to account for rising standards of living, changes in housing patterns and conservation measures."[22] Population statistics were taken from ABAG-Projections '83. For additional information on population statistics and land use, see the Social and Economic Setting section and the Land Use chapters.

2. Industrial Water Demand

Present and future industrial water demand was calculated for areas with significant industrial uses, by multiplying water use values by projected acreage according to the type of use. Industrial demand for most areas is expected to increase moderately except for Foster City, which will increase significantly from .47 mgd in 1980 to 1.30 mgd in 2000. San Carlos and Redwood City are other areas where the demand is expected to increase significantly. San Carlos is expected to escalate from its 1980 level of .68 mgd to 1.14 mgd in 2000, and Redwood City from 1.0 mgd in 1980 to 1.6 mgd in 2000. Menlo Park and East Palo Alto are also expected to increase from 1.02 mgd in 1980 to 1.39 in 2000. For anticipated demand in other areas, see Table 10.12.

TABLE 10.9

WATER SUPPLIERS IN RURAL AREAS

WATER SYSTEM	SOURCE OF SUPPLY	NUMBER OF CONNECTIONS	AVERAGE DAILY CONSUMPTION RATE (mgd)
County Water Districts			
Los Trancos County Water District	San Francisco Water Department	236[1]	---
Skyline County Water District	San Francisco Water Department, Well	400	.10
County Service Areas			
County Service Area No. 7	Alpine Creek	67	.01
Mutual Water Companies			
Redwood Terrace Mutual	Well	26	---
Woodside Mutual	California Water	65±	---
Skylonda Mutual	La Honda Creek, Well	152	.025
Loma Mar Mutual	Pescadero Creek	35	
Butano Canyon Mutual	Springs, Stream, Butano Creek	84	.0004
Portola Improvement Assoc. Mutual	Springs	35	
La Honda Vista Mutual	La Honda Creek	13	---
Kings Mountain Park Mutual	Purissima Creek	25	---
Private Water Companies			
Cuesta La Honda Guild	Woodham Creek, Mindego Creek, Springs	310	.07
Martins Beach	Well	35	---
Tunitas Beach Land Company	Spring	20±	---

Note: 1. Skyline-Santa Cruz Mountains Study.

TABLE 10.10

AVAILABILITY OF RURAL WATER SERVICE

WATER SUPPLIER	UNINCORPORATED AREA	AVAILABILITY OF SERVICE[1]
Skyline County Water District	Redwood Park Subdivision Quail Lane Area Sierra Morena Woods Subdivision	A[2]
Skylonda Mutual Water Co.	Skylonda Subdivision	L[3]
La Honda Vista Mutual Water Co.	La Honda Vista Subdivision	L[4]
Portola Improvement Association Mutual Water Co.	La Honda Vista Subdivision	L[5]
Woodside Mutual Water Co.	--	L
County Service Area No. 7	La Honda-Redwood Subdivision	L[6]
Cuesta La Honda Guild	La Honda	L[7]
Butano Canyon Mutual Water Co.	Butano Falls	L
Los Trancos Co. Water District	Los Trancos Woods/Vista Verde	L[8]
Redwood Terrace Mutual System	Rural South Coast	L[9]
Kings Mountain Park Mutual Water Co.	Area in Vicinity of Skyline	L[10]
Martins Beach Land Co.	Tunitas Beach Area	A
Loma Mar Mutual Water Co.	Area in Vicinity of Memorial Park	A[11]

Notes: 1. A - Water service available. L - Water service limited.

2. Approximately 400 additional connections can be accommodated. Service availability beyond that questionable and linked to manner in which large vacant parcels are subdivided.

3. Can accommodate eight additional connections.

4. Has had same number of connections for many years and unlikely to increase.

TABLE 10.10 (Continued)

AVAILABILITY OF RURAL WATER SERVICE

Notes (Continued):

5. Needs a second source of water to accommodate new connections.

6. Does not have adequate storage capacity to accommodate new connections; ability to accommodate current demand hindered by adverse weather.

7. Ability to accommodate new connections hindered by deteriorating water mains. System has reached operational capacity (see Skyline Area General Plan Amendment).

8. Cannot accommodate additional connections; lack of funding/contractual agreements limit facility expansion.

9. Has enough water to accommodate existing demand; members have decided against any future growth so facilities won't be expanded.

10. Original charter limits number of connections to current number; no plans for expansion.

11. Can accommodate an additional 95-105 connections; however, no demand for new connections.

TABLE 10.11

PROJECTED DOMESTIC WATER DEMAND

GEOGRAPHICAL AREA[1]	GALLONS PER CAPITA/DAY[2]			PROJECTED DEMAND (mgd)		
	1980	1990	2000	1980	1990	2000
Midcoast[3]	96	108	121	1.5	2.1	3.2
North County	98	100	102	12.1	13.0	13.3
North Bayside	124	124	124	10.6	10.9	10.7
North Central Bayside	129	129	129	6.1	6.0	5.8
Central Bayside	153	153	153	17.7	18.5	18.2
South Central Bayside	132	132	132	16.3	16.8	18.3
South Bayside	197	197	197	13.8	13.9	14.2
Rural Unincorporated	100	100	100	0.5	0.5	0.6
TOTALS				78.6	81.7	84.3

Notes: 1. Composition of Geographical Areas:

Midcoast - Half Moon Bay, Montara,* Moss Beach,* El Granada,* Princeton.*

North County - Pacifica, Daly City, Broadmoor,* Brisbane, Colma, San Bruno Mountain.*

North Bayside - South San Francisco, Country Club Park,* San Bruno.

North Central Bayside - Burlingame, Burlingame Hills,* Millbrae.

Central Bayside - San Mateo, Highlands,* Hillsborough, Foster City.

South Central Bayside - Belmont, San Carlos, Redwood City, North Fair Oaks*, Devonshire*, Palomar Park,* Emerald Lake Hills,* Harbor Industrial.*

South Bayside - Atherton, East Palo Alto, Menlo Park, Woodside, Portola Valley, Skyline Area,* Stanford Lands,* Ladera,* Sequoia Tract,* Menlo Oaks*, West Menlo Park.*

(*unincorporated areas)

2. Values taken from Water Action Plan Central and South San Francisco Bay Area.

3. Values taken from Local Coastal Program.

TABLE 10.15

EXISTING AND PROJECTED AGRICULTURAL LAND USE
AND WATER REQUIREMENTS BY SOUTH COAST WATERSHEDS

WATERSHED	1975 AGRICULTURAL ACREAGE	1975 AGRICULTURAL WATER REQUIREMENTS (Acre-Feet)	2000 AGRICULTURAL ACREAGE	1975 AGRICULTURAL WATER REQUIREMENTS (Acre-Feet)
Purisima-Tunitas	399	563	833	1223
La Honda-San Gregorio	223	312	543	797
Pomponio	70	100	205	301
Pescadero	638	900	736	1081
Butano	355	502	472	695
Bean Hollow	747	1055	1281	1886
Gazos	63	90	101	151
Ano Nuevo	855	1210	1188	1752
TOTAL	3350	4732	5359	7886

Source: Skyline-Santa Cruz Mountains Area Study, 1982.

d. Davis-Grunsky Act

The Davis-Grunsky Act authorized State financial assistance for local water projects. This program, administered by the Department of Water Resources, provides seven types of loan and grant assistance for projects involving the development of new water supplies. The Department can make grants of up to $400,000 for any one project.[27] While larger grants are available, they must be authorized by the Legislature. Only cities, counties, districts or other political subdivisions are eligible to receive assistance.

e. State Drinking Water Bond Law of 1984

The State Drinking Water Bond Law of 1984, authorized State loan and grant assistance for eligible water projects. The program is administered by the Departments of Water Resources and Health Services. The program provides loan and grant assistance to eligible water suppliers to construct, improve or rehabilitate domestic water systems to meet, at a minimum, safe drinking water standards. Eligible projects are prioritized according to severity of contamination or supply problems.

C. REGIONAL

1. Local Agency Formation Commission (LAFCo)

Local Agency Formation Commissions were established to govern the boundary changes of all local governments, except school districts. LAFCo's are empowered to, among other things, review and approve or disapprove annexations and detachment of a territory, incorporation of cities, and the formation and dissolution of special districts. They also determine spheres of influence or ultimate service area boundaries for each city and special district in the county. Prior to assigning a particular sphere, comprehensive studies are developed which include an assessment of the existing infrastructure, including water supply districts.

2. Association of Bay Area Governments (ABAG)

a. Environmental Management Plan (1978)

The San Francisco Bay Area Environmental Management Plan, developed by the Association of Bay Area Governments (ABAG), addresses, among other issues, water supply. This plan, taking into account the 1976-77 drought, contains three policies which seek to conserve existing water supply and establish a mechanism to ensure efficient water use in the future: (1) establishing a Water Management Coordinating Committee to provide a forum for discussion and possible resolution of issues affecting agencies concerned with water management; (2) reducing residential water demand to a moderate level through water savings programs designed to retrofit existing housing with water savings devices and mandate such devices in all new construction; and (3) encouraging the reuse of wastewater where cost-effective.[28]

b. First Annual Report on Environmental Progress (1979)

The 1979 Update of the Environmental Management Plan addresses the status of the Water Supply Management Plan policies described above. Two of the three policies were approved and certified by the State Water Resources Control Board and the Environmental Protection Agency. Specifically, these policies call for establishing the Water Management Coordinating Committee and reusing wastewater, a policy which is being examined through the Regional Reclamation Study.[29]

3. San Francisco Water Department (SFWD)

The San Francisco Water Department service area includes most of the urban areas in San Mateo County, cities in Santa Clara County, and cities in Alameda County. Water is supplied to these areas in accordance with contractual agreements. This regionally significant municipal utility is owned and operated by the City and County of San Francisco.

D. COUNTY

1. General Plan Policies

a. Conservation and Open Space Element (1973)

The Conservation and Open Space Element of the General Plan discusses water resources, including the beneficial and degrading uses of water, alternative water resource management techniques, and local water suppliers and governmental agencies concerned with water management. It also analyzes relevant issues and sets forth goals, objectives and policies designed to conserve and manage water resources, protect water quality, encourage the reuse of wastewater, establish flood plain management programs, study water aquifers, monitor turbidity in watersheds, establish a Countywide water agency and planning document, and finally, establish criteria to determine primary value water resource areas and manage primary water resources.

b. Area Plans

(1) San Bruno Mountain General Plan Amendment (1976)

The San Bruno Mountain General Plan Amendment contains policies to guide the preparation of specific plans. Policies indicate that water quality and usage must be addressed in specific plans. Other policies identify the San Francisco Hetch-Hetchy Water System as the source of supply for the plan area and call for phased water supply facilities with the development needs of each planning area.

(2) Emerald Lake Hills Community Plan (1977)

The Emerald Lake Hills Community Plan contains policies which seek to develop a water distribution system to serve dwellings and provide for fire protection by encouraging the County to work with Redwood City to coordinate the installation of water lines with the construction of the sewer system, examine alternatives for ownership of the water distribution system, and finance and schedule the replacement of water lines.

(3) Montara-Moss Beach-El Granada Community Plan (1978)

The Montara-Moss Beach-El Granada Community Plan includes policies which seek to provide Montara and Moss Beach with an adequate water system by encouraging the consolidation of water districts and reducing the size of water service areas to correspond to the limits of urban development.

(4) Local Coastal Program (1980)

The Local Coastal Program and policies are divided into 12 components to address the many issues confronting the County's Coastal Zone. Four components address water supply: the Locating and Planning New Development Component, the Public Works Component, the Agriculture Component, and the Recreation and Visitor-Serving Facilities Component.

(a) Locating and Planning New Development Component

The Locating and Planning New Development Component of the Local Coastal Program is designed to restrict new development to those areas already developed and/or served adequately by public services and facilities. Policies addressing water supply limit residential building permits based upon adequate water facilities and encourage monitoring water availability for new development in rural areas.

(b) Public Works Component

The Public Works Component limits the development or expansion of public works facilities to an amount which does not exceed that needed to serve the buildout of the LCP Land Use Plan. The Component requires: (1) all public utilities, governmental agencies, or special districts wishing to undertake public works projects to obtain a development permit; (2) phasing of public works facilities consistent with need; (3) reserving capacity for priority land uses; (4) monitoring of first phase public works projects; and finally, (5) establishing criteria for service area and special district boundaries.

The Component also sets forth more specific regulations and policies governing water supply. In urban areas (Mid-coast), water supply guidelines seek to ensure that Phase I water capacities do not exceed development which can be sewered and also meet the needs of floriculturists, monitor Phase I capacities, reserve water supplies for priority land uses, establish quality control for groundwater, establish criteria for any facilities wishing to use Pillar Point Marsh, Denniston Dam, Crystal Springs or Andreas Lake to increase water supplies, and finally, establish criteria for water suppliers wishing to expand service area boundaries.

The Component also establishes guidelines for any new water system developed for the town of Pescadero. These policies seek to control future supplies of water to an amount sufficient to serve the buildout allowed by the LCP Land Use Plan, reserve capacity for priority land uses, limit permits for new connections, monitor use consumption, set forth criteria for groundwater sources used to increase water supply, confine water connections to use within the rural service center boundaries, and finally, examine the need to change current sewage disposal practices which impact new sources of water.

(c) Agriculture Component

The Agriculture Component of the Local Coastal Program seeks to provide an adequate and dependable supply of water for agricultural uses through policies and regulation which protect agricultural water supplies, establish priorities for issuance of appropriate water rights permits, monitor agricultural water supplies; establish criteria for the development of on-stream dams, encourage the use of small water impoundments, require water allocations for floriculture operations, monitor wells, and finally, require a grading permit for water impoundments.

(d) Recreation and Visitor Serving Facilities Component

The Recreation and Visitor Serving Facilities Component of the Local Coastal Program seeks to encourage the provision of drinking water at recreation and visitor serving facilities and require these facilities to connect to public or community water systems wherever they exist.

(5) Skyline Area General Plan Amendment (1983)

The Skyline Area General Plan Amendment contains policies designed to address upstream water diversions for residential use and the impact of this practice upon downstream agricultural water supplies through policies that require the

obtained all other necessary permits and could be constructed immediately if connections were available.

3. Coordinating Urban Water Supplies with Land Use Plans

One way to furnish adequate water supplies in urban areas is to encourage the capacity of public water systems to correspond to the level of development proposed in the land use plan. When public water systems are deficient in capacity, development will often be hampered. Similarly, when excessive water capacities are available, more intense levels of development than desired can result. By synchronizing the capacity of public water systems with the desirable level of development, urban water supplies can be used more efficiently. Such comprehensive water supply management planning could allow public water systems to better anticipate necessary expansions, arrange to obtain additional water entitlements in a timely fashion, and plan a program for necessary capital financing.

B. PROVIDING ADEQUATE WATER SUPPLIES IN RURAL AREAS

1. Coordinating Water Supplies with Rural Land Use Plans

Water supplies to accommodate rural development are provided by wells, streams and public water systems. The potential of developing large public water systems in rural areas which stimulate high levels of growth is of concern. Recently adopted rural land use plans emphasize the protection of resources while allowing a low level of development. However, the capacity of these large systems can undermine the intent of the land use plan. Because these water systems can accommodate hundreds of service connections, they have a clear potential to induce growth at higher than desired levels. Types of water supply facilities more appropriate for low level rural development are individual wells or, in some instances, small water systems. These facilities are generally less costly and are better suited to accommodate rural community development objectives.

2. Quality and Reliability of Rural Water Sources

The quality and reliability of wells, streams and small water systems is often of concern. The following sections discuss the advantages and disadvantages of these sources.

a. Wells

Using wells as a water source has certain advantages. They provide a relatively economical way of obtaining water, require low maintenance if the quantity and quality are adequate, are reasonably reliable during droughts, especially when exceeding a depth of 20 feet, and do not involve water rights, a permit process associated with using surface water. Wells, however, do have some disadvantages. Locating a subsurface water source is more of an art than a science, as there is no reliable way to predict the best site for a well unless a costly hydrogeological study is performed. Also, once a subsurface water

source is tapped, it must yield an amount acceptable to County standards: 5 gallons per minute (gpm) or 2.5 gpm with adequate storage.[39] Wells can also adversely affect surface streamflow if located too close to stream floodplains. Well water is also susceptible to contamination from many sources, although not all of these pose health threats. Often well water contains concentrations of iron and manganese which give a metallic taste, harshness and brown color. These constituents are more a nuisance than a threat and are easily removed. However, other constituents such as nitrates and fecal bacteria pose more serious health threats. The groundwater underlying the town of Pescadero is well known to be contaminated by these constituents. Once groundwater is contaminated, it is difficult if not impossible to correct. Because groundwater flows so slowly, much slower than surface water, a contaminated aquifer may remain polluted indefinitely, even if the source of pollution is removed.[40]

b. Surface Water

Quantity and quality are benefits associated with using an aboveground source. Stream flows are abundant during the wet season of November through May and can produce significant amounts of water. The San Gregorio and Pescadero watersheds average 22,410 acre feet and 25,600 acre feet per year, respectively. The high quality of stream water also makes it an attractive source. South Coast streams contain a low level of constituents making it generally satisfactory for use; however, these waters are also excessively hard and contain high amounts of sodium. There are, however, some disadvantages in using stream water. A significant drawback is the complete dependence upon rainfall for replenishment. It is a "feast or famine" situation where the weather either produces a significant amount of stream water or none at all. Another drawback is the regulatory process required to appropriate water from streams. State law requires various licenses, permits and statements of diversion before taking water from streams by either appropriative or riparian rights.

Often this administrative process can take from eight months to two years to complete.[41] An additional disadvantage in using stream water is that its removal can adversely impact fish and other wildlife along with agricultural uses. (For more information on the impact on fish, see the Vegetative, Water, Fish, and Wildlife Resources Chapter.) Impacts of water removal from streams on agricultural uses are discussed later in this Chapter.

c. Small Water Systems

Small water systems also have advantages and disadvantages. The water provided is usually of high quality as the majority of these purveyors obtain water from streams and creeks. Local control is another advantage. These systems are owned by the people receiving the service. The main disadvantage of this water source is quantity. Often these small systems have inadequate storage capacity and/or transmission systems that prevent them from meeting demand.

SAN MATEO
LAFCO
LOCAL AGENCY FORMATION COMMISSION
455 COUNTY CENTER, 2ND FLOOR • REDWOOD CITY, CA 94063-1663 • PHONE (650) 363-4224 • FAX (650) 363-4849

October 12, 2011

TO: Members, Local Agency Formation Commission

FROM: Martha Poyatos, Executive Officer

SUBJECT: Municipal Service Review and Sphere of Influence Update for County Service Area 11 (Pescadero)

Summary:

Attached please find the municipal service and sphere of influence update for County Service Area 11 (Pescadero) (CSA 11). This is the first municipal service review for CSA 11. LAFCo is required by State law to complete municipal service and sphere of influence reviews for all cities and special districts in the County by taking the following actions: prepare a Municipal Service Review report and adopt Municipal Service Review Determinations pursuant to Government Code Section 56430; adopt Sphere Influence Determinations pursuant to Government Code Section 56425; and reaffirm or amend the sphere of influence.

The Commission held a study session in Pescadero on September 21 and received comments. The attached report reflects comments received at the study session and new comparative water rate information. The recommended service review determinations in many cases serve as recommendations to the County of San Mateo and the community regarding the Community's water system and other infrastructure deficiencies including flooding and lack of a public sewer system. The report also recognizes the limitations of a municipal service review when applied to a County Service Area serving the rural service center portion of the Community of Pescadero and recommends that the County of San Mateo consider preparation of an area plan or community plan for Pescadero to more comprehensively address local issues and unique physical and land use situations found in various areas of the County including Pescadero.

It is recommended that the Commission:

1) Accept the attached Municipal Service Review and Sphere of Influence Report
2) Adopt Municipal Service Review Determinations found on pages 23 to 25
3) Adopt Sphere of Influence determinations found on pages 25 to 26
4) Reaffirm the status quo sphere of influence of CSA 11 as detailed on page 26
5) Direct the Executive Officer to transmit the adopted report and determinations to the County of San Mateo, Pescadero Municipal Advisory Council and other affected agencies.

Municipal Service Review and Sphere of Influence Update
County Service Area No. 11 (Pescadero)
October 12, 2011

Introduction

This municipal service review and sphere of influence update for County Service Area 11 is being completed as required by Government Code Sections 56425[1] and 56430. County Service Area 11 is a County-governed special district formed in 1988 to finance the development of a new water source and serve as the water provider for the Pescadero community. Section 56425 requires LAFCo to periodically update spheres of influence. Section 56430 requires that in order to prepare and update spheres of influence in accordance with Section 56425, the Local Agency Formation Commission[2] shall conduct a service review of the municipal services provided in the county or other appropriate area. A municipal service review is an analysis of public services in which determinations are made regarding adequacies or deficiencies in service, cost effectiveness and efficiency, government structure options and local accountability. This version of the report includes new text responding to comments received at the September 21 LAFCo workshop in Pescadero and comparative water rates.

Section 56430 requires LAFCo to adopt considerations in the following areas.

1) Growth and population projections for the affected area.
2) Present and planned capacity of public facilities and adequacy of public services, including infrastructure needs or deficiencies.
3) Financial ability of agencies to provide services.
4) Status of, and opportunities for, shared facilities.
5) Accountability for community service needs, including governmental structure and operational efficiencies.
6) Any other matter related to effective or efficient service delivery, as required by commission policy.

Documents referenced in this municipal service review include the following and are available on the LAFCo website (www.sanmateolafco.org):

- Assessment of Source Water for the Pescadero Water System – CSA 11, 2002, Todd Engineers

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[1] Sphere of Influence is defined as the plan for the probable physical boundaries and service area of a city or district, as determined by the Commission. County Service Area 11 boundaries are limited by the Local Coastal Program to the existing boundaries of Pescadero as a rural service center.

[2] Created by the State legislature in 1963, the Local Agency Formation Commission (LAFCo) is a State-mandated, independent commission with countywide jurisdiction over the boundaries and organization of cities and special districts including annexations, detachments, incorporations, formations, consolidations and dissolutions. A fact sheet on LAFCo is attached to this report.

- Pescadero Community Sewer Project, Facilities Planning Report, 2008 HydroScience Engineers, Inc.

- Pescadero Fire Flow Analysis, 2009, Winzler & Kelly

County Service Area 11

County Service Area 11 (CSA 11) was formed in 1988 pursuant to enabling legislation permitting creation of a county service area (Government Code Section 25210 et seq.) to provide water service to the portion of Pescadero included in the boundaries of the urban rural boundary. The urban rural boundary is coterminous with the rural service center boundary and designates the area as eligible for municipal water service under the County of San Mateo General Plan and Local Coastal Program.[3] At the time of formation, the only water supply was individual domestic wells, water from surface impoundments, and locally derived groundwater from wells installed in the alluvial aquifer of Pescadero and Butano Creeks. In the 1970's and 1980's these sources were found to contain relatively high concentrations of nitrate and other naturally occurring salts. This prompted the development of a public groundwater source. The water system was constructed in 1991-1992 and water rates were established at that time. Portions of Pescadero are also served by the County-governed Pescadero Highway Lighting District. Formed to finance street lighting, the District is not subject to sphere of influence designations but is included in this study under discussion of municipal services provided in the area. (Map #1 attached.)

County Service Areas under their enabling legislation may provide all the services of a city, except land use. The only active power provided by CSA 11 is water. If as discussed below it is determined that other services such as sewer can be provided and that CSA 11 would be the operator, it would be necessary to apply to LAFCo for expansion of powers to provide that service.

Pescadero

Located in San Mateo County's rural south coast approximately 14 miles south of the City of Half Moon Bay and two miles east of Highway One, Pescadero is an unincorporated community with a Census 2010 population of 643[4] and comprising 77.4 acres. First settled in the 1800's on the flood plain of the Pescadero Creek, Pescadero is designated a rural service center in the County's General Plan and Local Coastal

[3]The County of San Mateo Local Coastal Plan (LCP) defines Rural Service Centers as small rural communities having a combination of land uses which provide services to rural areas. The LCP identifies Pescadero and San Gregorio as Rural Service Centers. County General Plan Policy 9.16 (a) provides for the Urban Rural boundary to be coterminous with the Rural Service Center boundaries.

[4] The Census Designated Place boundaries for Pescadero are not coterminous with the LCP boundaries of the Rural Service Center boundaries of Pescadero. The Pescadero Community Sewer Project Report (October 2008) cites a population of 755, noting that this may include residents outside the Rural Service Center.

Program. The Pescadero Rural Service Center boundaries are coterminous with Urban/Rural boundary, which designates areas eligible for urban services. The Rural Service Center area of Pescadero consists of three non-contiguous areas: the eastern area has residential and commercial land uses as well as Pescadero Elementary School, to the west is an area of residential uses, further west on Pescadero Road is County Fire Station Number 59, which was annexed to CSA 11 in 1994.

The Pescadero community and surrounding rural areas are represented by the Pescadero Municipal Advisory Council (PMAC). Established by the Board of Supervisors in 1992, PMAC advises the San Mateo County Board of Supervisors on issues affecting residents of Pescadero, Loma Mar, Butano Canyon and other South Coast communities. PMAC is comprised of 13 members including the Board Member representing Supervisorial District 3 and twelve members, eleven of whom must reside in one of four districts and there is one member-at-large. Pescadero is part of District 1. (Map #2 attached.) The Council meets the second Tuesday of the month at 7:30 p.m. More information about PMAC is available at: http://www.pescaderocouncil.org.

Municipal type services provided in the area are summarized below.

Pescadero (Census 2010 Population - 643						
Police	**Fire & Emergency Response**	**Water**	**Sewer**	**Garbage/ Recycling**	**Lighting**	**Roads/Other**[5]
Sheriff	County of San Mateo via contract with CalFire	County Service Area 11 (San Mateo County Dept. of Public Works)	Private Septic Systems	See footnote[6] and discussion below	Pescadero Highway Lighting District	County of San Mateo

Key Issues

1. Pescadero's remote location and small population base inherently result in relatively high cost of services including municipal water and solid waste collection.

2. Infrastructure and funding deficiencies exist in the areas of water supply and distribution, flood control and mitigation, solid waste and no public wastewater system.

3. The CSA 11 water system consists of 90 connections and relies on well water with an aquifer, which has been determined to have a limited life. When

5 Roads, General Government Services

6 As a remote community there is limited garbage collection service with approximately 80 residents or business owners contracting individually for curbside service. Residents and business owners who do not pay for curbside service take solid waste to the transfer station accessed from Bean Hollow Road, near Pescadero Creek Road or other disposal facilities. See discussion of Transfer Station in following pages.

constructed, the distribution system met and continues to meet residential fire flow requirements, but was not designed to meet current fire flow requirements of the commercial district.

4. Absent CSA 11 system improvements to meet commercial fire flow requirements, new development in the commercial district would be subject to on-site fire suppression water systems.

5. Current water rates do not support year-to-year operation of the water system, and do not include costs associated with capital improvements that would allow the system to meet commercial fire flow requirements or drilling of an additional well to address the limited aquifer.

6. Solid waste services for the Pescadero Rural Service Center and surrounding areas are provided via a County operated transfer station. Rates for use of the transfer station do not cover the cost of operations. A subsidy from the Solid Waste Fund has been used to subsidize the transfer station budget. As the Solid Waste Fund balance declines the subsidy will be eliminated. The County of San Mateo Public Works Department has deferred issuing a request for proposal for consultants to evaluate options for providing disposal/recycling without the Solid Waste subsidy pending a proposal from the Pescadero Municipal Advisory Council for operation of the transfer station by a non-profit.

7. Pescadero is located in the Pescadero-Butano Watershed, the largest coastal watershed between the Golden Gate and San Lorenzo River in Santa Cruz. Much of the Town of Pescadero and Pescadero Creek Road (main access from Highway 1) are located in the flood plain of the Pescadero and Butano Creeks and are subject to flooding annually. Frequent flooding causes physical damage and negative economic impact and is a threat to public safety, public health and natural resources. Flooding on Pescadero Creek Road causes closure of the road and is a severe public safety problem.

8. Challenges to preparation of a comprehensive plan to respond to flooding in Pescadero include multiple layers of regulatory jurisdiction, surrounding sensitive habitat, combination of public and private landowners, and lack of funding to develop a comprehensive plan.

9. The San Mateo County Resource Conservation District has applied for a Bay Area Integrated Regional Water Management Plan Grant to create a watershed council and develop a comprehensive plan[7] to remediate flooding in Pescadero.

[7] The Grant provides for 15% design completion. Additional grants or other funding would be required to finish the design and complete the project.

10. The Community does not have a public wastewater system. Homes and businesses in Pescadero are served by individual septic systems. The California Regional Water Quality Control Board (CA RWQCB) and San Mateo County Environmental Health Department support conversion from individual septic systems to a public sewer system due to inadequate soil structure and high ground water. These conditions result in inadequate treatment of septic wastes and a threat to public health and impediment to installation of effective new septic systems.

11. Since the recommendations of San Mateo County Environmental Health and CA RWQCB, efforts continue to identify a sewer collection system design, sewage treatment alternatives and funding sources. Challenges include availability of land on which to locate the sewage treatment plant and a location that is not in the flood plain or environmentally sensitive and the cost of construction of the system for a relatively small customer base and funding.

12. Individual property owners would be responsible for the cost of abandoning septic systems and connecting homes to the distribution system.

13. The cost of operations, maintenance and future capital improvements of the new system would be funded through rates on a small ratepayer base.

14. County of San Mateo growth projections appear to be overstated given location of Pescadero in a flood plain and for commercial growth, given CSA 11 water system's lack of adequate fire flow.

Service review criteria as set forth in Government Code Section 56430 are examined below.

1) Growth and population projections

Census 2010 population for the Census Designated Place (CDP) of Pescadero is 643. As noted above, the CDP boundaries are not coterminous with the Rural Service Center boundaries.

As noted above, Pescadero is a small rural community with a combination of land uses, which provide services to surrounding rural areas. Land use includes residential, commercial, elementary school, and a fire station. The boundaries of Pescadero are delineated by the Urban/Rural boundary, which designates areas eligible for urban services. Use of septic systems and limited water supply combined with limited opportunity for subdivision indicates minimal potential for population growth in Pescadero.

The Pescadero Community Sewer Project (October 2008) cites the County of San Mateo Local Coastal Program, which proposes that the number of parcels will double in building out to 291 as shown below. Actual build-out is dependent upon water

availability, sewer or septic capacity and economic conditions. Comments on the circulation draft Municipal Service Review also cite unlikelihood of build out reaching projections due to constraints of the Town of Pescadero being within a flood plain. (Map #3 attached.)

	Existing Developed Parcels	Build Out
Residential Dwelling Units	78	250
Commercial	11	40
Other	5	1
Total	94	291

It is recommended that in updating the General Plan, the County reevaluate build out based on current infrastructure conditions and recognizing Pescadero's location within a flood plain. It is also recommended that the County and the Pescadero community consider preparation of an area plan also known as a community plan, which is a plan to resolve local issues and unique physical and land use situations found in various areas of the County.[8]

2) Present and planned capacity of public facilities and adequacy of public services, including infrastructure needs or deficiencies

Water Infrastructure and Operations

The water system consists of two wells (production and emergency/standby well, each with a pump), one140,000-gallon distribution tank and a distribution system. The water pumped from the wells meets all Federal and State water quality standards and does not require treatment. Water flows from the distribution tank through the distribution system mains by gravity. No distribution pumps are required. CSA 11 has approximately 90 residential and commercial customers.

Operations

CSA 11 office staff is housed at 555 County Center in Redwood City (Administration, Accounting, and Engineering). Field staff is Public Works staff from the Facilities Services Division, based in the Tower Road complex in San Mateo near Highways 280 and 92.

Based on the remote location and distance of the system from the Tower Road complex, one alternative for more efficient operations would be to explore the option of contracting with another water agency such as the Coastside County Water District or

[8] Area plans also known as community or neighborhood plans serve to guide decisions about development of a community. The County has adopted area plans for San Bruno Mountain, Emerald Lake Hills, Montara-Moss Beach-El Granada, North Fair Oaks, the Coastal Zone in the form of the LCP and Skyline. The County is currently updating the North Fair Oaks Community Plan with Metropolitan Transportation Commission Grant Funding.

private entities that provide contract service, or share services with the numerous, small water systems that serve the south coast area.[9]

The Public Works Department maintains an internet webpage for CSA 11 on the County Public Works website at http://www.co.sanmateo.ca.us/portal/site/publicworks/.

Contact information for County Service Area 11:

County Service Area No. 11
County of San Mateo
Department of Public Works
555 County Center, 5th Floor
Redwood City, CA 94063
(650) 363-4100; or acsanchez@co.sanmateo.ca.us

Water Infrastructure

Three issues are identified with water infrastructure: limited life of the aquifer, inadequate fire flow for commercial uses and most recently reliability of the primary pump for the production well and adequacy of the auxiliary well and pump in the event the production well fails.

Pump Failure

On the afternoon of Monday, August 22, 2011, the Public Works Department (DPW) received calls from Pescadero community residents reporting no water. Public Works dispatched staff and on arrival the staff person found the pump off and the tank with less than one foot of water. He restarted the pump and stayed until approximately 9:30 p.m. at which time CSA 11 customers had water.

Early morning Tuesday, August 23, 2011, DPW received a text message from a CSA 11 customer that there was no water. At 6:40 a.m., DPW staff left for CSA 11 and on arrival determined the pump was not working and needed to be replaced. The emergency/standby well was put into operation immediately and continued to pump until the replacement pump was on line.

[9] South coast water suppliers include three county operated systems, two State Park systems, and six mutual (property owner) operated systems. Some or all of these operators may benefit from sharing services. (Map #4 attached.)

Corrective Actions

The following summarizes subsequent events and actions taken by DPW to respond to the pump failure and water outage.

1. Tuesday, August 23, DPW delivered 3,500 gallons of water to CalFire Pescadero station for fire fighting purposes at approximately 11:30 a.m.
2. DPW located a specialized pump repair contractor and a pump that could be at the site on Tuesday. The new pump was installed by approximately midnight on Wednesday, August 24. The pump was lowered approximately 37 additional feet into the well. DPW staff was on site until approximately 4:30 a.m. Wednesday.
3. The California Department of Public Health, Division of Drinking Water and Environmental Management (CA DPH) required DPW to issue a boil water order because the system lost pressure. DPW went door-to-door providing Boil Water Notices to each CSA 11 customer.
4. The boil water notice caused the San Mateo County Environmental Health Department to require the businesses that sell food to close unless they sold prepackaged food exclusively.
5. DPW investigated providing a water truck, but the trucking companies would not leave a truck in Pescadero for people to draw water from. DPW also considered trucking in water, but the 13,000 gallons needed to pressurize the tank would require too great a number of trucks, it would be difficult to get water into the tank and customers would still be under a boil water notice. Also, using water that could introduce unwanted materials/substances presented a risk to the integrity of the water system. DPW therefore decided against trucking in water.
6. On Tuesday August 23, DPW ordered and had delivered 900 gallons of water with two gallons per person per day delivered to the Princeton Yard by 3:00 p.m. which were delivered by DPW to Pescadero for distribution. Four portable toilets were also delivered to a lot at Stage Road and Pescadero Creek Road.
7. The pump charged the CSA 11 system (approximately 13,000 gallons needed for system). Due to loss in system pressure, chlorination was required. After the system was charged, DPW discharged water from hydrants to ensure that chlorine residual was present in the system. Five samples from various locations within the system were collected beginning at 3:00 p.m. and delivered to the lab at 5:00 p.m. on Wednesday August 24.
8. At 2:40 p.m. on Thursday, August 25, DPW learned that samples taken for testing on Wednesday, August 24 were found to be safe and at 12:45 p.m. Thursday, August 25, DPW learned that the second round of samples tested were found to be safe
9. DPW contacted the CA DPH, which provided a Cancellation of Boil Water Order, DPW called the four food establishments in town, e-mailed the Puente Resource Center for the printing of notices in English and Spanish, contacted the Pescadero Elementary School regarding the cancellation, and delivered the cancellation notices door-to-door.

10. On Tuesday, August 30, DPW met with representatives of PMAC and outlined the chain of events, DPW response to water outage outlined above and measures to be taken to assure reliability of system.

The pump that failed had been replaced in 2009. It was installed at the depth indicated on the record drawing, which showed a well depth of 260 feet. However, when the pump was removed, a 300-foot metal tape was lowered into the well and was reported not to reach bottom. If that measurement is accurate and based on prior well soundings by CSA 11, it may indicate the pump was not fully submerged in water and may have been pumping water and air which would cause premature pump failure. A decision was made to install the new pump an additional 37 feet lower.

Priorities identified by DPW include continued monitoring of the storage tank level and associated measuring devices each week day from August 29 to September 9, 2011 and two times per week thereafter; testing the existing alarm system and ways to improve alarm reliability; investigating the standby well to determine why the output was not as anticipated; determining the well depth and screen depth based on a video inspection of both wells; determining whether the three-inch galvanized pipe in the production well should be replaced; connecting stainless steel cable to the pump and reconnecting the sounding tube; completing cost accounting of water outage to determine impact to CSA 11 fund balance; and considering potential modifications to operations for wells, pumps and tank including permitting by CA DPH to allow use of Well 2 for non-emergency purposes.

DPW is scheduling a meeting in Pescadero to meet with CSA 11 customers to discuss the water outage, operations moving forward and future water rates. DPW is also working with the Rural Communities Assistance Corporation (RCAC)[10] for assistance in establishing a new rate structure and conducting outreach with CSA 11 customers toward adopting an appropriate rate structure.

Aquifer

The water system relies on well water from an aquifer that has been determined to have a limited life. The wells (main well and standby well) are located on County owned property accessed from Bean Hollow Road. When the system was designed and constructed it met the current local fire flow requirement for Pescadero, which was 500 gallons per minute for 2 hours with a residual pressure of 20 pounds per square inch at the fire hydrant. However, the system was not designed to meet the current fire flow needs of the Commercial district.

[10] RCAC provides assistance to small municipal and nonprofit water systems, wastewater systems and solid waste management programs in 11 western states. RCAC offers technical assistance in assessment of infrastructure, organizational and financial capacity and needs, identifying and evaluating potential solutions, analysis and comparison of financing and rate scenarios, identification of funding sources and assistance with financial packaging and funding applications.

In 2002, a study prepared by Todd Engineering for CSA 11 identified the limited life of the aquifer. Analysis concluded that wells could fail in 8 to 15 years due to lack of water and that installation of a new deeper well in the vicinity of the existing wells would extend the life of the CSA 11 water supply to at least 38 years. Based on the report, it was determined that grant money combined with a loan from the County General Fund should be sought to drill a deeper well. After obtaining a USDA grant in the amount of $135,000 for this purpose, due to lack of support from the community, the Board of Supervisors took action to decline the grant and no further action was taken.

CSA 11 continued to monitor the water surface elevation of the well and recent data indicates that levels are declining. In response to disagreement by the community regarding results of well monitoring, DPW has included community members in observation of well monitoring and as noted above under “Pump Failure” has outlined steps to verify well depth.

Fire Flow

In 1999, a fire flow analysis was prepared by Winzler & Kelly at the direction of the Board of Supervisors with funding from the County Fire Budget. The fire flow analysis identified and evaluated three alternatives for meeting fire flow requirements for the commercial district.

The first alternative analyzed the existing water system under an increased fire flow of 1,500 gallons per minute (GPM) with gravity flow. The results confirmed that the Pescadero water system was not capable of supporting a fire flow of 1,500 GPM. The most significant deficiencies for the Commercial District occurred at the south end of Stage Road south of Pescadero Creek Road. The second alternative represents the existing system under an increased fire flow of 1,500 GPM with the inclusion of a fire protection pump. The third alternative includes a fire flow analysis with new improved distribution main sizes to achieve fire flows by gravity flow.

The study recommended that although installation of a fire protection pump at the water storage facility is feasible for meeting new fire code requirements of 1,500 GPM for 2 hours, the County of San Mateo and the Pescadero Municipal Advisory Committee should strongly reconsider the alternative of upsizing the Pescadero water system distribution mains to meet fire flow goals by gravity. The study stated that gravity flow systems are much more reliable for water service and the long term costs of maintenance and repair prove less costly to providing adequate fire protection and water service than when compared to a fire protection pump.

The study estimated the cost of Alternative 2 at $542,000 and the cost of Alternative 3 at $1,006,000. No action has been taken on the recommendations in the report.

Absent improvements to the CSA 11 system to meet fire flow, new commercial construction in Pescadero would require individual developers to include on-site water systems for fire suppression that meet specifications approved by CalFire.

3) Financing constraints and opportunities

CSA 11 Budget

The District's 2009-10 Actual, 2010-11 Actual and the 2011-12 Adopted Fiscal Year budgets are summarized in the table below:

County Service Area 11 Budget			
	Actual 2009-10	**Actual 2010-11**	**Adopted 2011-12**
Revenue			
Water Sales and Monthly Charges	43,878	43,382	42,000
Returned Check	75	0	0
Surcharges & Penalties	1,698	1,620	0
Connection Charges	2,310	0	0
Interest/other	538	[11]16,545	440
Total Revenue	48,499	61,547	42,440
Fund Balance	**59,777**	47,637	**43,512**
Total Sources	**$108,276**	**$109,184**	**$85,952**
Expenditures			
Misc. Office (Outside Printing, Postage, and Paper)	37	558	0
Software License (Billing Software)	6,125	3,200	3,300
Misc. Maintenance	6,198	6,086	3,550
Utilities	4,325	4,026	7,700
Contract Services (Lab. Testing and Backflow Prevention Testing)	2,501	1,555	7,000
Engineering, Operations & Maintenance	18,118	29,581	25,000
Other Special Expenses	2,601	190	3,400
Admin. Accounting	0	0	3,000
Retirement of Long Term Debt	18,368	18,993	19,511
Interest on Long Term Debt	2,108	1,483	1,110
Uncollectable Amounts	258	0	300
Total Expenditures	60,639	65,672	73,871
Operating Revenue less Expenditures	**(12,140)**	**(4,125)**	**(31,431)**
Fund Balance at End of FY	47,637	43,512	[12]12,081

The budget format above allows for comparison of operating revenues and expenditures and changes in fund balance as the fund balance offsets operating

[11] Includes a refund of $15,963 for utility costs incorrectly applied to CSA 11.
[12] Estimated fund balance. The Adopted 2011-12 budget does not reflect yet to be calculated cost of water pump failure and water outage.

deficits. The Adopted 2011-12 Budget reflects a projection of revenues and expenditures.

Upon formation, CSA 11 obtained a loan in the amount of $296,100 from the State of California Department of Water Resources. If upon formation, the property owners did not pay their assessment in full 45 days after approval of the final project report, the property owners paid assessments for 10 years beginning FY 1994-1995 and ending FY 2003-04. The payments were collected through the property tax roll. The Loan Payment Schedule is April 1, 1993 through October 1, 2012, which will reduce budget expenditures by approximately $21,000 thereafter.

The Adopted 2011-12 budget above includes $42,000 in water fee revenue and $73,871 in appropriations including $25,000 for engineering, operations and maintenance, and $20,621 for retirement of long-term debt. The fund balance has been drawn down in prior years to balance the operating budget with the estimated fund balance at the end of 2011-12 fiscal year estimated at $12,081. This will be impacted by the costs associated with the pump failure. As discussed below, it will be necessary to raise water rates to provide for a balanced operating budget including a contingency reserve for the 2012-13 fiscal year.

Looking forward, with retirement of the loan obligation and elimination of the annual debt payments of approximately $21,000, without rate adjustment, annual revenues from water sales and monthly service charges are projected at $42,000 and annual expenditures, excluding funding for capital improvements are an estimated $53,250 for FY 11-12, resulting in an estimated annual deficit of approximately $11,250.

Water Rates:

CSA 11 customers are billed bi-monthly based upon meter readings for the preceding sixty days. The bill is comprised of a “Service Charge” and a “Volume Charge” component. The Service Charge is a flat monthly charge designed to recover costs that do not vary with consumption, such as meter reading and billing and maintenance of the distribution system. The “Volume” charge is based on the amount of water used. One unit (100 cubic feet) equals 748 gallons. Water rates were last amended in September 2003.

Service Charge:	$22.00 per month for a 5/8" or 3/4" connection $33.00 per month for a 1" or 1 1/2" connection
Volume Charge:	$1.38 per unit

New customers whose properties are within CSA 11 may connect to the system upon payment of a buy-in charge, service connection fee and meter deposit as detailed below.

Buy-in Charge	Base buy-in charges are effective October 1, 2003 and are adjusted annually on July 1 according to the ENR Construction Cost Index: $ 8,000.00 base charge for connections less than 1-inch in diameter $10,000 base charge for connections greater than 1-inch in diameter
Connection Fee	Varies from $660.00 to $1650.00
Meter Deposit	$35.00

As shown in the budget and discussed above, water rates are not sufficient to cover operations and maintenance and the budget has been balanced by application of fund balance. It is crucial that water rates be adjusted by the beginning of the 2012-13 Fiscal Year to cover the cost of service in addition to building a prudent reserve or capital fund. This rate setting process could examine tiered versus flat rates and could take into consideration costs associated with needed improvements for commercial fire flow, the need to address limitations of the aquifer and the priorities identified in response to the pump failure. It is recommended that CSA 11 begin a rate setting process immediately.

Rate Comparison – Other Agencies:

In updating rates the County may wish to consider a tiered rate pricing versus flat rate. The following includes examples of tiered rates structures of other public water agencies in San Mateo County. One hundred cubic feet (hcf) is the standard unit of water and equals 748 gallons.

North Coast County Water District (12,412 customers)

Monthly Service Charge: 24.94
Volume Charge:

First 5:	2.53 per hcf
6 to 16:	5.62 per hcf
17 to 28	8.04 per hcf

Bill for 12 hcf : $24.94, 5 x 2.53 and 7x5.62= $76.93

Coastside County Water District (6,583 customers)

Bi-Monthly Service Charge $30.72
Volume Charge:

0-8 hcf	$5.02 per hcf
9-25 hcf	$5.53 per hcf
26-40 hcf	$7.19 per hcf
41 or more hcf	$8.88 per hcf

Bill for 12 HCF: $15.36+8x5.02+4x5.53 = $77.60

Montara Water and Sanitary District (1,656 customers)

Monthly Service Charge Meter 5/8" $20.84
Volume Charge:

0 to 6 hcf	$6.54 per hcf
7 to 13 hcf	$8.72 per hcf
14-27 hcf	$10.90 per hcf
over 27 hcf	$15.26 per hcf

Bill for 12 HCF: $20.84+6x6.54+6x8.72 = $112.40

County Service Area 11 (100 customers)

Monthly service charge: $22
Volume Charge: $1.38 per unit
Bill for 12 units: 12x1.38= $16.56 plus $22 = $38.56

County Service Area 7 (68 customers)

Monthly Service charge $20
Volume Charge $4.80
Bill for 12 units: $57.60+20=$77.60

Future Review of Rates

Future review of rates could include factors such as updated capital improvement priorities, on-going maintenance and rate structure models including a tiered rate model that encourages conservation. Consideration can also be given to a rate structure that phases increases over time to allow for gradual implementation of some improvements. It is also recommended that the County adopt a policy for the frequency of rate reviews to ensure that water service revenues keep pace with the cost of operations and capital improvements to the extent possible.

As discussed in Pump Failure above, the County has contacted RCAC for assistance with rate setting and community education and outreach.

Septic Systems and State Water Resources Control Board

There is not a public sewer system or centralized sewage treatment plant in Pescadero. Development is served by individual septic systems. In 2004, the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), issued Resolution 04-R2-0088, supporting a 2004 Public Health Declaration by the County. The County declaration stated that "inadequate soil structure and high groundwater in the area provides poor conditions for adequate treatment of septic wastes from the residences and businesses in the Community resulting in a threat to public health, and precludes the installation of effective new septic systems." As a result, the County commissioned a study to evaluate potential options for a sewer collection and treatment system for the Rural Service Center of Pescadero.

Construction of a new sewer collection and treatment system has four basic component costs: capital costs for construction of the sewer collection system, capital costs for construction of the sewage treatment plant, on-going annual operations and maintenance (all of which are funded by property owners that connect to the system) and the costs for each property owner to abandon the septic system and connect the structure to the sewer main. Please see the following tables for estimated capital cost annualized and operations and maintenance costs that would be funded through rates or assessments.

The study titled "Pescadero Community Sewer Project" was completed in October 2008 and identified that gravity and Septic Tank Effluent Pump (STEP) systems or Septic Tank Effluent Gravity (STEG) system are feasible in Pescadero. The following table summarizes the estimated costs of these alternatives.

	Gravity	STEP/STEG
Total Capital Cost	$2.7 million	$2.5 million
Annualized – 20 yrs	$256,000	$237,000
Annual O & M Cost	$39,000	$54,000

The Sewer Project Report identified three possible locations for the sewage treatment plant and three types of sewage treatment plants. Excluding land acquisition, the report estimated costs of these three alternatives as shown below. [13]

Cost Item	MBR Plant	IMAS Plant	SBR Plant
Total Capital Cost	$600,000	$400,000	$481,000
Annualized – 20 yrs	$57,000	$38,000	$45,000
Annual O & M Cost	$12,000	$16,000	$19,000

[13] Please refer to the complete report at www.sanmateolafco.org for more information.

Challenges in developing a new public sewer system include the high cost of construction and maintenance for a system serving a relatively small customer base (90 connections),[14] locating a treatment plant out of the flood plain and not in proximity to sensitive habitat, and on land that is owned by the County of San Mateo or can be made available by another entity. In addition, the remote location of Pescadero, travel time from County facilities affect costs and ability to comply with State regulations that require response to spills within a specified time period.

Also of note is that water demand in areas with septic systems is typically lower than areas with public sewer systems. If the community is successful in developing a public sewer system, it is likely there will be an increase in demand for domestic water. In that regard, priority must be placed on establishing a sustainable water supply for potentially increased demand.

Since completion of the Sewer Project Report, the Pescadero Municipal Advisory Council continues to work with the County of San Mateo and Rural Communities Assistance Corporation (RCAC) to pursue potential funding sources and alternative designs. Comments from PMAC reflect lack of support for the recommended design of the sewer project and concern that alternatives be explored that would result in a more affordable treatment plant and collection system. Constraints to designing and constructing a sewer collection system and treatment plant for the study area include location of development to be served in the floodway, availability of land on which to locate a sewage treatment plant that is not in the floodway or distant from the collection system and the small customer base that must fund construction and operation.

Pescadero Lighting District

Formed in 1949, Pescadero Highway Lighting District is one of 12 county-governed lighting districts. The District territory includes the majority of the largest non-contiguous portion of Pescadero. District infrastructure includes 29 streetlights. As a non-enterprise district, the primary funding for the district is property tax to fund repair and maintenance, energy costs and capital improvement (replacement or addition of light poles).[15]

Pescadero Highway Lighting District Budget

The Adopted 2011-12 budget includes a fund balance of $159,758, property tax and other revenue of $9,446 for a total of $169,209. Financing requirements include services and supplies of $10,200 and an appropriation for contingencies of $159,004 for total appropriations of $169,204.

Pescadero Highway Lighting District	2009-10 Actual	2010-11 Actual	2011-12 Adopted

[14] Costs provided do not include cost of abandoning septic and connection to sewer which should be estimated based on individual parcel site conditions.
[15] As a district formed prior to Proposition 13, the District receives a share of the 1% property tax.

Revenues			
Property Tax	9,076	8,993	8,446
Interest	1,443	1,861	1,000
ERAF Rebate	5,849	5,208	0
Fund Balance	145,861	168,758	159,758
Total Sources	$162,230	$184,820	$169,204
Expenditures			
Operations/Maintenance/Repairs	5,709	1,327	7,500
Electric & Gas Utilities	1,237	1,261	2,700
Appropriation for Contingency	155,284	182,233	159,004
Total Requirements	$162,230	$184,820	$169,204

The five-year average of revenue for the District (FY 2006-07 through FY 2010-11) has been approximately $15,345. Approximately 30% or $4,590 of this revenue is derived through refunds from the Educational Relief Augmentation Fund (ERAF).[16] This revenue is not budgeted annually as a revenue because it is not a dependable revenue source. It has however become a significant contributor to the revenue and fund balance of the District. The interest earned by the District has averaged to be approximately 12% or $1,892. The remaining revenue is generated through an allocation from the property taxes paid, which averages to be 58% or $6,906.

The five-year average expenditures for the District (FY 2006-07 through FY 2010-11) have been approximately $4,400. These expenditures are primarily comprised of electrical expenses (approximately 27% or $1,206) with the remaining expenditures associated with repairs to existing streetlights and administration of the District. District repairs or service to streetlights are driven primarily by street light outages reported by residents or property owners or by night surveys performed by staff. Repairs vary from replacing bulbs, replacing fixtures, and upgrading fixtures. The number of repairs per fiscal year varies during the five year period from 0 repairs in one fiscal year to 9 repairs in another fiscal year. The average number of repairs per year over the five-year period was three. To perform this work, assigned staff travel from the County's Tower Road complex to Pescadero.

District revenue has exceeded expenditures each fiscal year, which has contributed positively to the District fund balance. The fund balance for the District at the end of the FY 2010-11 was $168,758 compared to a fund balance of $93,431 at the end of the FY 2003-04. An appropriate fund balance target would be based on the number of lights maintained by the District, the average operation and maintenance expenditures, replacement costs, an estimate of additional lights that could be added to the District without additional funding, and any future infrastructure upgrades that may be desired or deemed necessary (new lights, stand-alone light poles, or undergrounding of utilities).

[16] ERAF refunds occur when the ERAF contributions to school districts from the county, cities and special districts exceed the amount required to fund schools up to their revenue limits.

Roads

Bay Area jurisdictions use the Pavement Condition Index (PCI)[17] to measure the condition of its roads. The Pavement Management System and PCI were developed by the Metropolitan Transportation Commission. The PCI is based on road conditions that include cracking, furrowing or rutting, potholes, and general weathering and provides information necessary to establish a maintenance program and budget for road maintenance. According to the County's Pavement Management Plan and PCI, the County maintains approximately 3.36 centerline miles within the rural service center portion of Pescadero and indicates the PCI for these sections is 62.36.

Public Safety

Pescadero is within the jurisdiction of County of San Mateo fire protection and emergency response. The County contracts with CalFire which operates out of Station 59 on Pescadero Road.. The next nearest stations are La Honda Station 57 and Coastside Fire Station 40 in Half Moon Bay. The County Sheriff serves Pescadero as part of Sheriff Beat 80 serving the rural south coast and Skyline areas

Flooding

As noted elsewhere, Pescadero is located in the Pescadero-Butano Watershed, the largest coastal watershed between the Golden Gate Bridge and San Lorenzo River in Santa Cruz. Much of the Town of Pescadero and Pescadero Creek Road (main access from Highway 1) are located in the flood plain of the Pescadero and Butano Creeks and are subject to annual flooding. Frequent flooding causes physical damage and negative economic impact, and a threat to public safety, public health and natural resources. Flooding on Pescadero Creek Road causes closure of the road and is a severe public safety problem.

The most frequent flooding occurs at the Butano Creek Bridge along Pescadero Creek Road. Flooding at this location often results in at least one of the two traveled lanes along Pescadero Creek Road between Highway 1 and the Town being under water and blocked access from Highway 1 including the CalFire Station.

Absent a comprehensive study of potential solutions, members of PMAC and others have suggested a variety of improvements intended to reduce instances of flooding along Pescadero Creek Road at Butano Creek Bridge. These have not been analyzed for feasibility, unintended impacts to other areas or cost. Suggestions include: dredging the Pescadero Marsh, excavation and clearing of debris in the Creek downstream of the bridge, a pump at the bridge on Pescadero Creek Road to pump water downstream and raising a section of Pescadero Creek Road above

[17] The pavement condition index, or PCI, is a measurement of pavement grade or condition and ranges from 0 to 100. A newly constructed road would have a PCI of 100, while a failed road would have a PCI of 10 or less.

flood level. There has not been a comprehensive analysis of solutions to flooding, however, such improvements have the potential to increase localized flooding elsewhere.

Challenges to preparation of a comprehensive plan to respond to flooding in Pescadero include multiple layers of regulatory jurisdiction, surrounding sensitive habitat, combination of public and private landowners, and lack of funding to develop a comprehensive plan. The San Mateo County Resource Conservation District has applied for a Bay Area Integrated Regional Water Management Plan Grant to create a watershed council and develop a comprehensive plan[18] to remediate flooding in Pescadero.

Solid Waste

Due to Pescadero's sparse population and remote location, there is no franchised garbage collection service in Pescadero or surrounding areas. Residents and businesses in Pescadero and surrounding areas either have individual subscription service with a garbage collection service, drop off solid waste at the Pescadero Transfer Station (PTS) located off of Bean Hollow Road near Pescadero Creek Road or take their waste to a landfill. The PTS is operated by Allied/Republic through an agreement with the County of San Mateo. The agreement stipulates the annual cost for operating the PTS. The PTS is open five (5) days per week and Allied/Republic receives $174,710 per year for operation of the PTS. In addition to the cost to operate the PTS, the County pays a per ton cost (currently $101.37/ton) to dispose of municipal solid waste from the PTS. Other disposal costs are indicated in the Agreement. The following table presents an analysis of the Expenses and Revenues for the PTS. The "Net Payment to Allied/Republic" is from the Solid Waste Fund. [19]

[18] The Grant provides for 15% design completion. Additional grants or other funding would be required to finish the design and complete the project. Staff in the office of Supervisor Horsley is also pursuing other grant sources.

[19] The Solid Waste Fund resulted from a Contract between the County and the Operator of Ox Mountain Land Fill that established a per ton compensation fee be paid to the County by the operator for every ton disposed at the landfill. That contract expired in 2009 and the new operator was not willing to negotiate new agreement. The Solid Waste Fund is receiving no revenue and being drawn down by other land fill related expenditures. Therefore it should not be considered a funding source/subsidy for solid waste disposal in Pescadero.

FY 2009-10 Pescadero Transfer Station Expenses and Revenue	
Annual Operations Expenditure	$174,701.04
MSW Disposal and Recycling Costs	$ 81,723.80
Gross Expenditure	$256,424.84
Tipping Fee Revenue	($ 78,893.78)
Net Payment to Allied/Republic	177,531.06
Solid Waste Fund Subsidy Percentage	69.23%

The PTS receives municipal solid waste, mixed recyclables, metal, yard waste, and construction and demolition debris of approximately 800 tons of material per year. The gate rate (or Tipping Fee Revenue as indicated in the table) is set by the Board of Supervisors through resolution. Rates were last raised in 2008. The San Mateo County Department of Public Works in prior studies has determined where materials are coming from and that PTS serves areas beyond the Pescadero Rural Service Center. (Stage, North Street, Water Lane, and Pescadero Creek Road.) The County of San Mateo has deferred issuing a Request for Proposal for a Study of Service and Rate Analysis to address service alternatives and rates, including elimination of the Solid Waste Fund Subsidy, in anticipation of a proposal from PMAC for non-profit operation of the Transfer Station.

4) Status of, and opportunities for, shared facilities and cost avoidance

The remote location of Pescadero limits opportunities for resource and facility sharing.

The recent pump failure and water outage illustrates the challenge of responding to a water emergency in a remote area and the County's ability to pool resources of the Public Works Department that would not be available to a small, single purpose special district with 90 connections.

As noted above, the County is encouraged to examine sharing service with other small water providers on the south coast. One identified opportunity is sharing of licensed operators. Map # 4 (attached) illustrates the location of the numerous small water systems in the area, each of which is required by State regulation to be operated by a State licensed operator. By convening a workshop or meeting of the managers of these systems, the alternative of sharing licensed operators can be discussed. It is also recommended that the County discuss the potential for contract service with Coastside County Water District or private firms for water system operation. Contracting with another entity could create efficiencies and improved response time.

5) Accountability for community service needs, including governmental structure and operational efficiencies

In regard to public accountability, the San Mateo County Board of Supervisors is the governing body ofCSA 11 and the County of San Mateo Public Works Department is

responsible for District operations. The Department of Public Works maintains a website with water rate and other information about water service. The San Mateo County Board of Supervisors as the rate setting body is subject to the Ralph M. Brown Act and Proposition 218 governing public meetings and public hearings to set rates. The Board of Supervisors adopts a budget for the CSA 11 annually and the Department of Public Works publishes an Annual Water Quality Report.

In addition, the Pescadero Municipal Advisory Council meets monthly and provides an additional opportunity for public input concerning public services in Pescadero and surrounding communities.

For the purpose of this report, discussion of government structure relates to alternative forms of government for service delivery that would promote efficiencies. As a District that operates a small system in a remote area, it does not overlap with any other local service provider. The nearest water provider is Coastside County Water District serving the City of Half Moon Bay and surrounding areas 14 miles to the north. Opportunities may exist for the County to contract with Coastside County Water District. In addition, there are private companies that provide contract operation and maintenance of public water and sewer systems.

Alternative models to the current governance by a County Service Area in which the Board of Supervisors is the governing body and the County of Public Works Department operates the water system, include:

- Community Services District that would be governed by a locally elected board that would either employ staff or contract with another entity for services. The locally elected board would be responsible for setting rates, operating the system and compliance with State regulations concerning public water systems. [20]
- Transfer of the system to a private utility or entity including Calwater
- Formation of a mutual water company

The alternatives summarized above would be alternatives to consider if the County of San Mateo determines that it is not feasible for the County to operate the system due lack of rate payer support resulting in inadequate revenues.

Inventory of Active Services: CSA 11

Enabling legislation for county service areas (Government Code Section 25213) authorizes county service areas to provide a broad set of municipal services, in essence all services a city may provide (except land use). Since 1997, provisions of the Cortese Knox Hertzberg Act were amended to require that LAFCo identify which of the services of a multi-purpose district are actively provided and which are inactive. Pursuant to Government Code Section 56425(i), in preparing a municipal service review and sphere

[20] Formation of a Community Services District (CSD) can be initiated by 25% registered voter petition or by resolution of application of the County. If approved by LAFCo, the CSD proposal is subject to majority voter approval at election.

update, LAFCo is required to prepare a statement of the nature and location of functions and services provided by the districts. If a district proposes to add a new service permitted under district enabling legislation, the District must apply to LAFCo for approval. County Service Area 11 provides the following services in the areas as specified and any other services authorized by County Service Area enabling legislation are inactive:

Water Service District-wide

If in the future it is determined that other services permitted in CSA enabling legislation should be provided and funded by CSA 11, the County Board of Supervisors as governing body of the District could apply to LAFCo. The application would include a plan for providing services and a proposed budget including revenues to fund service and any associated revenue sources such as an assessment, fee or tax.

Recommended LAFCo Determinations Pursuant to Government Code Section 56430

1) Growth and population projections for the affected area.

County of San Mateo growth projections may be overstated given location of Pescadero in a flood plain. For commercial growth, CSA 11 water system's lack of adequate fire flow is an impediment to new commercial construction. The County is encouraged to reevaluate growth projections for Pescadero with the update of the General Plan.

2) Present and planned capacity of public facilities and adequacy of public services, including infrastructure needs or deficiencies.

a) Infrastructure and funding deficiencies exist in the areas of water supply and distribution, flooding, solid waste and lack of wastewater system.
b) The County Service Area 11 water system consists of 90 connections and relies on well water with an aquifer with limited life. When constructed the distribution system met and continues to meet residential fire flow requirements but was not designed to meet current fire flow requirements of the commercial district.
c) Absent CSA 11 system improvements to meet commercial fire flow requirements, new development in the commercial district would be subject to on-site fire suppression water systems.
d) The Community does not have a public wastewater system. Homes and businesses in Pescadero are served by individual septic systems. The California Regional Water Quality Control Board and San Mateo County Environmental Health Department support conversion from individual septic systems to a public sewer system due to inadequate soil structure and high ground water providing poor conditions for adequate treatment of septic wastes resulting in a threat to public health and impediment to installation of effective new septic systems.
e) Pescadero is located in the Pescadero-Butano Watershed, the largest coastal watershed between the Golden Gate Bridge and San Lorenzo River in Santa Cruz. Much of the Town of Pescadero and Pescadero Creek Road (main access from Highway 1) are located in the flood plain of the Pescadero and Butano Creeks and are subject to flooding annually. Frequent flooding causes physical damage and negative economic impact, and a threat to public safety, public health and natural resources. Flooding on Pescadero Creek Road causes closure of the road and is a severe public safety problem.

3) Financial ability of agencies to provide services.

a) Current CSA 11 water rates do not support year-to-year operation of the water system, and do not include costs associated with capital improvements

that would allow the system to meet commercial fire flow requirements or drilling of an additional well to address the limited aquifer.

b) New infrastructure (sewer, flood control infrastructure) for existing development is dependent upon a funding source such as an assessment, tax, or State or Federal assistance.

4) Status of, and opportunities for, shared facilities.

a) Opportunities exist for CSA 11 to examine sharing resources with the numerous small water systems operated on the rural south coast and to examine contracting with Coastside County Water District for system operation.
b) Opportunities may exist for non-profit operation of the transfer station in partnership with the County of San Mateo.
c) Opportunities exist to jointly pursue a comprehensive plan to remediate flooding through a partnership of the County of San Mateo, Pescadero Municipal Advisory Council, San Mateo County Resource Conservation District and public and private landowners in the area

5) Accountability for community service needs, including governmental structure and operational efficiencies.

a) The Board of Supervisors serves as the governing body of CSA 11 and the County Public Works Department operates the system and is the point of contact for water rate payers.
b) The County Public Works Department maintains a website with contact information, rate information and water quality.
c) As a small, remote community there are inherent service inefficiencies in providing service to Pescadero due to distance from Public Works facilities in San Mateo and Redwood City.
d) Because the County of San Mateo Public Works Department operates many non-contiguous systems, when needed it is able to pool resources to respond to emergencies, in a manner that a small, single purpose district could not.

6) Any other matter related to effective or efficient service delivery, as required by Commission policy.

State policy gives LAFCo the discretion to determine the geographic area to be studied in municipal service reviews. There is not a Commission policy concerning limiting service reviews to a specific geographic area, nor is the LAFCo service review mandated to include general county services or polices. While this municipal service review focuses on County Service Area 11, which is limited to the urban rural boundaries of the Pescadero Rural Service Center, it identifies service or infrastructure challenges in the areas of flooding and solid waste that affect the broader rural south coast because these issues impact the territory of CSA 11.

Assessment of Source Water for the Pescadero Water System - CSA 11

Prepared for:
Department of Public Works
San Mateo County, California

March 2002

TODD ENGINEERS

Department of Public Works
San Mateo County, California

Assessment of Source Water for

the Pescadero Water System – CSA 11

March 2002

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Executive Summary

Prior to installing and operating the two County Service Area (CSA 11) water supply wells, the Town of Pescadero relied on small domestic wells, water from surface impoundments, and locally derived groundwater, from wells installed in the low-lying alluvial aquifer of Pescadero and Butano Creeks. In the 1970's and 1980's, these sources were found to contain relatively high concentrations of nitrate and other naturally occurring salts. This prompted the development of alternative groundwater sources located in the Pigeon Point Formation, about one mile west of Pescadero on the top of a northwest trending ridge, and adjacent to the Pacific Ocean. The wells have been operating since 1993. Well 1 was installed in 1983; Well 2, located 300 feet from Well 1, was installed in 1992. At the time of installation the water level elevation at the wells was about 106 feet above mean sea level. The estimated quantity of water used by CSA 11 is about 25 acre feet per year or about 16 gallons per minute.

Since well pumpage began, the depth to water in Wells 1 and 2 have dropped to 90 feet above mean sea level. This is equivalent to a drop in water level of about 1.6 feet per year. The top of the well screens for Wells 1 and 2 are at 70 and 66 feet above mean sea level, respectively. Assuming that the lowering of the water level is linear, then the current wells will fail in 8 to 15 years. The longevity of the aquifer is about 25 years. Groundwater quality has met drinking water standards for Wells 1 and 2 and water quality does not appear to deteriorate with depth.

We recommend that CSA 11 install a new production well in the vicinity of Wells 1 and 2 or at a lower elevation near the distribution tank to reduce overall drilling depth. The well should be drilled to at least 100 feet below mean sea level to take advantage of the overlying potable water. We estimate engineering costs to install a new well and above-ground facilities at about $45,000 to $55,000 and drilling contractor costs at about $150,000. Accordingly, an installed, fully equipped and functional well can be constructed for $200,000 to $250,000. Installation of such a new production well will extend the life of the CSA 11 water supply to at least 38 years.

Introduction

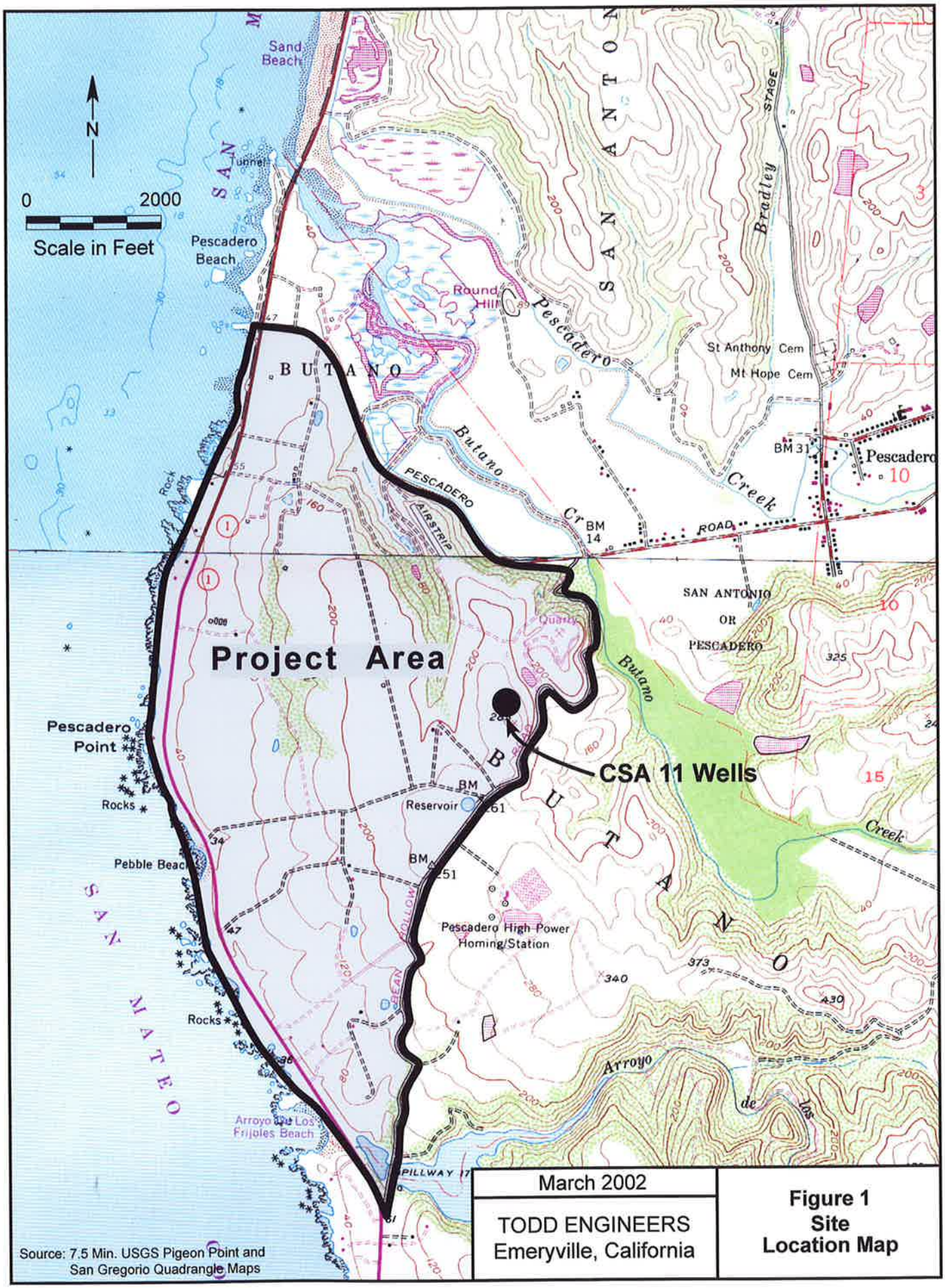
In April 2001, the Department of Public Works (DPW) of the County of San Mateo requested a technical proposal from Todd Engineers addressing the Town of Pescadero water system, specifically the source water. The source water consists of two wells tapping the same aquifer and installed approximately one mile west of Pescadero. The wells have been operating since 1993. Well 1 was installed in 1983; Well 2, located 300 feet from Well 1, was installed in 1992. The DPW maintains and operates the County Service Area 11 (CSA 11) system for Pescadero.

After a preliminary review of existing documents, the proposal was submitted to DPW on April 13, 2001. The proposal consisted of five general tasks: (1) review existing hydrogeologic information, (2) conduct preliminary aquifer testing, (3) conduct optional formal step-drawdown testing, (4) coordinate and conduct constant rate aquifer test, and (5) prepare a technical report. On September 7, 2001 Todd Engineers received official notice from DPW to proceed with the scope of work. This report presents our findings.

The goals of this investigation are to determine and re-assess the long-term sustainability of the aquifer pumped by the CSA 11 water supply wells and to determine the reliability of the wells. To accomplish these goals, Todd Engineers conducted a review of all available and relevant hydrogeologic information in the area to assess the long-term aquifer supply and performed pumping tests to assess well performance.

Figure 1 shows the location of the water supply wells and the geographic setting of the area. The wells are located near the top of a ridge. In general, the project area is triangular-shaped (shown on Figure 1) and is defined by Highway 1 along the west, Pescadero Road on the northwest, and Bean Hollow Road on the southeast. The project area is about 1,042 acres or 1.6 square miles and is located at the extreme north end of a northwest trending ridge. Butano Creek represents the major drainage east of the ridge while Arroyo de los Frijoles, located south of Bean Hollow Road, nearly dissects the ridge.

Topographic elevations for the area range from 0 to 285 feet above mean sea level (msl). The west-facing slopes of the ridge have shallower ground surface gradients (7 percent) than the east-facing slopes (11 percent). The east-facing slopes tend to have



March 2002

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Figure 1
Site Location Map

more pronounced drainage areas than the west-facing slopes. Pescadero Beach and the Pescadero Creek estuary are located near the northern extent of the project area. Arroyo de los Frijoles and Lucerne Lake are located south of the project area. Average annual rainfall ranges between 20 and 25 inches (Rantz, 1969; Shah and Nahn, 1989).

Prior to installing these CSA 11 water supply wells, the Town of Pescadero relied on small domestic wells, water from surface impoundments, and locally derived groundwater from wells installed in the low-lying alluvial aquifer of Pescadero and Butano Creeks. In the 1970's and 1980's, these sources were found to contain relatively high concentrations of nitrate and other naturally occurring salts. This prompted the exploration and development of alternative groundwater sources in the early and late 1980's (Wood, September 13, 1982; Geoconsultants, May 1983; Kennedy/Jenks/Chilton, September 2, 1987; Todd Engineers, July 14, 1989; and Winzler & Kelly, August 25, 1989).

Based on the history and metered usage of groundwater pumpage between 1993 and 2001, the estimated quantity of water used by CSA 11 is about 25 acre feet per year (AFY) or about 16 gallons per minute (gpm). Annual usage ranges between 17 to 29 AFY (11 to 19 gpm). Therefore, the total amount of water pumped by CSA 11 between 1993 and 2001 is about 200 acre feet (AF).

Well Information and Location

Figure 2 shows the location of all wells available for this hydrogeologic analysis. The project area is located in portions of sections 5, 8, 9, 16, and 17 of Range 5 West, Township 8 South. Forty-four wells were identified in the project area including six wells located in Pescadero Creek alluvium, and eleven wells documented from consultant reports and files. Much of the well information was compiled from the Department of Water Resources (DWR) records, County of San Mateo files and records, and Geoconsultants, Inc. and Todd Engineers files. DWR Water Well Drillers Reports could not be found for nine wells. The location of the wells shown on Figure 1 were obtained from the Drillers Reports and have not been field checked to verify the location.

Table 1 summarizes the construction details for the wells in the vicinity of CSA 11 water supply wells. The table is divided into three categories. From top to bottom they are: probable Pigeon Point Formation wells, probable marine terrace wells, and

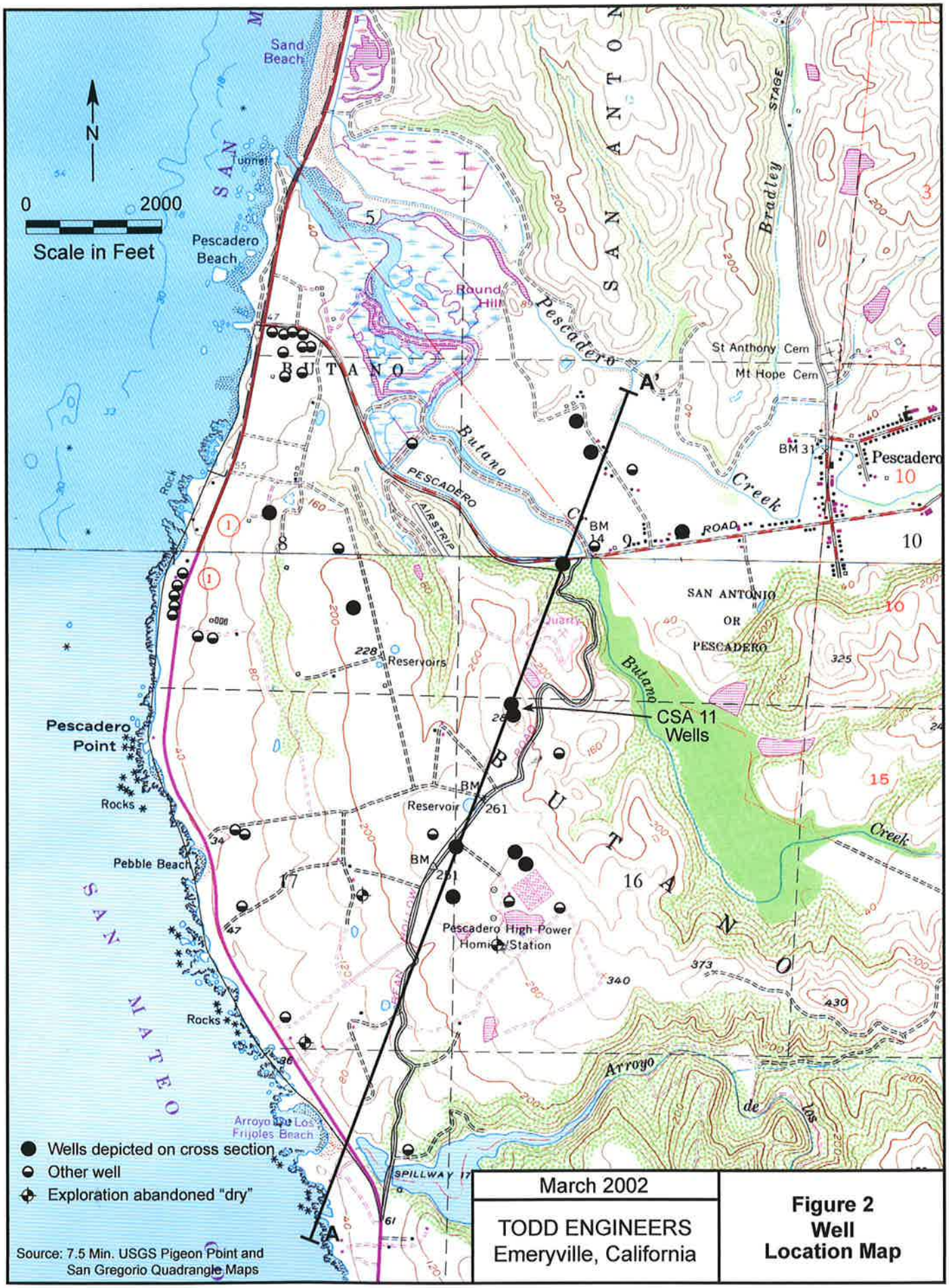

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Figure 2
Well
Location Map

Table 1

Summary of Wells in the Vicinity of the CSA 11 Wells

Name	Date	Elev.	Total Depth	CD	Csg. Diam.	Screen	Slot	SWL	Driller
Probable Pigeon Point Formation Wells									
CSA 11 Wells									
Exp Well	08/82	275	244		Abandoned			~190	Earthflow
Well 1	04/83	277	280	247	6	207 to 247	0.040	170	Earthflow
Well 2	01/92	276	260	260	'10	210 to 250	0.040	170	Maggiora
SDF Well	unk	20	unk	68	8	44 to 68 ?	unk	unk	unk
Neighboring Wells									
Well 1	05/91	290	360	350	5	200 to 320	0.032	36	Digges
Well 2	05/91	270	400		Abandoned				Digges
Well 3	06/91	280	355	350	5	90 to 340	0.032	28	Digges
Well 4	01/92	260	700	635	5	228 to 628	0.040	24	Landino
Well 5	06/92	245	805	800	5	260 to 780	0.040	34	Landino
Domestic	unk	unk	unk	unk	unk	unk	unk	unk	unk
Other Wells									
62221	07/61	N/A	100	60	8	unk	unk	32	Digges
119527	02/75	N/A	220	220	5	100 to 220	unk		Maggiora
227086	04/85	N/A	100	100	4	50 to 90	unk	2	Earthflow
208314	10/85	N/A	200	200	4	40 to 180	unk	0	Earthflow
207980	12/86	N/A	100	100	5	80 to 100	unk	35	Earthflow
207981	12/86	N/A	100	100	5	80 to 100	unk	30	Earthflow
207993	06/87	N/A	160	160	5	80 to 160	unk	15	Earthflow
Probable Marine Terrace Wells									
62203	04/60	N/A	24	24	10	12 to 24	unk	6	Digges
62212	02/61	N/A	90	90	6	27 to 90	unk	24	Digges
85178	03/63	N/A	36	35	8	27 to 35	unk	23	Freedom
85178	03/63	N/A	36	35	8	27 to 35	unk	24	Freedom
107515	07/65	N/A	60	56	6	15 to 56	unk	4	Digges
122526	08/66	N/A	60	60	10	12 to 60	unk	18	Digges
122537	08/67	N/A	60	56	10	0 to 56	unk	7	Digges
122546	09/68	N/A	48	44	10	24 to 44	unk	15	Digges
13909	07/69	N/A	60	58	10	12 to 58	unk	6	Digges
13920	05/70	N/A	80	80	10	22 to 80	unk	2	Digges
13923	06/70	N/A	60	56	10	10 to 56	unk	2	Digges
13936	04/71	N/A	60	60	10	12 to 60	unk	4	Digges
13937	04/71	N/A	60	60	10	12 to 60	unk	3	Digges
13938	04/71	N/A	60	60	10	18 to 60	unk	10	Digges
20217	06/73	N/A	60	56	10	12 to 56	unk	8	Digges
20218	06/73	N/A	60	56	10	12 to 56	unk	6	Digges
110201	06/73	N/A	60	56	10	10 to 56	unk	8	Digges
38284	06/78	N/A	60	60	5	10 to 60	unk	6	Digges
38285	06/78	N/A	60	60	5	11 to 60	unk	6	Digges
227085	04/85	N/A	80	80	4	30 to 80	unk	2	Earthflow
Pescadero Creek Alluvium Wells									
107509	03/65	N/A	60	58	8	22 to 58	unk	24	Digges
91108	11/66	N/A	52	52	10	28 to 52	unk	2	Western
13915	12/69	N/A	60	56	8	20 to 56	unk	12	Digges
13925	07/70	N/A	56	56	8	18 to 56	unk	19	Digges
144907	07/76	N/A	27	27	8	12 to 27	unk	unk	Maggiora
144915	07/76	N/A	26	0	unk	unk	unk	dry	Maggiora

Name	Name of Well or State DWR Report Number	Screen	Screened interval in feet
Date	Date well drilled	Slot	Aperture size in inches
Elev.	Elevation feet mean sea level	SWL	Static Water Level in feet at well construction
CD	Completed Depth feet	unk	Unknown
Diam.	Casing (csg.) Diameter inches	N/A	not available

Pescadero Creek alluvium wells. The Pigeon Point Formation wells are further subdivided into CSA 11 wells, neighboring wells, and other wells. Each category is then arranged by date of drilling. With the exception of the State Division of Forestry (SDF) and the domestic well, information is recorded fully in reports and notes for the CSA 11 and neighboring wells. The well names for the remaining wells are the Water Well Drillers Report number.

Well depths range from 24 feet in the marine terrace wells (Well 62203) to over 800 feet (Well 5) in the Pigeon Point Formation. Most of the wells (26 wells) are located on the west-facing slope of the ridge and were drilled for domestic use. Fifteen wells exceed 100 feet in depth, while the remaining 29 wells are drilled to a relatively shallow depth and tap the Pescadero Creek alluvium or the marine terrace deposits. About twenty wells are located within 500 feet of Highway 1 and were drilled for domestic water supplies. Note that with the exception of the CSA 11 wells, the depth to water for all wells ranges between 2 and 35 feet; the CSA 11 wells have water levels of about 170 feet. In general, between 1961 and 2001, the drilled depth of wells becomes progressively deeper in the project area.

Acknowledgements

Todd Engineers acknowledges DPW staff, specifically Mr. Daniel Wang and Mr. Robert Frame, for their assistance in completing this project and coordinating contractor pre-testing activities in order to implement an acceptable pumping test. The contractor, Mr. Ron Parker of Cornerstone Pump of Morgan Hill, California, removed and re-installed the pumps in the CSA 11 wells so that reliable aquifer testing and water levels could be conducted and measured, respectively, on the pumping and the observation wells. We also appreciate the information and well construction reports (Geoconsultants, December 1991 and July 1992) provided to DPW from Geoconsultants, Inc. Discussions with Mr. Jeremy Wire of Geoconsultants, Inc. were very helpful in compiling all available information for the project area.

Hydrogeology

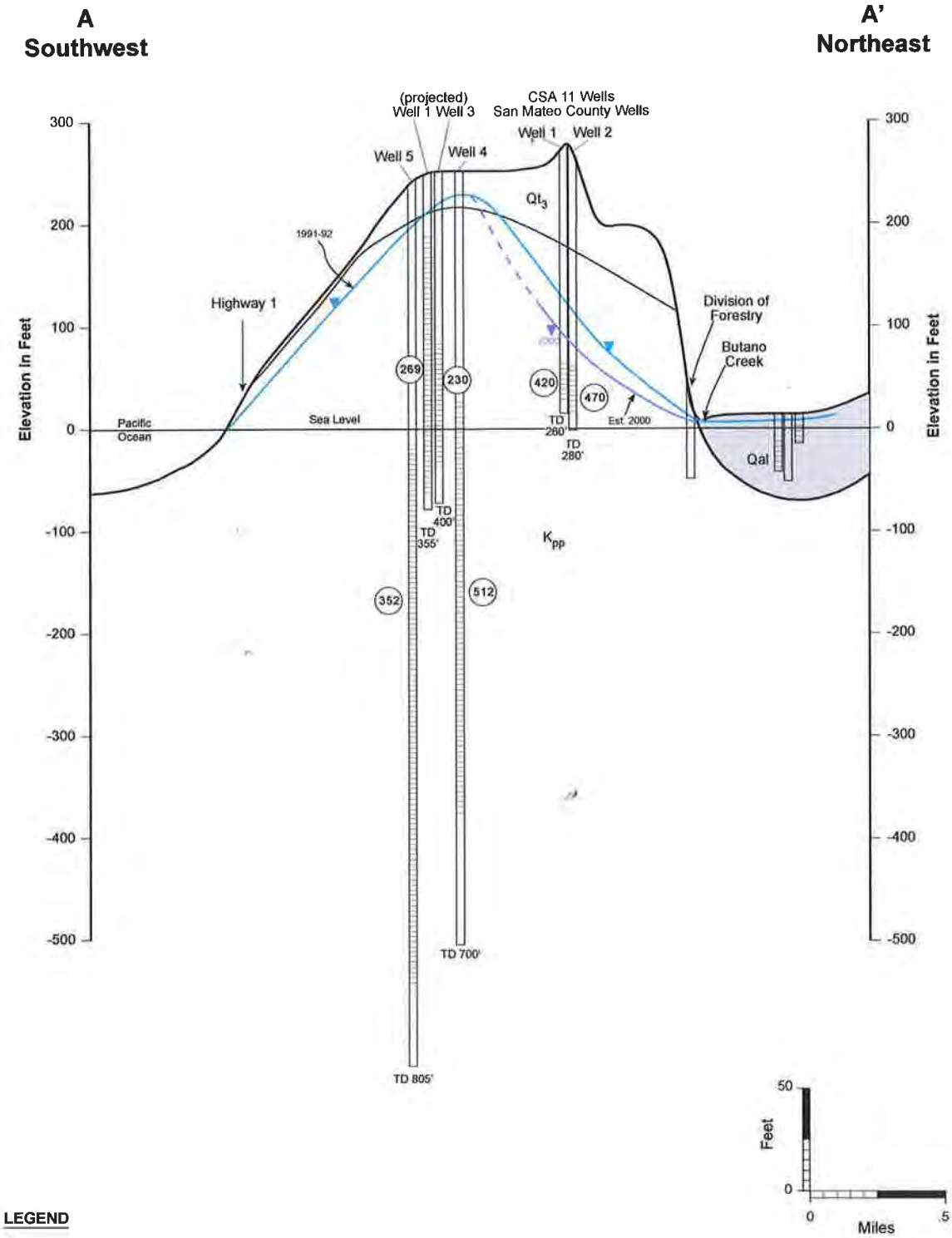
Geology

The hydrogeology of the area consists of essentially two potential moderately yielding aquifers: (1) recent unconsolidated alluvium deposited adjacent to and by Pescadero and Butano Creeks and (2) semi-consolidated to consolidated materials of the Pigeon Point Formation. A third aquifer, marine terrace deposits, exists as a thin veneer overlying the Pigeon Point Formation and is a minor water-bearing unit (low-yield). Nevertheless, these terrace deposits are suitable for domestic use. Groundwater is stored temporarily in the terrace deposits and rapidly drains from these materials.

Recent alluvium deposited by Pescadero and Butano Creeks consists of inter-bedded gravel, sand, silt, and clay. The sand and gravel units are very permeable but thin. The limited areal extent and thickness of these deposits results in a small amount of available aquifer storage. In addition, rapid percolation of surface water and septic tank return flow impacts the quality of groundwater in the alluvium (Geoconsultants, January 1981). Because aquifer storage and groundwater recharge are limited, saltwater migration or intrusion is likely to occur, also resulting in deterioration of groundwater quality.

The Pigeon Point Formation is mainly composed of jointed or fractured sandstone and conglomerate distinctly interbedded with siltstone and mudstone (Wood, September 13, 1982). Although the permeability of the Pigeon Point Formation is significantly lower than the recent alluvium, groundwater storage in the formation is much greater. The saturated portion of the Pigeon Point Formation is at least 800 feet thick. In contrast, the recent alluvium is less than 60 feet thick.

Figure 3 is a hydrogeologic cross section aligned northeast-southwest across the structural grain of the ridge and parallel to Bean Hollow Road; the location is shown on Figure 2. The cross section shows the relationship between the two main aquifers, the alluvium and the Pigeon Point Formation, and also depicts the approximate screened intervals for selected wells and measured static water levels observed in 1991 and 1992. Not much is known about the specific construction details (i.e., no Water Well Drillers Report) of the State Division of Forestry well near the Fire Station at the intersection of Bean Hollow Road and Pescadero Road.



LEGEND

Qal	Alluvium
Qt_3	Terrace Deposits
K_{pp}	Pigeon Point Formation
(352)	TDS
TD	Total Depth

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Figure 3
Hydrogeologic Cross Section

As shown in Figure 3 depth of wells in the alluvial aquifer range from about mean sea level to 50 feet below msl. In contrast, well depth elevations range from 30 feet above msl to 500 feet below msl for the Pigeon Point Formation. Note that the CSA 11 water supply wells are screened above mean sea level at elevations ranging between 20 and 30 feet above msl. This suggests that the CSA 11 wells are not taking complete advantage of the full saturated thickness (i.e., storage) of the Pigeon Point Formation.

Water levels are shown on the cross section for 1991 and 1992. In general, the water table surface parallels the ground surface. High elevation water levels are found near the top of the ridge, while low elevation water levels occur along the base of the ridge; this is referred to as a groundwater mound. The groundwater mound is not oriented in the middle of the ridge with respect to surface topography. This asymmetry may reflect that more groundwater recharge occurs on the west side of the ridge as a result of local precipitation patterns, leakage of surface water storage ponds south of Bean Hollow Road, and/or temporary groundwater storage in the marine terrace deposits.

Weather storms generally arrive at the project area from west to east, thereby releasing a significant portion of rainfall on the west-facing slopes. Precipitation soaks into the terrace deposits and recharges the underlying Pigeon Point Formation and also moves laterally along the terrace deposit and Pigeon Point Formation contact. A significant amount of this water drains down slope along the contact between the two units emerging as springs and seeps. Groundwater storage in the terrace deposits is temporary and may, in most years, be completely drained by mid- or late-summer. This, in part, is the reason that a proliferation of wells exists along the Highway 1 corridor as land owners have sought sustainable water supply (see Figure 2).

The water levels for the CSA 11 water supply wells and neighboring wells are significantly different indicating that groundwater flow diverges from the ridge (see Table 1). The CSA 11 water supply wells had water elevations of about 110 feet above msl compared to neighboring wells with water elevations of about 250 feet above msl. Local groundwater movement is from the neighboring wells near the top of the ridge to the CSA 11 wells.

Also shown on the cross section is an estimate of the current (2000) water table elevation at the CSA 11 water supply wells, which is 16 feet deeper than the 1991 and

1992 elevation. Recent (January 2001) water level measurements from the neighboring wells indicate water levels are at higher elevations than in 1991, suggesting that the drop in water levels at the CSA 11 wells are a local impact rather than a regional impact.

Groundwater Occurrence and Movement

Figure 4 is a water table map for 1991 and 1992. The groundwater contour interval is 25 feet. Water levels from sixteen wells were used to construct this map including three deep exploration wells in the southwest corner of the area reported to be "dry". However, it should be noted that if these "dry" exploration holes were cased and were able to stabilize, water levels would be expected to rise to the elevations shown on the contour map. The time for water to stabilize or seek it's own level in the borehole is related to the borehole/formation interface (i.e., well efficiency) and the permeability of the aquifer. High-permeable aquifers tend to stabilize to the static water level sooner than low-permeable aquifers. Furthermore, clay or drilling mud smeared along the borehole/aquifer interface will reduce the seepage into the borehole and lengthen the time for stabilization.

Diverging radial groundwater flow occurs in the project area and flows from the top to the base of the ridge. Although not shown on Figure 4, the water level contours between the study area and Arroyo de Los Frijoles wrap around to close the groundwater contours. Groundwater contours are also drawn for the alluvial aquifer in the Pescadero Creek and Butano Creek floodplains. Note the significant difference in contour spacing and groundwater gradients between the alluvial aquifer (0.0021 feet/feet) and Pigeon Point Formation (0.077 feet/feet) aquifer. This suggests that the Pigeon Point Formation has a significantly lower permeability than the alluvial aquifer. The permeability is a measure of the relative ease of fluid flow under unequal pressure (Gary et al., 1977).

The CSA 11 water supply wells are located half-way between the top and the base of the ground surface ridge and also the groundwater mound on the east-facing slopes draining to Butano Creek. This specific location and well depth does not take full advantage of the total available groundwater stored beneath the ridge. The significant drop in water levels at the CSA 11 water supply wells implies that total groundwater discharge, both from natural discharge of springs, seeps, and pumpage, exceeds groundwater recharge from rainfall. This may be a local impact caused by low

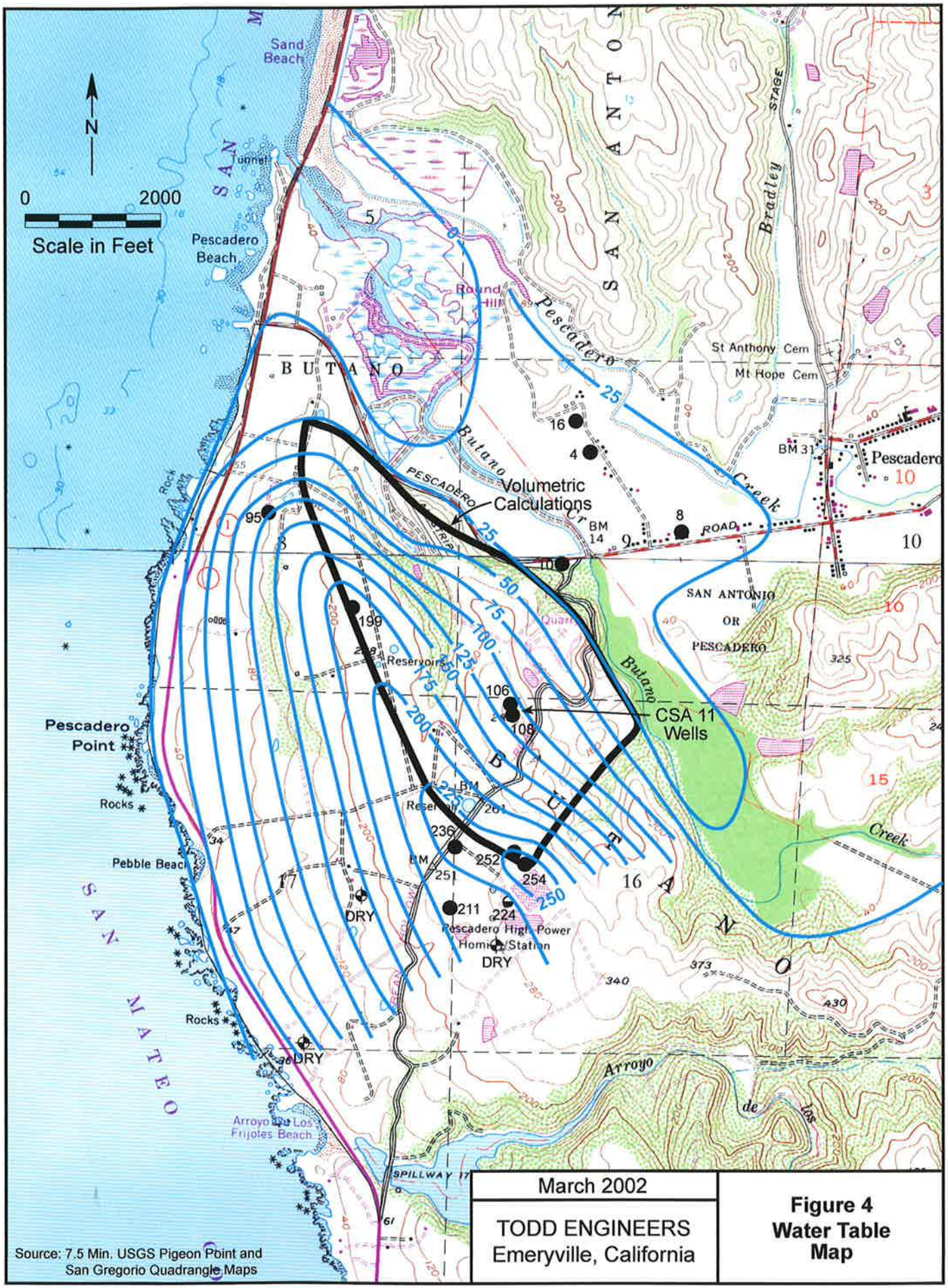

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Figure 4
Water Table Map

permeability materials in the surrounding area and consequently low recharge to the CSA 11 water supply wells or a more regional impact.

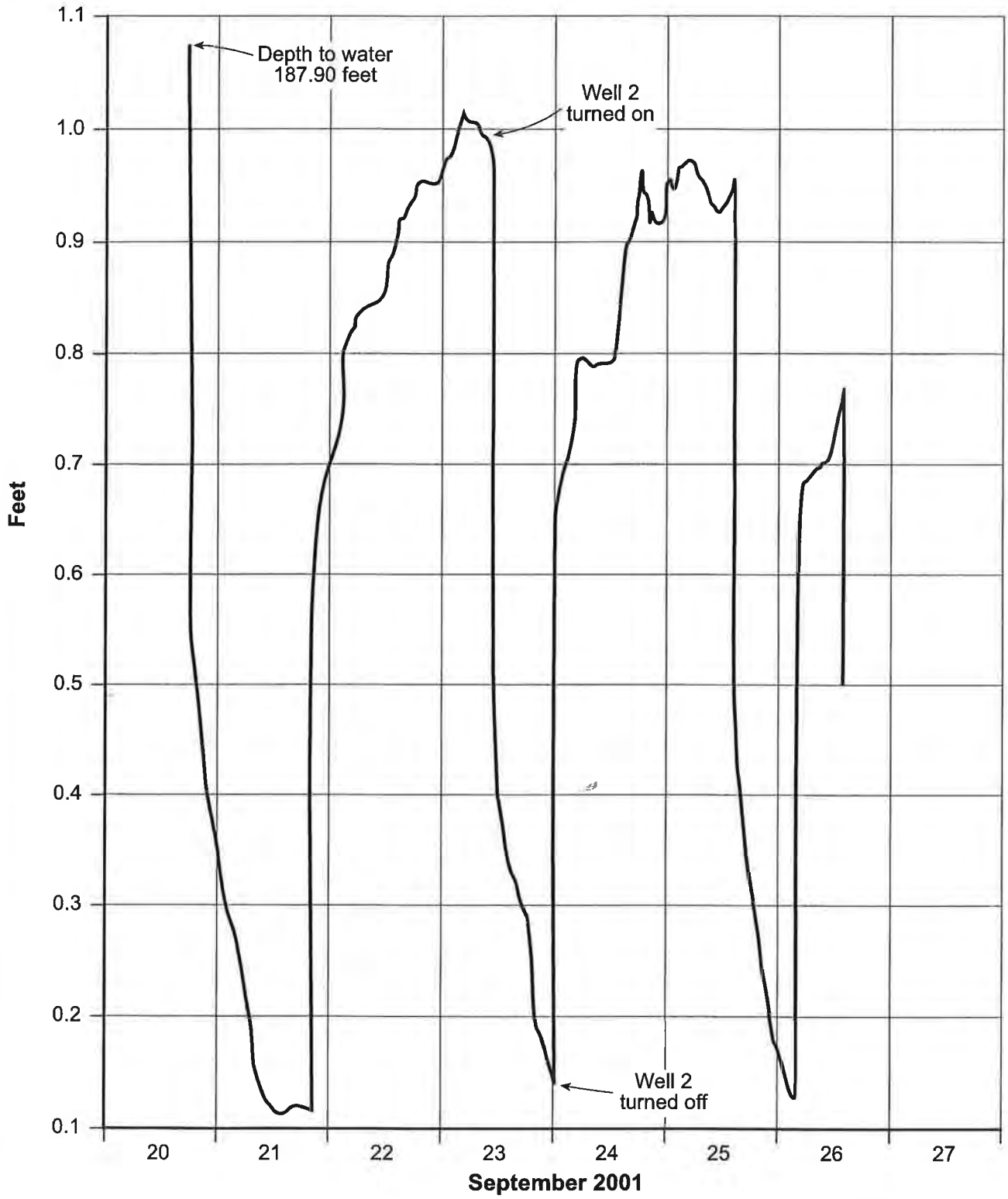
Water Level Fluctuations

Water table elevations fluctuate because aquifer recharge, discharge, and pumpage vary through time. Water level fluctuations in the Pescadero Creek alluvium would be expected to be smaller and less severe than fluctuations in the Pigeon Point Formation. Groundwater in the alluvium benefits from the Pigeon Point Formation groundwater draining to the northeast into Pescadero Creek and Butano Creek alluvium. In addition, the porosity of the Pigeon Point Formation (estimated at five percent) is probably much smaller than the porosity of the alluvium aquifer (estimated at fifteen percent) resulting in greater net groundwater fluctuation in the Pigeon Point Formation. For example, a change in volume of one foot of groundwater in alluvium would be comparable to three feet in the Pigeon Point Formation.

Prior to conducting the pumping tests, Todd Engineers installed a Leopold-Stevens Type F water level recorder in the observation well (or Well 1). The recorder consists of a clock driven mechanism with a horizontal drum covered with removable graph paper for recording water level fluctuations and a float to follow water level changes in the well.

Well 1, also referred to as the "Warheit Well", is 300 feet southwest of Well 2 and about 2,400 feet from neighboring wells. Figure 5 shows a typical response for water level changes observed at Well 1 due to pumpage from Well 2. This particular record was made between September 20 and 26, 2001 after the pumping test was completed on Well 2. The fluctuations in water levels caused by pumping Well 2 at about 25 gpm for several hours is about 0.80 feet. This indicates that the transmissivity (or field permeability) of the Pigeon Point Formation is moderate-low but sufficient for a small water system such as CSA 11. The transmissivity is the rate at which water is transmitted through a unit width under a unit hydraulic gradient (Gary et al., 1977).

The step-graph of Figure 5 shows that the water levels drop rapidly in the observation well when the pumping well is turned on. As pumping continues the water levels drop at a slower rate to drawdown stabilization. A similar, but reversed recovery response occurs when the pump is turned off. From available information, it is unclear



February 2002	**Figure 5**
TODD ENGINEERS Emeryville, California	**Groundwater Hydrograph of Well 1**

the significance of the minor groundwater fluctuations on the graph. Each successive recovery does not return fully to the previous non-pumping water level either because elapsed time of recovery is different or, alternatively, groundwater is being removed from aquifer storage. Additional aquifer testing and long-term groundwater monitoring would be needed to clarify these small fluctuations. Note that the final pumping water level for each step is the same because of mechanical pump constraints (i.e., pump rating curves and decrease in pump yields).

Regular and consistent water level monitoring has not been conducted on the CSA 11 water supply wells. Long-term records will provide the hydraulic information necessary to predict water level and aquifer behavior. Nevertheless, the static water levels in 2001 for Wells 1 and 2 are about 188 and 186 feet below ground surface, respectively, while the top of the screen intervals for the two wells are 207 and 210 feet below ground surface, respectively. Therefore, the vertical distances between the static water level and the top of the screens (referred to as the available drawdown) are 19 and 24 feet. Based on the 16-foot drop in water level over a 10-year period, calculations show that the static or non-pumping water level will reach the top of the screens in 12 years (Well 1) and 15 years (Well 2). A rule of thumb indicates that a well should utilize only two-thirds the available drawdown. This two-thirds rule provides conservatively for unforeseeable factors such as changes in well pump efficiency, seasonal and regional fluctuations in water levels, and impacts from adjacent pumping wells. Using this rule, Wells 1 and 2 can be pumped at current rates for another 8 and 10 years, respectively, before encroaching on the two-thirds rule.

Hydraulic Testing and Analysis

Pumping Tests

On September 13, 2001 a Leopold-Stevens water level recorder was installed on Well 1. Prior to recorder installation, Cornerstone Pump was contracted by DPW to remove the pump from Well 1 and to modify the wellhead of Well 2. The pump in Well 2 was removed and re-installed with a 2-inch diameter sounding tube strapped to the pump column. The pump in Well 1 was removed for the duration of the aquifer test and then re-installed with a 2-inch diameter sounding tube after aquifer testing.

The wellhead for Well 2 was modified to accommodate a tee-valve to shunt water from delivery to the nearby storage tank to open discharge near the well. A low-flow water meter that measured in cubic feet (ft^3) was also installed on the discharge pipe. The 2-inch diameter sounding tube allowed unrestricted manual access with an electric sounder to measure water levels in the well during the pumping test, and use in recommended ongoing water level monitoring.

Because aquifer testing must be conducted with stable or static groundwater conditions and water should be pumped to atmospheric pressure at the wellhead instead of the storage tank, we requested that DPW refrain from using the well for three days prior to our testing. To meet these requirements DPW filled the storage distribution tank so that the CSA 11 system demands could be met for five days with the stored water.

A preliminary pumping test was conducted on Well 2 on September 13 to assess the general performance of the well, operation of the installed monitoring equipment, and magnitude of water fluctuations in the observation well. Unfortunately, the water level sounding probe became stuck in the pumping well at a depth of 30 feet. Instead of the probe being lowered in the 2-inch sounding tube, the sounding probe was inadvertently lowered between the 5-inch diameter casing, the 2-inch diameter sounding tube, and the pump column. No water level measurements could be collected from the pumping well at this time. Cornerstone Pump was called back to the site to correct the problem.

On September 13, 2001, the static water level for the observation well was 187.71 feet below the top of the casing. Because of the inability to measure water levels at the pumping well (Well 2), we decided to abort the pumping test activities. Since the ongoing

operation of the CSA 11 system was necessary, the storage tank was re-filled and a second day of pumping was scheduled seven days later. The recorder on Well 1 was left in place to measure pre-testing water levels.

On September 20 a formal pumping test was conducted on Well 2. At 0830 hour the static water levels for Wells 1 and 2 were 187.55 and 185.81 feet below the top of casing, respectively. The pump was turned on at 0920 hour and pumped until 1520 hour (6 hours) at an average discharge of about 23.5 gpm. A five gallon bucket and stop watch was used to measure the pump discharge periodically to verify the flow meter readings. The pump was turned off and two hours of water level recovery were collected to verify drawdown measurements.

Pumping Test Analysis

Figure 6 shows the results of the constant discharge testing. The data are meaningful and internally consistent. The data are analyzed by the Cooper-Jacob semi-logarithmic method (Driscoll, 1986). Drawdown is plotted on the arithmetic scale, time is on the logarithmic scale. Both the observation well and pumping well drawdown curves are shown on Figure 6. The curves are nearly parallel. The pumping well curve is lower than the observation well. Drawdown or the water level change caused by pumping is deepest in the pumping well and systematically smaller with radial distance from the pumping well resulting in an inverted cone referred to as the cone of depression.

Based on the graphs of Figure 6, calculations show that the transmissivity or T-value of the aquifer is about 26,000 gallons per foot (gpd/ft) or 3,484 square feet per day (ft^2/day). The transmissivity of an aquifer is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width under a unit hydraulic gradient (Gary et al., 1977). High T-values represent more prolific aquifers while low T-values indicate poorer or low-yielding aquifers. Low-yielding aquifers are suitable for domestic water supplies and are typically less than 2,000 to 3,000 gpd/ft. High-yielding aquifers can range between 8,000 to over one-million gpd/ft. The Pigeon Point Formation is a medium- to low-yielding aquifer and can be expected to yield less than 100 gpm or 19,250 cubic feet per day (ft^3/day) depending on the available drawdown.

Because Well 1 is an observation well, calculations can be made to estimate the storativity of the aquifer. The storativity of an aquifer is the volume of water released

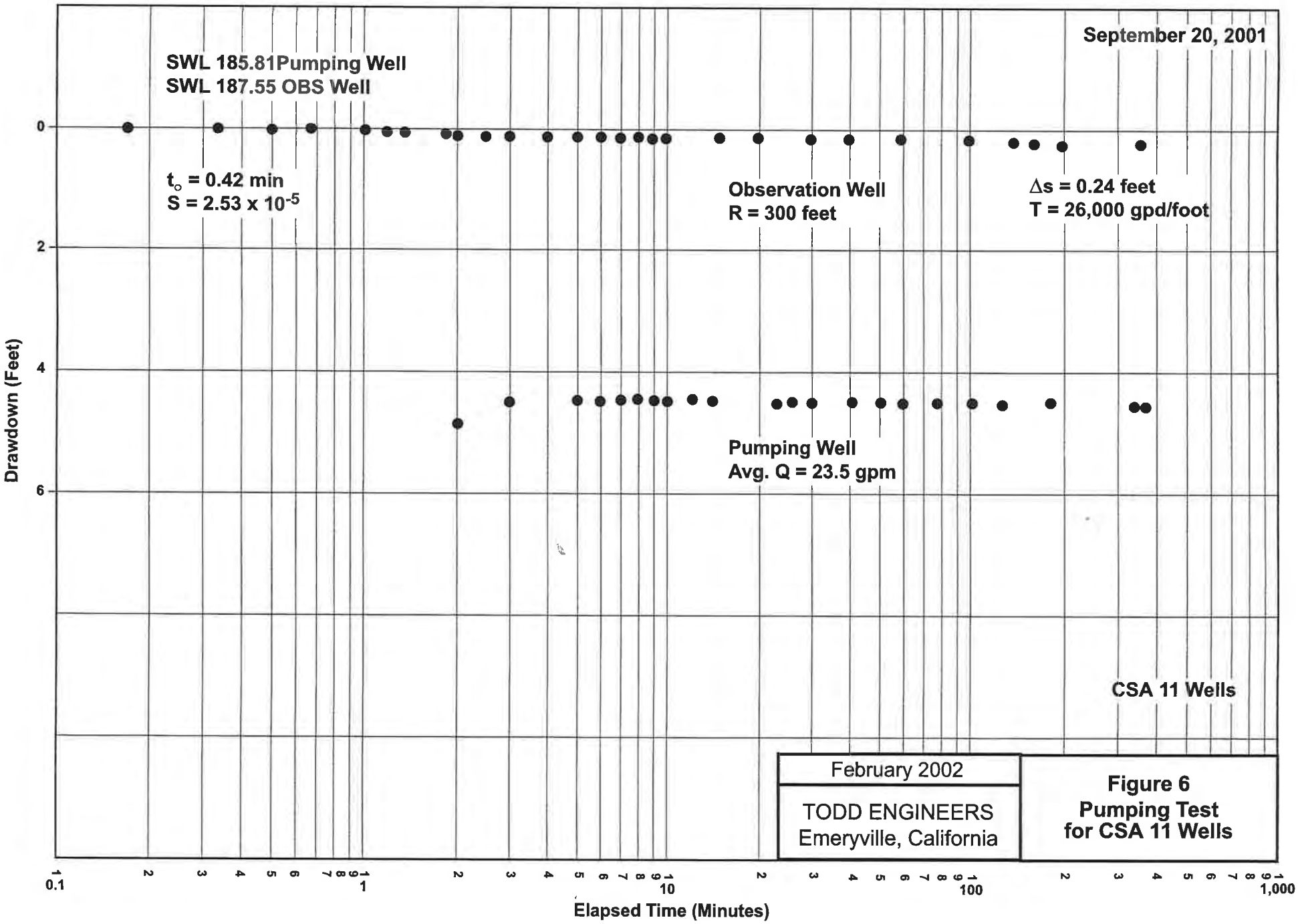


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Figure 6
Pumping Test
for CSA 11 Wells

from storage in a vertical column of one square foot when the water table or potentiometric surface declines one foot (Gary et al., 1977). The storativity (S-value) indicates whether the aquifer is unconfined or confined. Large S-values (greater than 0.01) indicate water table conditions and values less than 0.005 indicate confined artesian aquifer conditions. A confined aquifer is bounded above and below by impermeable beds or beds of distinctly lower permeability than that of the aquifer itself (Gary et al., 1977). In contrast an unconfined aquifer (or water table) contains water that is not confined under pressure beneath relatively impermeable rocks (Gary et al., 1977). Calculations (Driscoll, 1986) indicate that the S-value for Well 1 is 0.000025 implying the aquifer is confined. Because the discharge for the test was only 23.5 gpm and the observation well was 300 feet from the pumping well, we believe this estimate is too low and may not reflect the true S-value for this aquifer system. The S-value should be verified with additional pumping at higher discharge rates (i.e., 75 to 100 gpm) or, alternatively, wells located closer to the pumping well (i.e., less than 30 feet).

Well Efficiency

Additional calculations indicate that Well 2 is about 40 percent efficient based on the empirical relationship between the measured transmissivity and the well specific capacity. The specific capacity is a normalized term that represents the amount of water in gallons per minute (gpm) that can be pumped from a well per foot of drawdown. The specific capacity is directly related to the T-value and well efficiency. Large specific capacities mean high-yielding aquifers, while small specific capacities mean low-yielding aquifers or low well efficiencies.

The projected 24-hour specific capacity of Well 2 is 4.94 gallons per minute per foot of drawdown (gpm/ft of dd); the theoretical specific capacity at 24 hours is about 13 gpm/ft of dd (see Driscoll, 1986). Therefore, the efficiency of Well 2 is 38 percent (4.94 ÷ 13 x 100). Current specific capacity data are not available for Well 1. Nevertheless, in 1987 the 46-hour specific capacity was 3.80 gpm/ft of dd or a well efficiency of 29 percent.

Well efficiencies are important if the pumping wells are to have optimum life expectancy and performance. Inefficient wells require greater amounts of drawdown,

require more energy to lift the water from the pumping water level, and deeper well screens.

Table 2 summarizes other hydraulic information collected by consultants on the two CSA 11 wells and other neighboring wells. Note that the water table elevations of the CSA 11 and neighboring wells are significantly different even though the wells are located in the same general geologic settings; and note that the specific capacity varies by at least one order of magnitude. This implies that the neighboring wells are located in less permeable material or, alternatively, well efficiencies are lower than CSA 11 wells.

It should be noted that the estimated T-values for the neighboring wells range between 30 and 249 gpd/ft implying that the Pigeon Point Formation is less permable in that area. However, seriously inefficient wells can result in low T-values. Pumping tests on CSA 11 wells have not encountered a change in permeability (i.e., a barrier boundary) with long-term pumping tests. Additional pumping tests on these neighboring wells, especially with an observation well, would be required to verify the T-values and well efficiencies in the vicinity of the neighboring wells.

The specific capacity can be used to estimate the recommended pumping rate provided the drawdown curve shown on Figure 6 does not steepen (i.e., encounter barrier boundaries). Two-thirds of the available drawdown or 100 feet, which ever is less, is used to estimate the recommended pumping rates for Wells 1 and 2. Well 1 and Well 2 have available drawdowns of 19 and 24 feet, respectively; the specific capacity of the wells at 24 hours are about 3.85 and 4.94, respectively. Therefore, the recommended pumping rates for Wells 1 and 2 are 49 gpm and 79 gpm if sufficient drawdown is available. For contrast, the recommended discharge for the neighboring wells ranges between 2 and 17 gpm. Prior to increasing the capacity of the CSA 11 wells, additional testing should be conducted to stress the aquifer and to confirm these estimates.

The transmissivity is also directly proportional to the aquifer thickness and the hydraulic conductivity (a more fundamental measure of permeability). For example, the Pescadero alluvial aquifer is thin (about 60 feet) has a relatively high hydraulic conductivity estimated at about 450 gallons per day per square foot (gpd/ft^2) or 60 feet/day (ft/day). This results in a T-value of 27,000 gpd/ft. In contrast, the Pigeon Point

Table 2

Summary of Aquifer Testing in the Vicinity of the CSA 11 Wells

	Date	GS Elev.	Test Duration	SWL	Q	PWL	Total DD	Q/s	WL Elev.
CSA 11 Wells									
Well 1	04/83	277	24 hour	169.50	22	176.00	6.50	3.38	108
	08/87	277	30 min	168.48	27	175.38	6.90	3.91	109
	08/87	277	30 min	168.48	41	179.28	10.80	3.80	109
	08/87	277	30 min	168.48	45	179.98	11.50	3.91	109
	08/87	277	46 hour	168.54	40	178.94	10.40	3.85	108
Well 2	01/92	276	30 min	170.00	50	182.67	12.67	3.95	106
	01/92	276	30 min	170.00	100	189.00	19.00	5.26	106
	01/92	276	30 min	170.00	150	199.00	29.00	5.17	106
	09/01	276	6 hour	185.81	24	190.26	4.45	5.40	90
Neighboring Wells									
Well 1	06/91	290	8	35.60	9	120.40	84.80	0.11	254
Well 3	07/91	280	5	27.60	4	144.00	116.40	0.03	252
Well 4	01/92	260	22	24.00	35	240.00	216.00	0.16	236
Well 5	06/92	245	24	34.30	37	235.00	200.70	0.18	211
Domestic	06/91	280	3	56.00	4	129.00	73.00	0.05	224

Date — Date of aquifer test
GS Elev. — Ground surface elevation feet
SWL — Static Water Level feet
Q — Discharge gpm
PWL — Pumping Water Level feet
Total DD — Total drawdown feet
Q/s — Specific capacity gpm/ft of dd
WL Elev. — Water Level Elevation feet

Formation is relatively thick (520 feet), with a low hydraulic conductivity (50 gpd/ft^2), resulting in a T-value of 26,000 gpd/ft, the same value as the alluvium.

In summary, the yield of a well is based, in part, on the available drawdown, the specific capacity of the well, the well efficiency, and the aquifer thickness. Therefore, the CSA 11 wells would be more productive if the well screens were at deeper depths providing additional available drawdown and capture of additional regional groundwater.

Assuming that the top of the well screen is placed at mean sea level, allowing approximately 90 feet of available drawdown, and the rate in drop of the water level (1.6 feet per year) remains the same; then the longevity of the aquifer should range between 38 years (utilizing two-thirds the available drawdown) and 56 years. In addition, calculations also show that if such a well has a specific capacity ranging between 3.38 and 5.40 gpm/ft of dd, then the well should be capable of yields ranging between 200 and 300 gpm.

Groundwater Chemistry

Table 3 summarizes inorganic groundwater chemistry for CSA 11 (three samples) and the neighboring wells (five samples). Water quality of the eight samples is similar. Total dissolved solids (TDS), a measure of the total inorganic constituents and an indication of salinity, ranges between 230 and 512 milligrams per liter (mg/l). The State Department of Health Services (DHS) suggests a TDS concentration of less than 500 mg/l for a drinking water supply. Elevated TDS concentrations are not harmful to health but may require treatment to reduce scaling and soap scum. The values of TDS are shown on the cross section (Figure 3). It appears that TDS does not vary significantly with depth in contrast to Wood (September 13, 1982) who suggested that the salinity increases to non-potable saline water below sea level. Groundwater at shallower depths would tend to have lower TDS concentrations than groundwater from deeper depths because of the less time for contact with aquifer materials.

The iron and manganese concentrations for CSA 11 wells are within the suggested drinking water standards. However, elevated iron and manganese concentration in the neighboring wells, while not harmful to human health, will stain fixtures and clothing. DHS recommends that iron and manganese concentration not exceed 0.3 and 0.05 mg/l, respectively. All other inorganic constituents are within the suggested DHS drinking water standards. A groundwater sample for Well 1 of CSA 11 was analyzed for organic constituents which were found below the detection limit. The CSA 11 wells tend to have higher sodium and chloride concentrations than those from neighboring wells, but the sodium to chloride ratios are about the same ranging between 0.52 to 0.63.

We recommend that future inorganic groundwater sampling be conducted annually on the CSA 11 wells to track groundwater quality changes. This tracking will help to identify the long-term reliability of the aquifer. Constituents that should be measured annually include major cations (calcium, magnesium, sodium, and potassium), major anions (bicarbonate, sulfate, and chloride), minor ions (iron, manganese, nitrate, and fluoride), general physical (total alkalinity, total hardness, pH, TDS, electrical conductivity, turbidity, color, and odor), and trace metals (arsenic, barium, cadmium,

Table 3

Groundwater Chemistry for Wells in Vicinity of CSA 11 Wells

	CSA 11 Wells			Neighboring Wells					
	Well 1 04/83	08/87	Well 2 12/95	Well 1 06/91	07/91	Well 3 07/91	Well 4 06/92	Well 5 06/92	DHS DWS
MAJOR CATIONS									
calcium	59	24	25	29	18	20	62	24	
magnesium	18	15	19	11	11	12	52	15	
sodium	62	63	62	41	37	41	65	74	
potassium	-	3	2	-	-	-	-	-	
MAJOR ANIONS									
bicarbonate	79	55	95	130	98	116	122	140	
sulfate	11	10	13	-	7	14	9	9	250
chloride	110	110	120	-	58	66	181	116	250
MINOR IONS									
iron	*	0.12	-	-	0.8	0.6	*	*	0.3
manganese	*	*	-	-	0.1	0.1	*	*	0.05
nitrate	12	9	16	-	11	12	8	6	45
flouride	*	*	0.19	-	-	-	-	-	1.4 to 2.4
GENERAL PHYSICAL PROPERTIES									
alkalinity	-	90	-	-	-	-	-	-	
total hardness	140	120	140	-	-	-	-	-	
pH units	7.6	7.7	7.5	8	6.9	7.1	7.3	8.4	
EC umhos/cm	490	610	520	-	400	420	800	550	900
TDS	420	390	470	230	256	269	512	352	500
MBAS	*	*	*	-	-	-	-	-	0.5
turbidity NTU	-	0.07	-	-	-	-	-	-	0.5
color units	-	*	-	-	-	-	-	-	
odor units	-	1	-	-	-	-	-	-	
TRACE METALS									
arsenic	*	*	*	-	-	-	-	-	0.05
barium	*	*	*	-	-	-	-	-	1
cadmium	*	*	*	-	-	-	-	-	0.005
chromium	0.009	*	*	-	-	-	-	-	0.05
copper	*	*	*	-	0.7	0.1	*	*	1
lead	*	*	*	-	-	-	-	-	
mercury	*	*	*	-	-	-	-	-	0.002
selenium	*	*	*	-	-	-	-	-	0.05
silver	*	*	*	-	-	-	-	-	0.1
zinc	0.11	0.15	0.11	-	0.1	0.1	*	0.1	5
OTHER									
phosporous	-	*	-	-	-	-	-	-	
boron	-	-	-	0.37	*	*	0.07	*	
organic suite	-	*	-	-	-	-	-	-	
SAR	-	-	-	50	2.32	2.67	2.98	4.91	
sodium:chloride	0.56	0.57	0.52		0.64	0.62	0.36	0.64	

* Below instrument detection limit
\- Not analyzed
All concentrations in mg/l except where shown
DHS DWS Department of Health Services Drinking Water Standards

total chromium, copper, lead, mercury, selenium, silver, and zinc).

Salt Water Wedge and Intrusion

The saturated Pigeon Point Formation above sea level is unlikely to experience salt water intrusion. Apparent elevated concentrations of sodium and chloride in the CSA 11 wells are probably caused by natural recharge of sea spray and mist on the west-facing slopes and the lower recharge of groundwater on the east-facing slopes. In general, as long as the pumping water level of a well is above sea level, horizontal salt water intrusion should not be experienced at the well. Inland movement of the salt water wedge will occur if pumpage is not balanced by groundwater recharge. Horizontal movement of the salt water wedge is a balance between the dynamic groundwater head of the water level above sea level and groundwater flow through the aquifer (Todd, 1980). Increased groundwater pumpage will move the salt water wedge inland while increases to groundwater head will move the salt water wedge toward the ocean.

A second method of saltwater contamination to a well can occur from vertical movement of water or upconing. Again, as long as the pumping water level remains above sea level, upconing should not be experienced in pumping wells.

In the project area, water quality data from neighboring deep wells suggest that significant quantities of fresh water occur below sea level. This would be expected since the hydrostatic balance or equilibrium between fresh (1.000 grams/cubic centimeter [g/cm^3]) and salt water (1.025 g/cm^3) is one to forty (1:40) [$1.000 \div (1.025 - 1.000)$]. Fresh water is lighter and tends to float on salt water. This means that if sufficient groundwater storage is available, then one-foot of fresh water above sea level at a well will have 40 feet of fresh water below sea level. This relationship is experienced on ocean islands and is referred to as the Ghyben-Herzberg lens (Todd, 1980).

Volumetric Calculations

The volume of groundwater available to the CSA 11 wells was estimated based on the 1991-92 water table map (Figure 4) and an estimate of the porosity of the aquifer (0.05). Not all water is available to the CSA 11 wells in the project area. We assumed that the northeast half of the ridge (shown on Figure 4) is available to recharge the CSA 11 wells. The area delineated on Figure 4 for the volumetric calculations is 442 acres. However, without additional wells and hydraulic testing in the northern portion of the area, actual water capture would be one-half of this area or 221 acres.

The area between the groundwater contours was measured and multiplied by the average groundwater elevation or the mid-point of the contour interval. This calculation provided the total volume of saturated material beneath this portion of the ridge. The volumes were summed for each interval to provide a total volume of saturated material (43,025 acre-feet [AF]). Assuming a porosity of five percent (0.05), then the volume of groundwater available above sea level is 2,151 AF in 1992. Without additional wells to the north, it is doubtful that Wells 1 and 2 could capture more than one-half this volume or 1,075 AF.

In addition, because Wells 1 and 2 are not screened below sea level, water beneath the screened interval would not be captured. Therefore, the 1,075 AF must be corrected to reflect this unavailable water. The bottom of the wells are screened about 25 feet above sea level and the area of the contribution is 221 acres (442 acres ÷ 2). The volume of groundwater inaccessible to the wells is about 277 AF (221 acres x 25 feet x 0.05) while accessible groundwater to Wells 1 and 2 is about 798 AF (1,075 AF – 277 AF). Currently the CSA 11 water supply pumps an average of 25 AFY. Therefore, the aquifer could last between 32 (current well depth) and 43 years (well depth to sea level) based on 1992 water levels assuming no recharge.

Since 1992 water levels have dropped 16 feet. Assuming that the water levels dropped uniformly across the project area, then the 1992 longevity calculations shown above must be adjusted accordingly. A 16-foot drop is approximately equivalent to 177 AF of water (221 acres x 16 feet x 0.05). This yields a net decrease in available water to the wells of 621 AF (current well depth) or 898 AF if new wells were installed to capture

groundwater to sea level. Therefore, the current estimate of the longevity of the aquifer is between 25 years (current well depth) and 36 years (well depth to sea level). It should be noted that the estimated 177 AF of water removed (18 AFY) in 10 years based on volumetric calculations is similar to the actual annual volumes removed (25 AFY).

Conclusions

Wells 1 and 2 were installed in the Pigeon Point Formation west of the Town of Pescadero for the CSA 11 water supply system in 1983 and 1992, respectively. These wells were installed to replace inadequate water supplies from domestic wells, small impoundments, and wells installed in the Pescadero Creek and Butano Creek alluvium. The wells began to operate in 1993. Average annual pumpage is 25 AFY. The water levels in both wells dropped about 16 feet in 10 years. Assuming linear declines, the wells could fail due to lack of water in 8 to 15 years.

A review of all relevant and available hydrogeologic information indicates that potable groundwater exists throughout the project area in the vicinity of the CSA 11 wells. Groundwater flows radially from the top of the groundwater mound at an elevation near 250 feet above msl to the base near sea level. Deep wells in the area suggest that fresh groundwater exists at depths of at least 400 feet below msl. Volumetric calculations indicate that the Pigeon Point Formation contains less than 621 AF of water (available to Wells 1 and 2) to 898 AF of water (available to wells tapping groundwater below sea level). These volumes correspond to potential aquifer longevity of less than 25 to greater than 36 years, respectively.

Recommendations

1. We recommend that CSA 11 install a new production well in the general vicinity of Wells 1 and 2 and the tank. The well should be drilled to at least 100 feet below msl to take advantage of the overlying potable water. A certified hydrogeologist should prepare well specifications, supervise construction, design the production well, and conduct formal aquifer testing. After well completion, a well construction report should be prepared to document site drilling and construction activities, pumping test analysis, and long-term operation and maintenance of the well. The well could be located at a lower elevation near the distribution tank to reduce overall drilling depth. Alternatively, the well could be located in the vicinity of Wells 1 and 2.

2. We recommend that CSA 11 collect annual groundwater samples for major cations and anions, minor ions, general physical, and trace metal concentrations.

3. We recommend that CSA 11 collect monthly static and pumping water levels on Wells 1 and 2. These data will be used to predict future hydrogeologic conditions.

4. Additional pumping tests to confirm aquifer parameters and aquifer response could be conducted on both Well 1 and Well 2. These tests would be conducted with larger pumps so that the Pigeon Point Formation could be fully stressed and drawdown data would be more defensible.

5. An investigation could be conducted to determine if it is economically feasible to install a storage/recharge pond in the vicinity of Wells 1 and 2. Because of the limited upstream watershed area, the water quality regulatory requirements, and unpredictable rainfall events (particularly in summer) it is doubtful that a recharge/storage pond would be successful or reliable for the CSA 11 water system.

6. With the permission of the well owner, an investigation and fieldwork could be conducted to assess if any of the existing wells in the vicinity of CSA 11 could be utilized to supplement the Town of Pescadero water system. Fieldwork would include verification of well dimensions and formal pumping tests, similar to those conducted on CSA 11 wells.

Estimated Costs

1. Todd Engineers can provide a formal proposal at a later date. Nevertheless, we estimate engineering costs to install a new well to be about $20,000 to $25,000 including technical specifications, onsite drilling, construction, and aquifer testing supervision, and inspection, and well construction report. Drilling contractor costs are estimated to be $150,000. Todd Engineers can provide above ground

engineering costs through an engineering subcontractor for between $25,000 and $30,000. Based on these estimates, an installed, fully equipped and functional well can be constructed for $200,000 to $250,000.

2. We estimate that annual groundwater sampling will cost about $2,000 per year for the laboratory.

3. We estimate that monthly water level measurements including static and non-pumping water levels will be minimal and coordinated with your daily or weekly operations site visit.

4. If additional design, coordination, supervision, analysis, and reporting of pumping tests are conducted, engineering costs may range between $5,000 and $15,000 for each aquifer test depending on the complexity of the testing. This does not include wellhead modifications and any outside contractors.

References

Applied Science and Engineering, September 1, 1993, Water Quantity and Quality Impact Study, Bean Hollow Housing Project, Perscadero, California.

Driscoll, Fletcher G., 1986, **Groundwater and Wells** (second edition), US Filter Johnson Screens, Saint Paul, Minnesota.

Gary, Margaret, Robert McAfee Jr., and Carol L. Wolf, 1977, **Glossary of Geology**, American Geological Institute, Falls Church, Virginia.

Geoconsultants, January 1981, Evaluation of Test Drilling Wells 3 and 4 Pescadero, San Mateo County, Department of Public Works, San Mateo County (alluvial exploration).

Geoconsultants, May 1983, Evaluation of Test Well "Warheit" No. 1 Pescadero, San Mateo County, California for San Mateo County.

Geoconsultants, December 1991, Test Well Evaluation, 75-Acre Parcel, Bean Hollow Road, San Mateo County, California.

Geoconsultants, July 1992, Summary Report Drilling and Well Completion Production Wells No. 4 and 5, 75-Acre Parcel, Bean Hollow Road, San Mateo County, California.

Kennedy/Jenk/Chilton, September 2, 1987, Letter Report: Feasibility of using the Warheit Well as a water supply source for Pescadero, California to Mr. R. George Zinckgraf, Department of Public Works, County of San Mateo.

Muir, Kenneth S., October 1978, Ground-Water Potential, Pescadero Area, San Mateo County, California (project proposal for alluvial exploration).

Rantz, S.E., 1969, Mean Annual Precipitation in the California Region, USGS Basic Data Compilation, South Half.

Shah, Abdullah D. and Charles E. Nahn, 1989, Mean Annual Precipitation Map for San Francisco and Monterey Bay Region, Santa Clara Valley Water District, Hydrology Open File Report.

Todd, David K., 1980, **Groundwater Hydrology** (second edition), John Wiley & Sons, New York.

Todd Engineers, July 14, 1989, Letter: Pescadero Water System – Hydrologic Investigation to Mr. Theodore H. Purcell of Winzler & Kelly.

Winzler & Kelly, August 25, 1989, Letter: Pescadero Community Water System to Robert Frame, San Mateo County, Department of Public Works.

Wood, Perry R., September 13, 1982, Warheit Water Test Well near Pescadero, San Mateo County, California for San Mateo County Department of Public Works.

WINZLER & KELLY
CONSULTING ENGINEERS

MEMORANDUM

TO: Ann Stillman

COMPANY: County of San Mateo-Department of Public Works

FROM: Jay Winzler
Peter Young

DATE: May 1, 2009

RE: Pescadero Fire Flow Analysis

JOB #: 0305608002

REGISTERED PROFESSIONAL ENGINEER
PETER M. YOUNG
C 054761
EXP. 12-31-09
CIVIL
STATE OF CALIFORNIA
5-1-09

At the request of the Pescadero Municipal Advisory Council (PMAC) the County of San Mateo (County) has retained Winzler & Kelly to analyze the existing water distribution system including storage capacity to determine the feasibility of adding a fire protection pump to meet the new fire flow requirements in the Commercial District of Pescadero.

EXISTING SYSTEM

Pescadero is an unincorporated community in San Mateo County California approximately 14.4 miles south of Half Moon Bay. The County Department of Public Works maintains and operates the water source and delivery system to the town of Pescadero. The existing water system supplies household water and fire protection to the town of Pescadero and the County Service Area 11 (CSA 11). The California Department of Fire currently operates a station on the outskirts of town and is the sole source of fire protection for the community. The existing water system was designed in 1990 by Winzler & Kelly Consulting Engineers and is comprised of PVC pipe ranging in size from 4-inch to 8-inch in diameter.

At the time of the original water system design, the local fire flow requirement for Pescadero was 1,500 gallons per minute (GPM) for two hours with a residual pressure of 20 pounds per square inch (psig) at the fire hydrant. The originally system was not designed or installed to meet the required fire flow needs of the Commercial District but was considered a vast improvement over the previous lack of any water system. Currently, the water system is capable of providing the residential portion of the system with a suitable fire flow capacity.

In November 2002, CSA 11 renewed the domestic water supply permit issued in 1992 by the County of San Mateo, Division of Environment Health Services to operate a public water supply for the Pescadero Community. Water demands are met by two vertical drilled water wells, each approximately 250 feet deep, identified as Well 1 and Well 2 (Warheit Well). Well 1 is a 7.5 horsepower (hp) Franklin Electric 3-phase pump motor with an approximate capacity of 45

GPM. The Warheit well is a 5 hp Franklin Electric 3-phase pump motor with an approximate capacity of 150 GPM. General water service is provided by Well 1 and the Warheit Well is reserved for emergency use. In March 2002, Todd Engineers completed an evaluation of the source water for the community titled "Assessment of Source Water for the Pescadero Water System-CSA 11" in which it was recommended that "...CSA 11 install a new production well in the vicinity of Wells 1 and 2 or at a lower elevation..." To date, no new production wells have been installed.

Groundwater is currently not treated before being pumped to the community's only water storage facility located at a base elevation of approximately 186.7 feet above sea level (ASL). Water storage is achieved in a single 140,000 gallon, 39 foot diameter cylindrical steel water storage tank. The on/off sequence for the groundwater wells are controlled by the water levels of the tank. At a low water level of 198.3 ft ASL in the tank, the groundwater pumps turn on until water levels in the tank reach approximately 202.3 ft ASL and the pump is shut off.

The existing distribution system is gravity fed from the water storage tank. The distribution piping consists of approximately 190 feet of 4-inch, 2,600 feet of 6-inch and 8,100 feet of 8-inch diameter PVC pipe for a combined total of 10,900 feet of pipeline. According to the original design specifications, all distribution pipe material is PVC "Thickwall" Class 150 pipe meeting the requirements of SDR-18. The customer base consists of residential, commercial and water users.

A site plan identifying the location of the major Pescadero water system facilities is shown on Figure 1.

EVALUATION CRITERIA

In order to perform the required hydraulic evaluation of the existing system and conduct pumping capacity evaluations, it is necessary to identify the evaluation criteria that will enable identification of deficiencies and judge the effectiveness of alternative improvements.

Performance and evaluation criteria include:

- Water demand peaking factors, including maximum day and peak hour demands for use in developing current demands
- Water system operating criteria, including minimum and maximum distribution system pressures and minimum and maximum pipeline velocities and head loss under a fire flow demand
- Storage criteria include the amount of water storage capacity available to meet operational and fire service needs

Water Demand

Bimonthly historical demand data dating to December 2005 was provided by the County to determine annual average day demand (ADD) for the system. Historical data is summarized in

Table 1. Peaking factors were then applied to yield maximum day demand (MDD) and peak hour demand (PHD) for evaluation. Water demand peaking factors represent the increase above average day demand experienced during a specified time period and are prescribed per the California Department of Public Health (CDPH) California Waterworks Standards recommendations.

Table 1
Pescadero Historical Water Demand

Billing Period	Days/period	Water Consumption[1] (Units)	Water Consumption (Gal)	ADD (Gal/Day)	MDD[2] PF	MDD (GPD)	PHD[2] PF	PHD (GPM)
2006								
DEC 05-JAN 06	62	1,500	1,122,000	18,097	1.5	27,145	1.5	28.3
FEB-MAR	59	1,658	1,240,184	21,020	1.5	31,530	1.5	32.8
APR-MAY	61	1,730	1,294,040	21,214	1.5	31,821	1.5	33.1
JUNE-JULY	61	2,626	1,964,248	32,201	1.5	48,301	1.5	50.3
AUG-SEPT	61	2,772	2,073,456	33,991	1.5	50,987	1.5	53.1
OCT-NOV	61	1,925	1,439,900	23,605	1.5	35,407	1.5	36.9
Total	**365**	**12,211**	**9,133,828**	**25,024**				
2007								
DEC 06-JAN 07	62	1,463	1,094,324	17,650	1.5	26,476	1.5	27.6
FEB-MAR	59	1,694	1,267,112	21,476	1.5	32,215	1.5	33.6
APR-MAY	61	1,901	1,421,948	23,311	1.5	34,966	1.5	36.4
JUNE-JULY	61	2,714	2,030,072	33,280	1.5	49,920	1.5	52.0
AUG-SEPT	61	2,529	1,891,692	31,011	1.5	46,517	1.5	48.5
OCT-NOV	61	1,997	1,493,756	24,488	1.5	36,732	1.5	38.3
Total	**365**	**12,298**	**9,198,904**	**25,202**				
2008								
DEC 07-JAN 08	62	1,604	1,199,792	19,351	1.5	29,027	1.5	30.2
FEB-MAR	59	1,851	1,384,548	23,467	1.5	35,200	1.5	36.7
APR-MAY	61	2,405	1,798,940	29,491	1.5	44,236	1.5	46.1
JUNE-JULY	61	2,303	1,722,644	28,240	1.5	42,360	1.5	44.1
AUG-SEPT	61	2,448	1,831,104	30,018	1.5	45,027	1.5	46.9
OCT-NOV	NA	NA	NA	NA	NA	NA	NA	NA
Total	**304**	**10,611**	**7,937,028**	**26,109**				

Note:
(1) Data summarized from billing records provided by the County of San Mateo.
(2) A Peaking Factor (PF) of 1.5 was used per the CDPHS Waterworks Standards

The MDD represents the highest daily demand for the entire year. Water systems are typically evaluated under MDD conditions or MDD plus fire flow conditions. The PHD represents the highest hourly demand on the entire system and simulates the highest flow rate expected on the hottest day of the year and is sometimes considered the "worst case" scenario. Due to Pescadero being a small community with a low MDD, the PHD will be utilized for this evaluation. This

AREA PLAN

Adopted May, 1996

PETALUMA RIVER ACCESS AND ENHANCEMENT PLAN

AREA PLAN

Adopted May, 1996

Funded by
California Coastal Conservancy
for the City of Petaluma

PETALUMA RIVER ACCESS AND ENHANCEMENT PLAN

"River planning is central to Petaluma planning. A plan for the river is the core of any General Plan for Petaluma."

Participant in March 14, 1992 River Walk Community Workshop

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Marin/Sonoma Mosquito Abatement
United Anglers of California
Native American Heritage Comm.
California Dept. of Parks & Recreation
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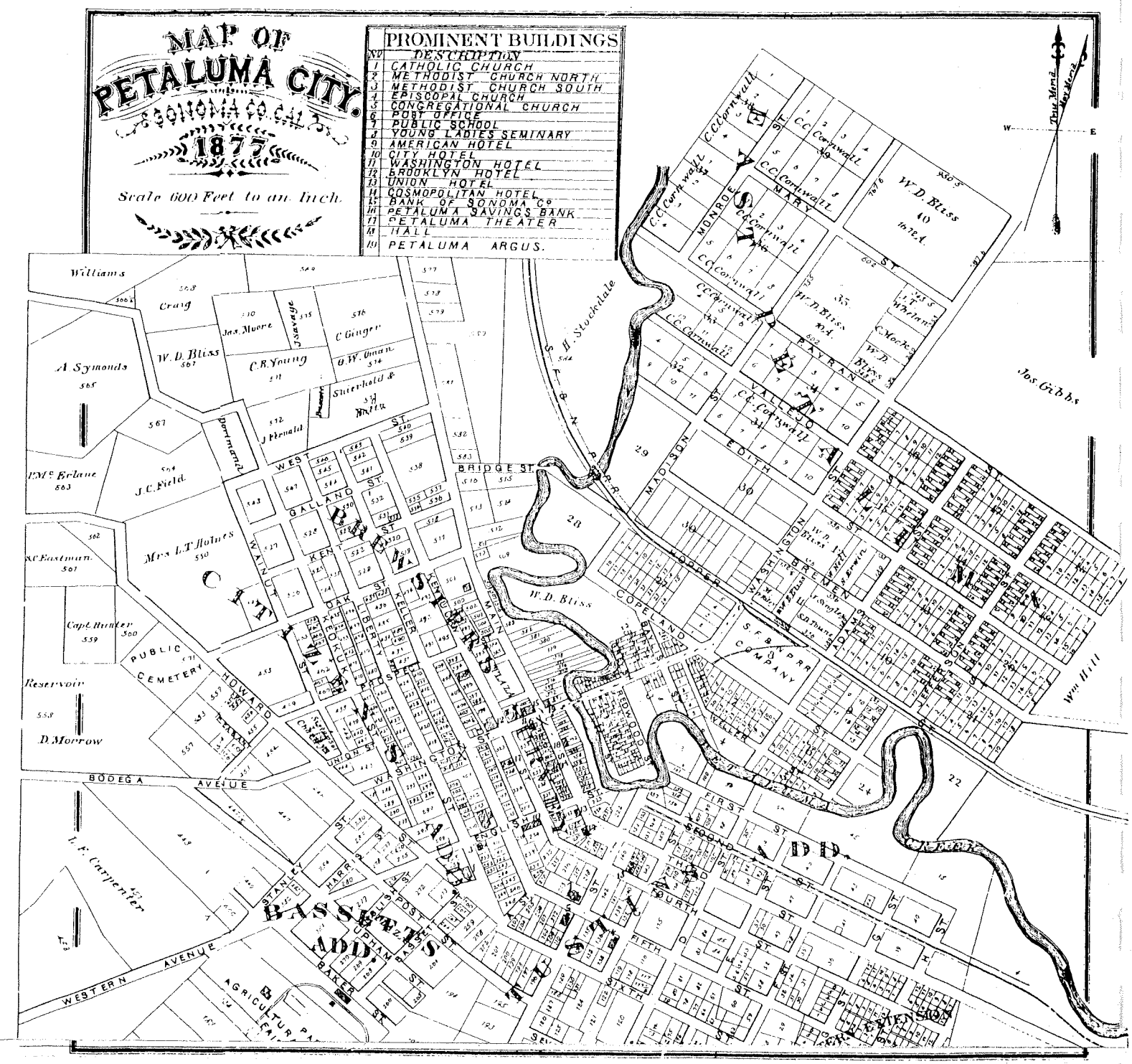
APPROVAL: RESOLUTION

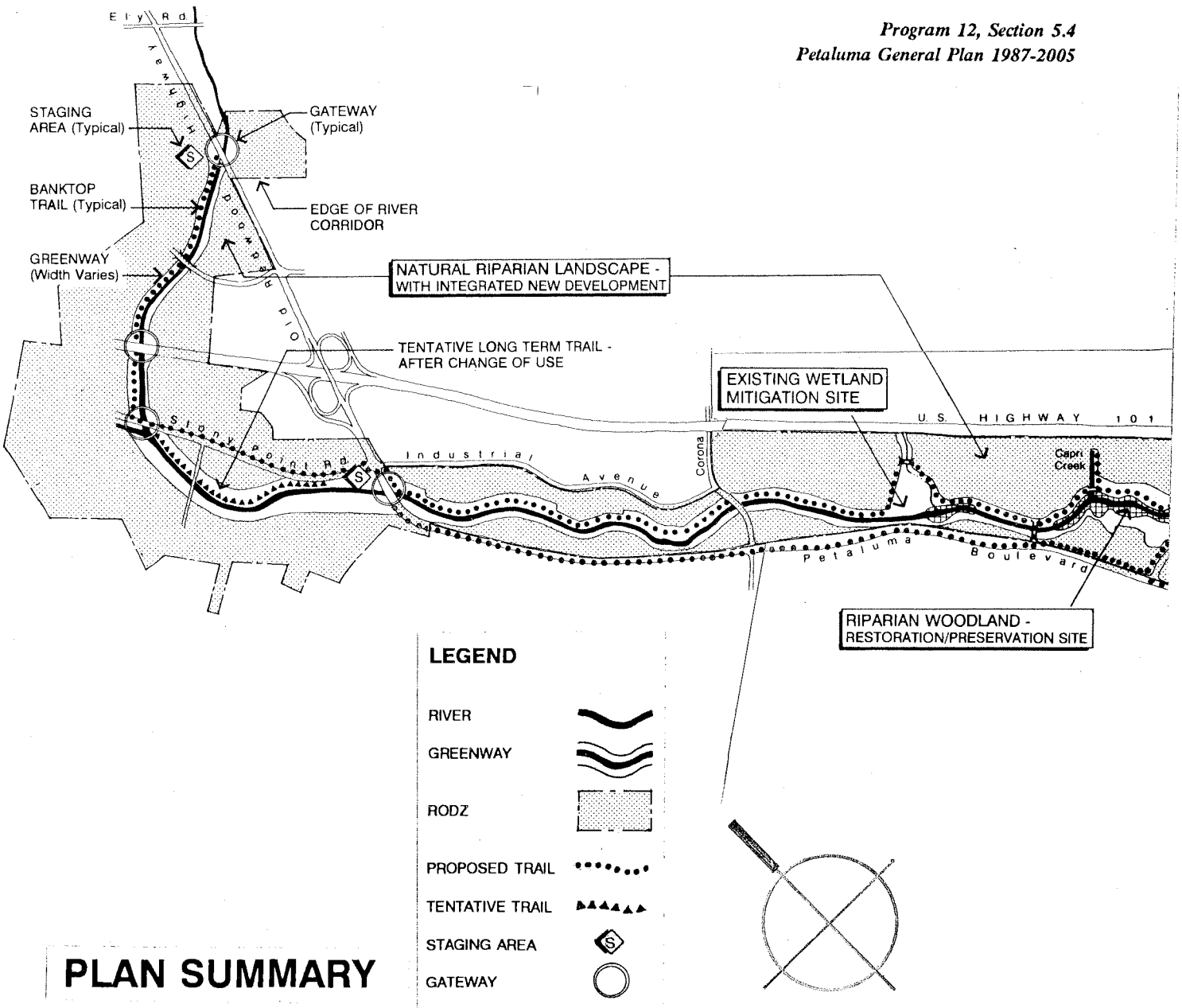


SUMMARY AND BACKGROUND

CHAPTER 1.0

"Prepare a comprehensive plan for the Petaluma River..."

Program 12, Section 5.4
Petaluma General Plan 1987-2005



PLAN SUMMARY

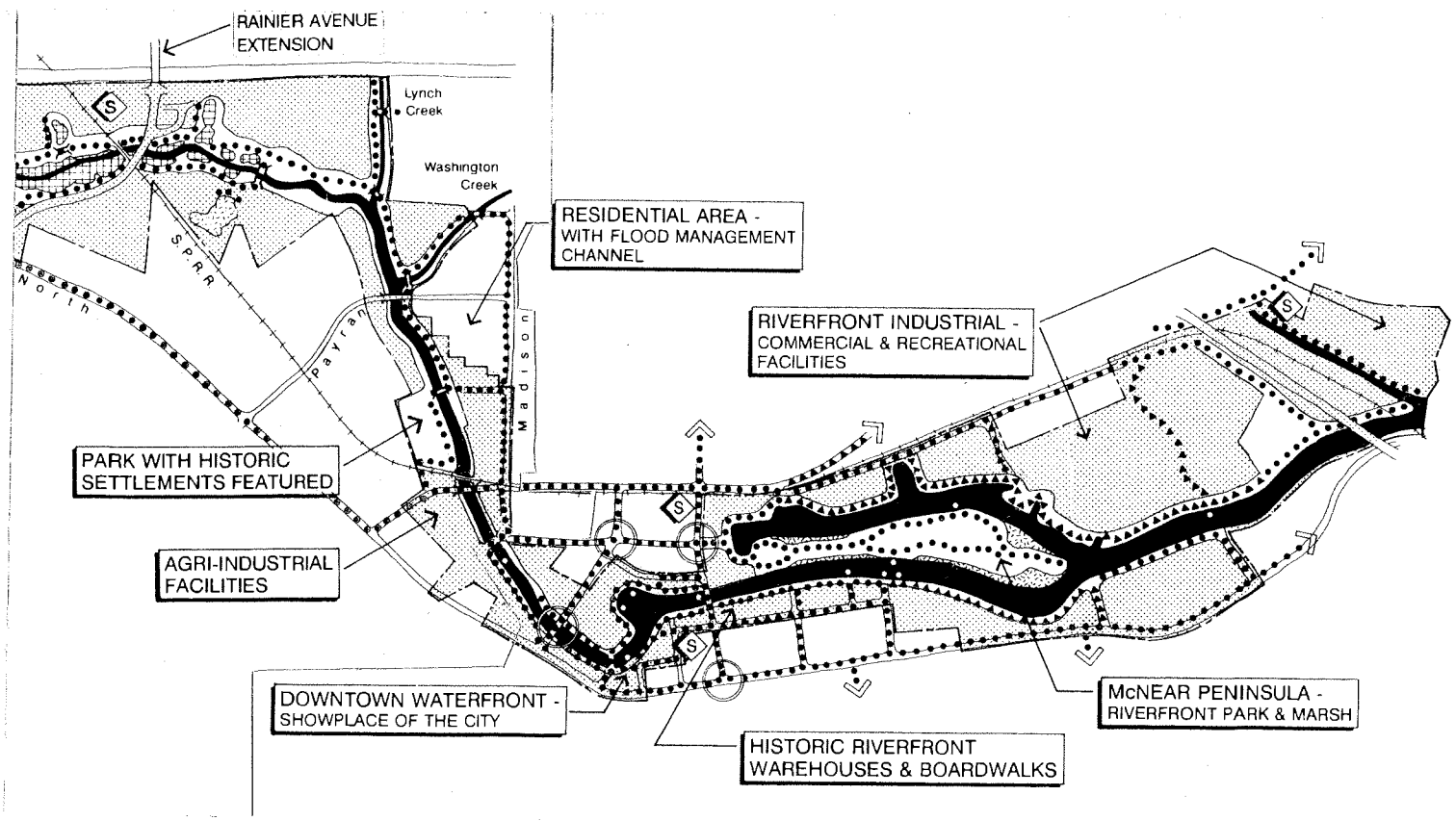
PLAN SUMMARY

1.1 PURPOSE

Petaluma is a river town. The Petaluma River is its lifeblood.

The overriding purpose of the Petaluma River Access and Enhancement Plan is to describe this community's vision for the Petaluma River, including its riverfront uses, activities, and developments. Implementation of this plan will result in a waterfront environment that is the jewel in Petaluma's crown.

This plan elaborates on the Petaluma General Plan 1987-2005 regarding the river and the properties abutting it. As the most comprehensive statement of this community's vision for the river and riverfront development, this plan will be used by policy-makers, property owners, and interested citizens to guide the metamorphosis of the river into the central feature of Petaluma.



In order to achieve the vision of this plan, the city must balance four principal components of the General Plan's directives:

* **Restoration and preservation of the natural resources.**

* **A pedestrian walkway and bike trail for the entire length of the river within the city limits.**

* **A vibrant, high density water-related commercial environment with combined tourism, recreation, commerce, and industry in and around downtown by the year 2015.**

* **A mixture of different uses and activities along the entire river corridor that complement the riverfront location.**

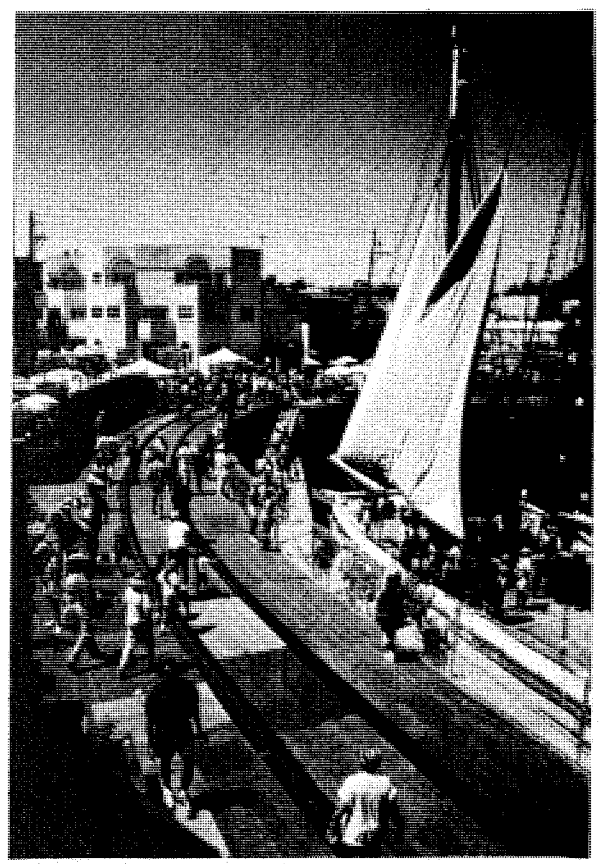
During the past half-century, the Petaluma River became a sadly neglected resource. Where once the city turned toward the river for its very life, the city began to turn away. Substantial opportunities to provide recreational and commercial services to a society with changing tastes, changing needs, and changing habits were too often ignored.

In recent years, efforts of local government, community groups, and individual entrepreneurs have begun to address the fact that there is tremendous potential for this river -- and potential to provide long-lasting benefits for the citizens of Petaluma.

To date, there has been no blueprint or comprehensive vision to guide future use and planning for this vitally important waterway. The River Plan is designed to provide that blueprint.

Implementation of this plan will result in a riverfront with people near the water, enjoying its presence and actively engaged in walking, boating, working, dining, or shopping -- whatever the activity -- with a heightened sense of place and relationship to the natural environment. This plan bases Petaluma's future relationship to its river on models of historic active waterfronts combined with modern environmental sensitivities.

Described in this plan are various means of enhancing the river, encouraging compatible developments along the river frontage, creating and maintaining a system of river-related public trails and direct riverfront access, and other methods of achieving goals of the Petaluma General Plan.



Over 20,000 people enjoyed the tenth annual River Festival at the downtown waterfront in August, 1995. The people of Petaluma are rediscovering their riverfront as a central community amenity and gathering place.

1.2 FORMAT OF THE PLAN

The Petaluma River Access and Enhancement Plan is organized to be consistent with the format of the Petaluma General Plan 1987-2005. Statements that guide future actions have been separated into **goals, objectives, policies,** and **programs.** This hierarchical approach allows the public and City decision-makers to distinguish between the desires of the community with respect to the river (stated as "goals" and "objectives") and the methods through which these desires can be achieved (stated as "policies" and "programs").

The *goals, objectives, policies and programs* are *italicized* and are adopted as city directives. As official city procedure, these directives must be considered by all city decision makers.

Contextual and other explanatory information in regular type clarify the intent of the adopted policies, but are not adopted as city directives.

Key terms and **phrases** are highlighted in **bold** print.

Maps, cross sections, sketches, and other graphic illustrations are provided to clarify the recommendations of the plan. Unless otherwise specified in the text and their titles, these are intended to be illustrative and are not intended to be statements of policy.

Definitions and Symbols

1. GOAL: A GENERAL, OVERALL, AND ULTIMATE PURPOSE, AIM OR END TOWARD WHICH THE CITY WILL DIRECT EFFORT.

(1.1) OBJECTIVE: A SPECIFIC STATEMENT OF DESIRED FUTURE CONDITIONS TOWARD WHICH THE CITY WILL EXPEND EFFORT IN THE CONTEXT OF STRIVING TO ACHIEVE A BROADER GOAL.

1. Policy: A specific statement of principle or of guiding actions which implies clear commitment but is not mandatory. A general direction that the City will follow in order to meet its goals and objectives by undertaking specific action programs.

1a. Program: An action, activity, or strategy carried out in response to adopted policy to achieve a specific objective. Policies and programs establish the "who", "how", and "when" for carrying out the "what" and "where" of goals and objectives.

Chapter 3, Goals, Objectives, Policies & Programs, provides the core regulatory features of the plan. The overall **Systemwide** policies that apply to the entire river corridor are discussed in the first part of the chapter, while the policies and programs specific to individual **River Segments** are described in the second part of the chapter. Projects proposed along the river will be subject to systemwide directives as well as those for the specific river segment.

1.3 RIVER PLAN AREA

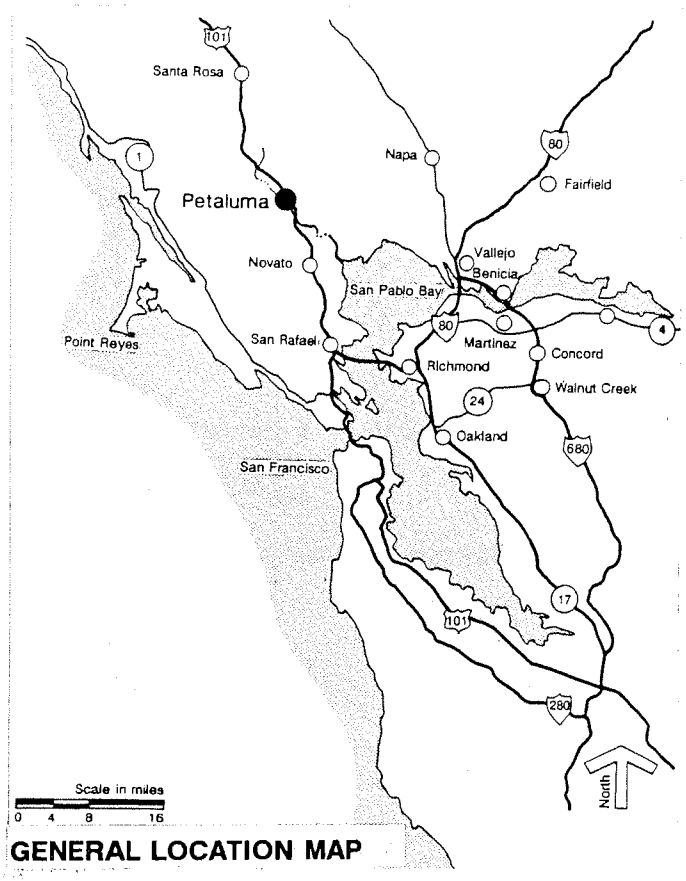
The subject of the River Plan is the 6.5-mile long, 800-acre section of the river and abutting properties that lie mostly in the City of Petaluma from the Old Redwood Highway road bridge over Willow Brook Creek near Redwood Business Park to the Petaluma Marina at the Highway 101 bridge. The river plan area (or **river corridor**) includes the river, its banks, and all properties that either directly abut the river or are near enough to be affected by the provisions of this plan (see River Segment Map page 18 and 19). Within the river corridor are industrial and commercial land uses (some that relate to the river and some that do not), the historic downtown commercial and warehouse districts, remnant agricultural areas, residential areas, riparian vegetation, existing and planned open spaces, and recreational facilities.

The **greenway** created by this plan is that part of the river corridor where flood waters are accommodated and where river front public access and habitat enhancement are recommended. The greenway includes the river channel and its banks, flood protection alterations, the trail and access amenities, habitat protection and enhancement zones, public parks as designated on the General Plan, and a buffer zone between the top of bank and the adjacent development.

For ease of reading, the Petaluma River Access and Enhancement Plan will be referenced simply as the **River Plan** or 'this plan' throughout this document.

Setting

The headwaters of the Petaluma River are several miles northeast of the City of Petaluma. The river flows first through gently sloping farmland, then through the center of the city, and finally, bordered by levees and salt marsh, past agricultural fields and small residential areas to San Pablo Bay, approximately fourteen miles from downtown Petaluma. It drains a watershed of approximately 32 square miles. Tributary streams are seasonal in the upper reaches of the watershed, but intercept groundwater in the flat valley landscape and sometimes flow year-round near the downtown area. There, the freshwater mixes with the salt water that flows up from the bay with the tides. Levees, cultivation, channelization, and urban development have significantly altered the natural riparian and wetland habitats that once flanked the river.

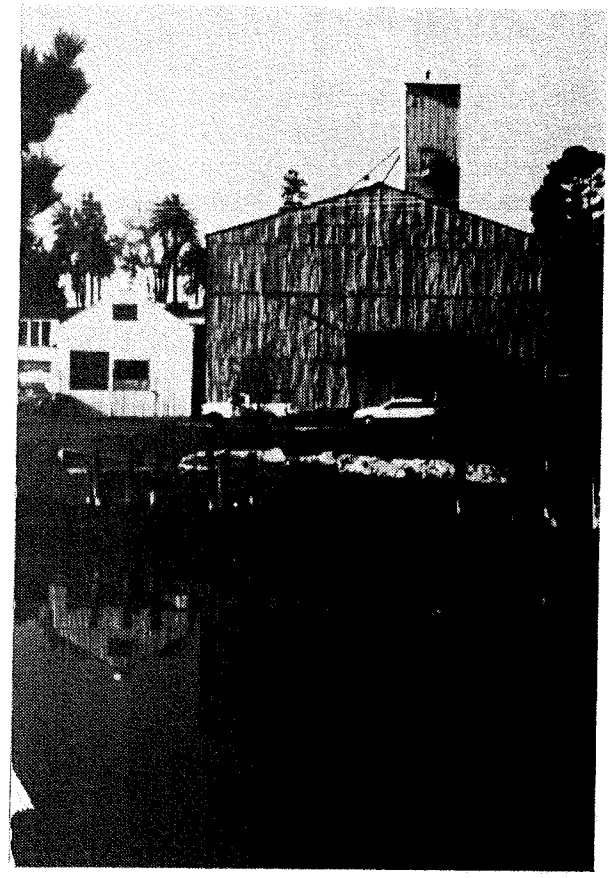


GENERAL LOCATION MAP

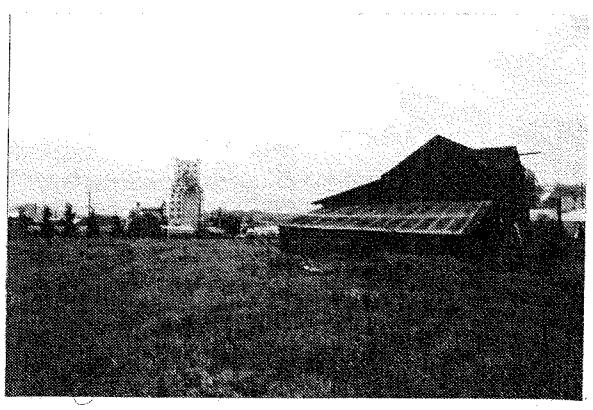
A Riverfront City

The river has been one of the most important factors in the evolution of the City of Petaluma. There is evidence of significant early Coast Miwok settlements along its banks just upstream of the downtown area. Later, shipping of goods in support of miners and settlers led to the development of the colorful historic downtown along its banks. Agricultural, industrial, and other commercial enterprises, dependent upon the river for shipping, flourished along the river from the late nineteenth to the early twentieth centuries.

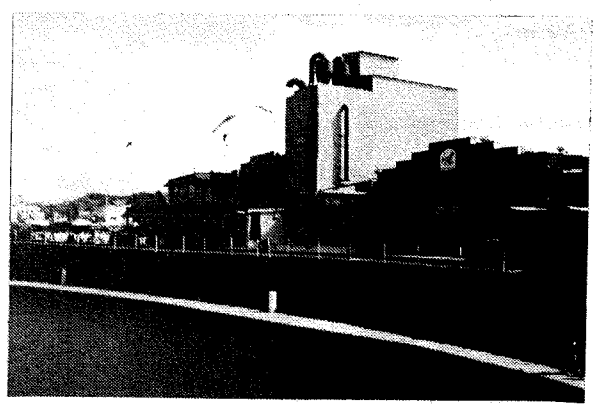
The river tied Petaluma to the outside world with paddlewheel steam ships, barges, and scows transporting Petaluma's agricultural bounty and manufactured goods to the outside world and bringing many necessities of life to the young city. The city grew outward from the bustling waterfront in a pattern responding to the location, activities, and shape of the river.



Old warehouses and wharf pilings are a common site along the riverfront near downtown.



An old Coast Miwok village and an early 20th century farm are found at the Cedar Grove property, just upstream of the granary towers and downtown Petaluma, seen in the distance. The River Plan encourages recognition of historic sites and events along the waterfront.



The Great Petaluma Mill and Steamer Gold are typical of the historic buildings facing the river that define the character of the downtown waterfront.

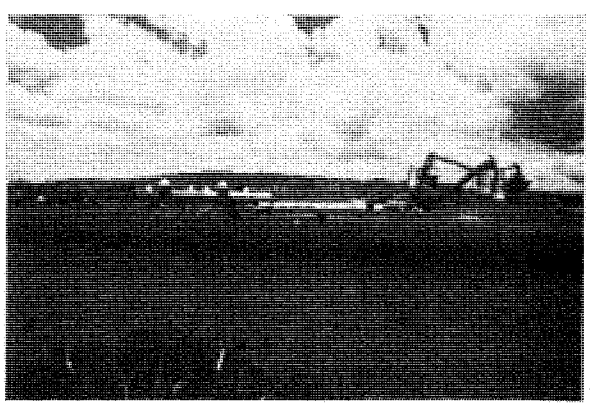
While most of the active river-dependent businesses have now disappeared, many old riverfront buildings remain. Downtown's development pattern is still inextricably linked to the river. Several viable river-dependent businesses remain, keeping up the tradition of an active working waterfront. The collection of old buildings hugging the banks of the river, a historic downtown that reminds us of the river's prominence in the town's formative years, active waterfront industries, and the heritage of riverfront settlements create the unique urban character of Petaluma. Today, this character supports a bustling pedestrian-oriented commercial center and increasing tourist trade.

Some of the largest remaining areas of open land within Petaluma are located along the river. Future use of these properties, like those found in the historic downtown, will also be linked to the river and its riparian habitats. The river will continue to be a central organizing feature of the city as it grows.

The River as a System

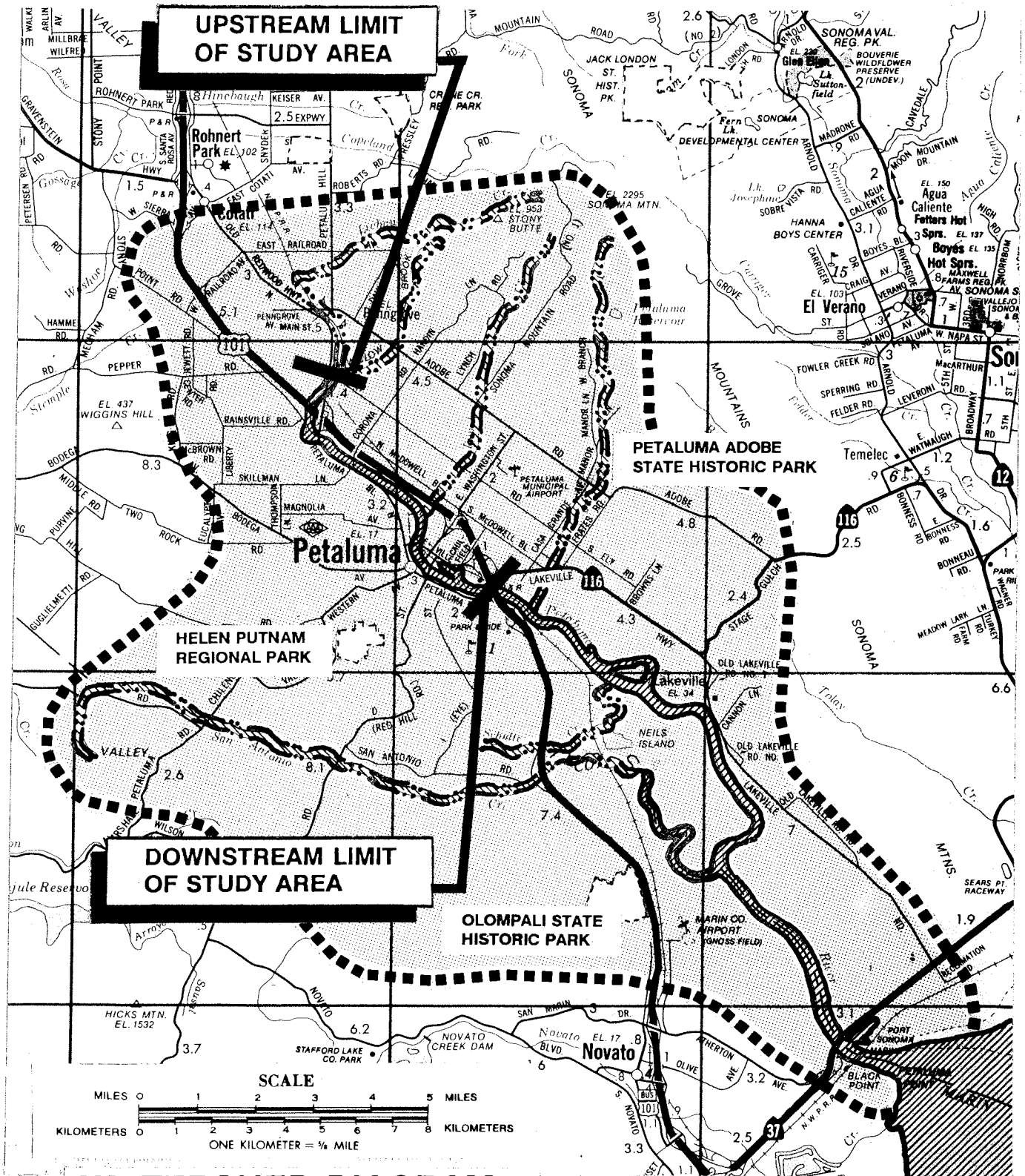
In the planning area, the Petaluma River is typical of urban streams in which water, plants and animals, and human activity interact as a dynamic system. The River Plan will enable all of the components to thrive interdependently, each enriched by the others and their relationship to the river. As envisioned, the river corridor will again become the most significant unifying feature of the city. It will provide peaceful settings amid nature, scenic backdrops to active workplaces, and an invigorating pedestrian and bicycle pathway network connecting many centers of activity within the city. If properly planned and cared for, the river will flourish as a life supporting habitat corridor and a focus for human interaction, commerce, and transportation.

This plan recognizes that the river corridor described in this document is only one portion of the entire river system. Actions taken within this area will affect and will be affected as well by the upstream and downstream reaches outside the City of Petaluma's jurisdiction.



The view across the river from the end of "G" Street includes McNear Peninsula in the foreground, riverfront industries, and the Sonoma Mountains in the distance. At a glance, the natural and cultural setting of the city is revealed with the river at the core.

Oak Creek Apartments, just upstream of Lynch Creek, successfully integrates the natural flood zone into the property's open space network and preserves the existing oak trees.



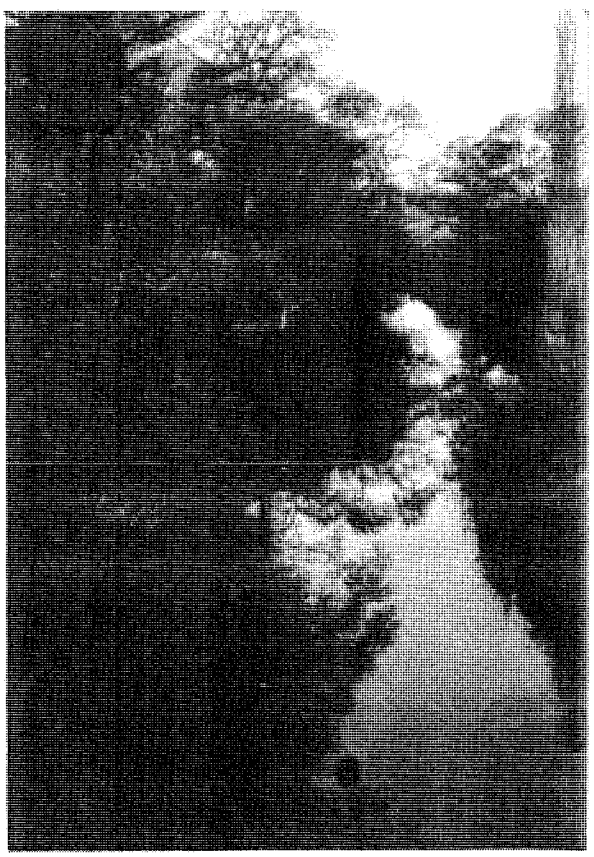
WATERSHED DIAGRAM

1.4 GUIDING CONCEPTS OF THE ACCESS AND ENHANCEMENT PLAN

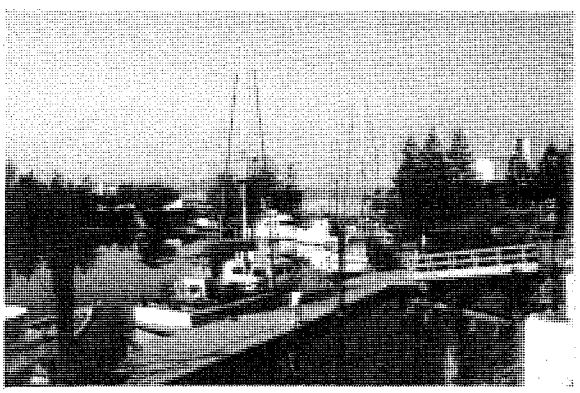
Through an aggressive public information and outreach process, the community's vision for the Petaluma River was gradually revealed. Consideration of the emerging themes guided the planning and design concepts for the plan. The following description of these themes is provided to give readers a conceptual framework for the regulatory text contained in Chapter 3.

Diversity: Urban and Wild
The river corridor is diverse and complex. Its richness reflects the heritage of local development patterns as well as the nature of the river itself. An important concept of the River Plan is to accept and build upon this heritage of diversity in a manner that will create a cohesive, mutually supportive whole. Urban features will be interwoven with the natural and wild, each contributing equally to the character of the Petaluma River corridor.

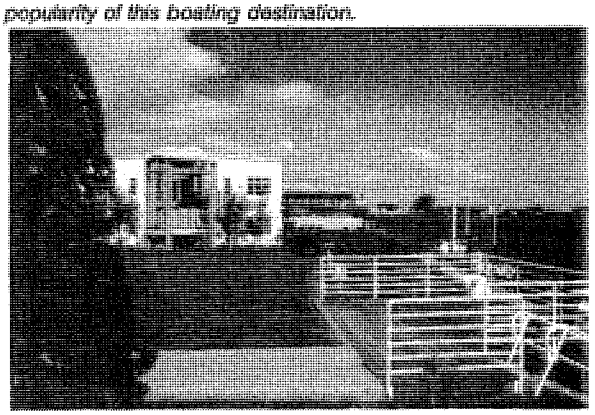
Complementary Riverfront Developments
Developments that feature the river as an integral component of their design are encouraged. New developments should build upon the city's authentic waterfront heritage. A revitalized, bustling urban waterfront in the downtown area will be supported by riverfront commercial, industrial, recreational, and residential activities throughout the river corridor.



The natural riparian area near the upstream railroad trestle is a prime wildlife habitat that will be expanded.



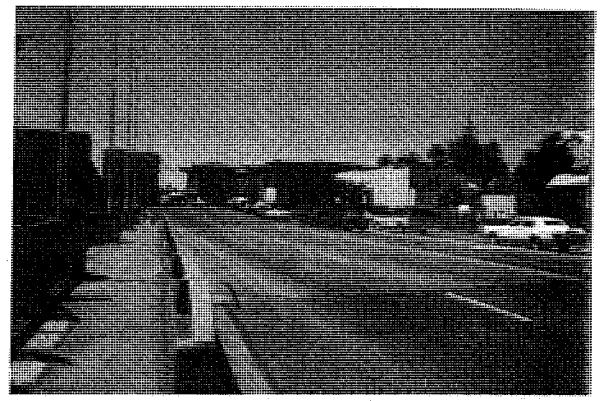
Downtown Turning Basin improvements will build upon the popularity of this boating destination.



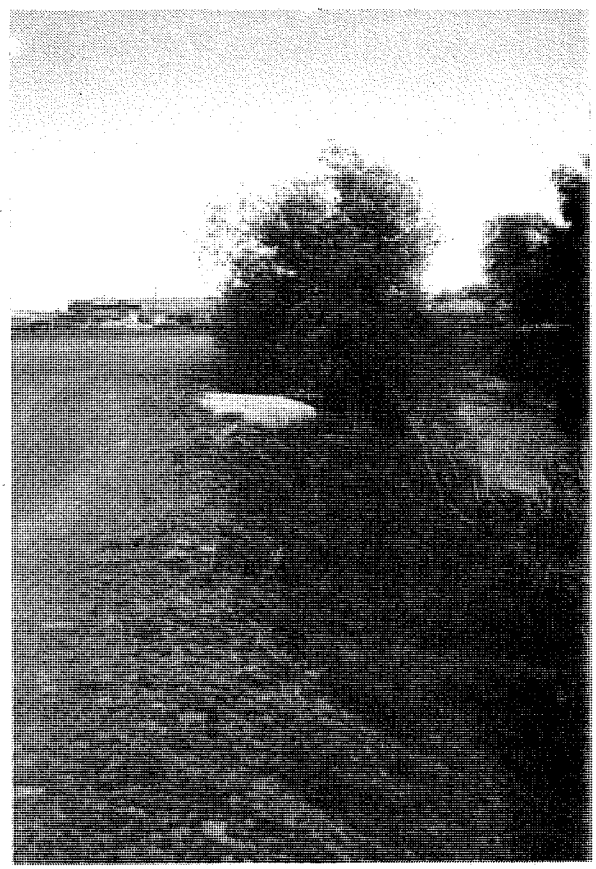
The Foundry Wharf features its river frontage and is a model for other complementary riverfront developments.

Education/Interpretation
The river's importance as natural habitat and its historic, cultural, and economic significance within the city provide rich material for learning about the region. Key topics of interest in the river area are Coastal Miwok activities, the history of later settlements, development of agricultural and industrial economies, use of the river and railroad as transportation systems, hydrology and geology, and the river's ecological functions. In addition, the current process of planning for, protecting, and restoring the river can be described as part of any public interpretation program.

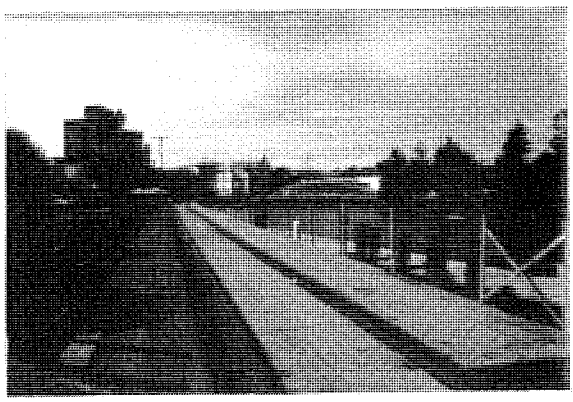
City Gateways
The Petaluma General Plan recommends the creation of "gateways" at important roadway approaches to the city. These areas impart a sense of entry to Petaluma and provide local information through extraordinary design, signs, and landscaping. Major river crossings and other points with distinct views of the river should also serve as gateways that link the river to the visitor's first impression of the city. Other river crossings or views can be similarly highlighted to orient and educate the viewer. The river corridor will be a continuous unifying element in the city's urban design, connecting such otherwise disparate elements as the historic downtown and riverfront industry to salt marsh habitat and oak woodlands. Gateways to the river will help orient visitors to their location within the city as well as to the city's place in the Petaluma valley and North Bay Region.



Recommended gateway improvements at the Washington Street bridge entry to downtown include riparian tree planting, expanded pedestrian areas and amenities, informational signs, trail links, and framed views of interesting buildings.



A city gateway along Petaluma Boulevard North at Stony Point Road would feature the restored riparian forest and could include a staging area.

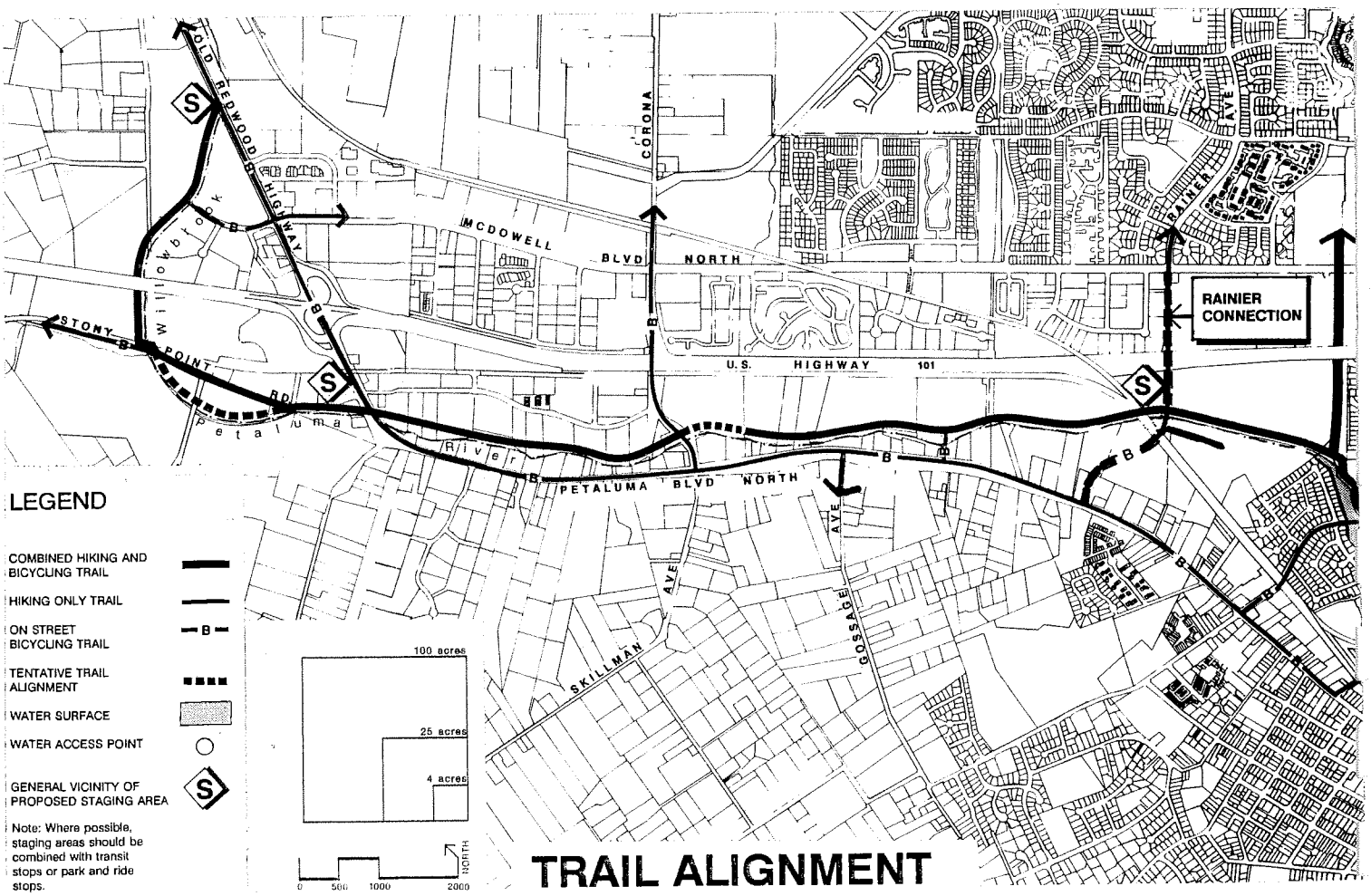


An important trail link will be made along the railroad trestle through downtown.

Continuous Trail System

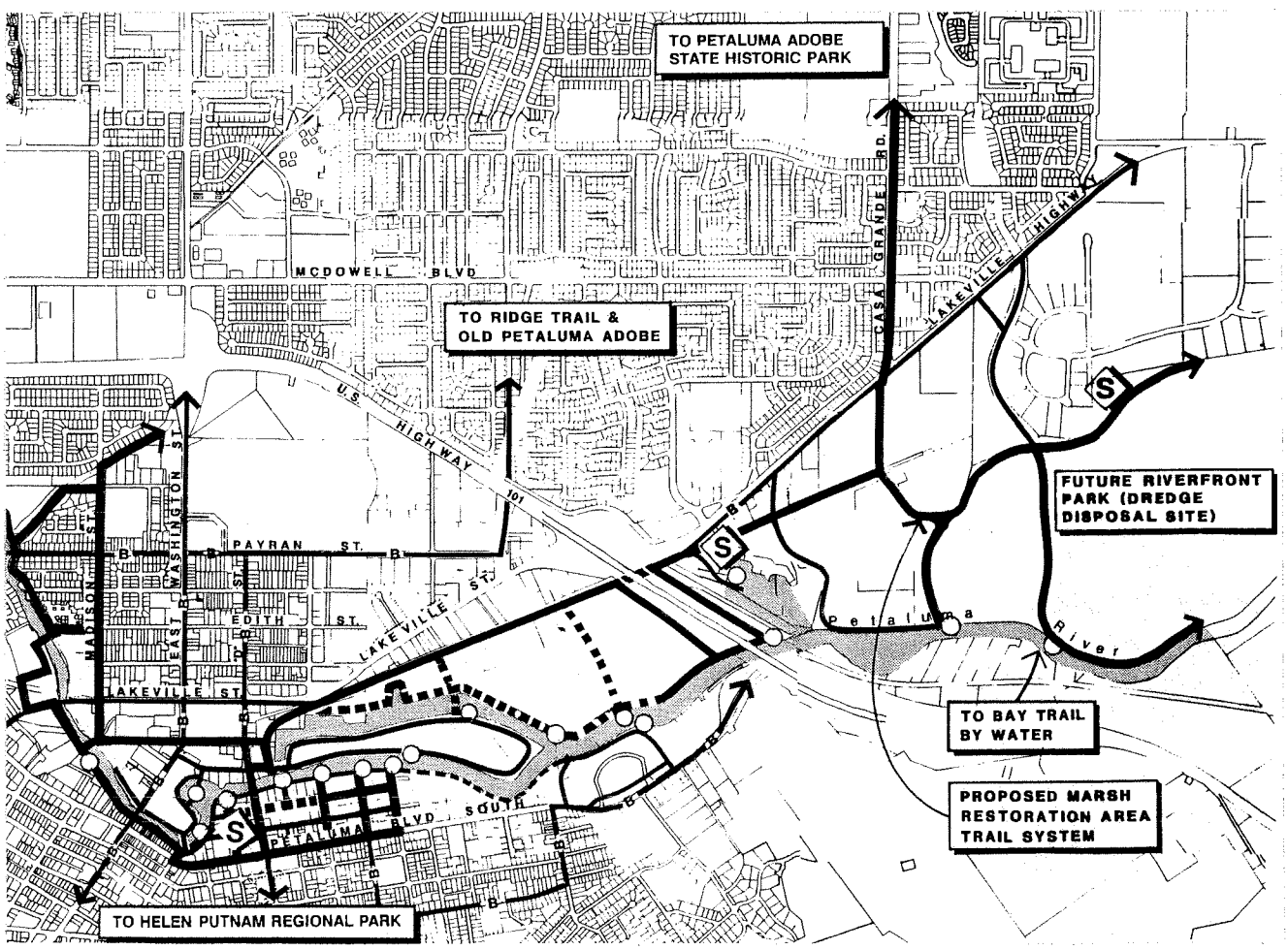
The River Plan will unite the 6.5 mile river corridor with a continuous trail system for bicyclists and pedestrians. The trails will link together neighborhoods, places of employment, commercial and cultural facilities, parks, and natural areas into a coherent system of amenities serving locals and visitors alike. A variety of direct water access points will encourage recreational and commercial activities throughout the river corridor.

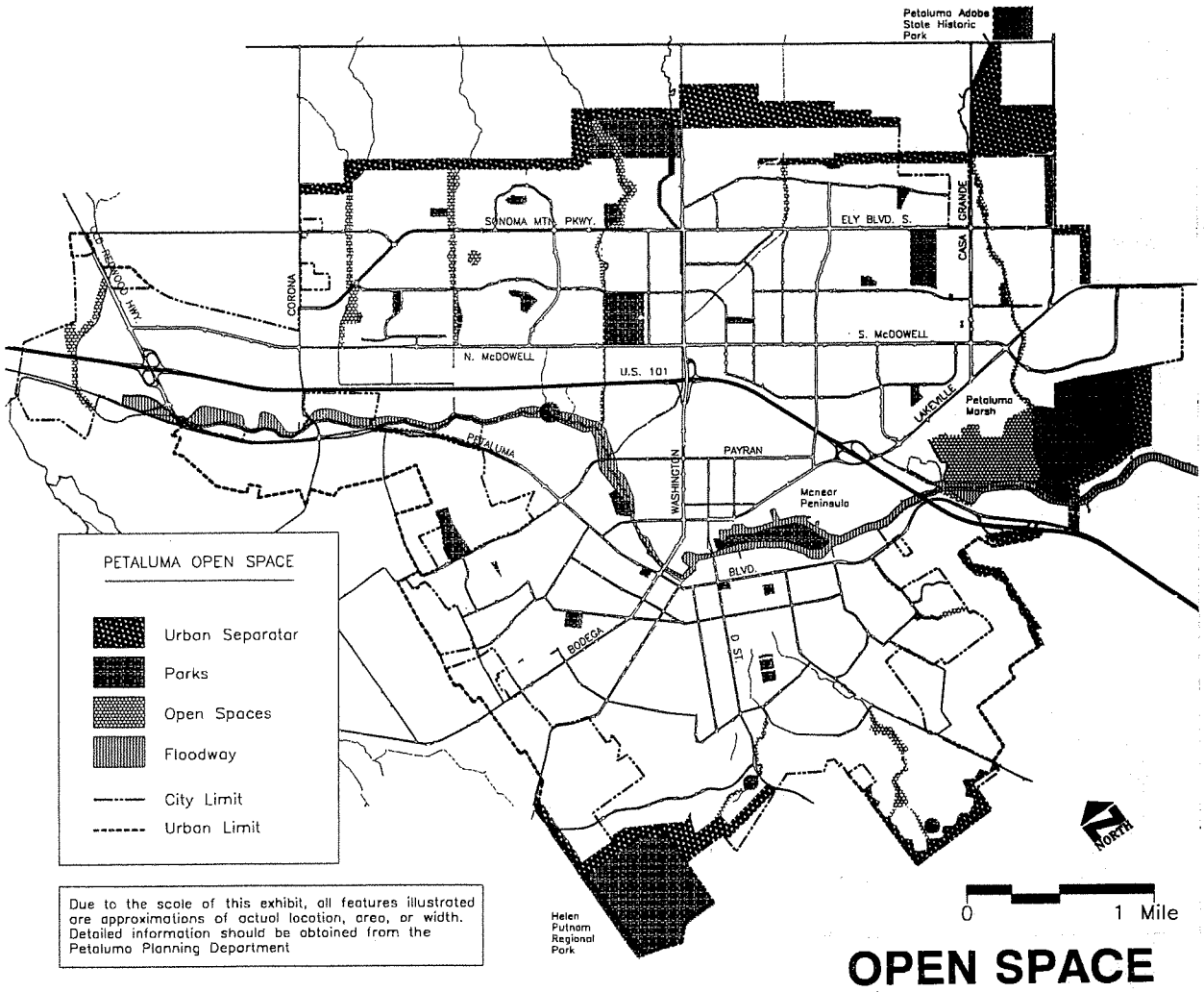
The river trail offers connections to a wide network of trails extending throughout the city and region. Ties to the Bay Area Ridge Trails and Bay Trail are encouraged.



Riverfront Habitats Enhanced and Linked
According to this plan, existing wildlife habitat and natural areas along much of the river corridor will be restored, linked, and protected. Landscape improvements in urbanized areas will also be designed to provide habitat. Bank stabilization and flood protection activities will utilize techniques that help support healthy environments appropriate for that property.

Within the city, river habitats vary from tidal salt marsh to fresh water stream. Linking these disparate areas into a linear continuum will provide untold benefits to the health and quality of the entire river eco-system.



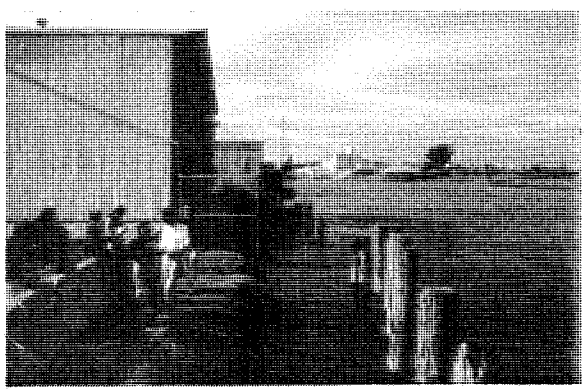


The oak woodland along river banks in the upstream segment is recommended for preservation.

The Cedar Grove property in the Payran segment is proposed for a public park with river access and historic features.

Immediate and Long Term Implementation
This plan presents a long term vision of the river as a central feature for Petaluma. It will take many years to accomplish and require multiple phases of public and private investment and action.

Most portions of the plan will be implemented by private development activities as they occur over time on riverfront properties. Utilization of the river as both a visual and recreational amenity, as well as a travel and activity corridor, will add value to adjoining properties, offsetting the burden to the property owners of implementing their portion of the plan. Initial public funding is recommended for high visibility and high impact improvements in or near the downtown area. Success with the earliest improvements will spark enthusiasm to carry out future phases of the plan. The River Plan coordinates each incremental improvement into a cohesive whole.



Waterfront improvements in the vicinity of downtown are recommended as first priority public investments, such as public access at the end of 'G' Street in the Warehouse Segment.

1.5 RIVER SEGMENTS

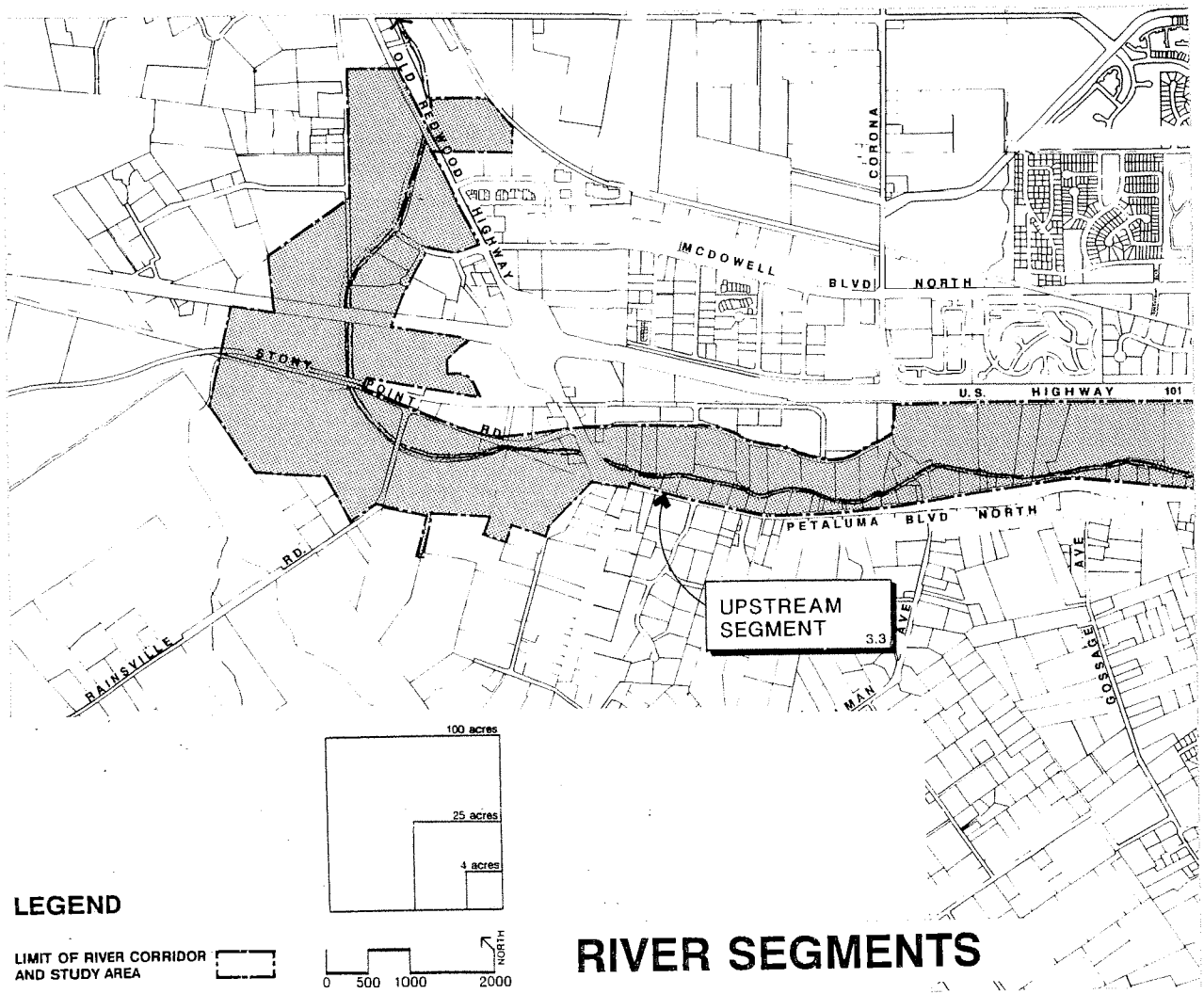
For planning purposes, the river corridor has been divided into six segments, each with distinct characteristics and internal similarities that allow logical clustering of design and planning policies. In Chapter 3, goals, objectives, policies, and programs are provided for the entire access and enhancement plan area (systemwide) as well as for the individual river segments. The planning and design concepts for each of the segments are summarized as follows:

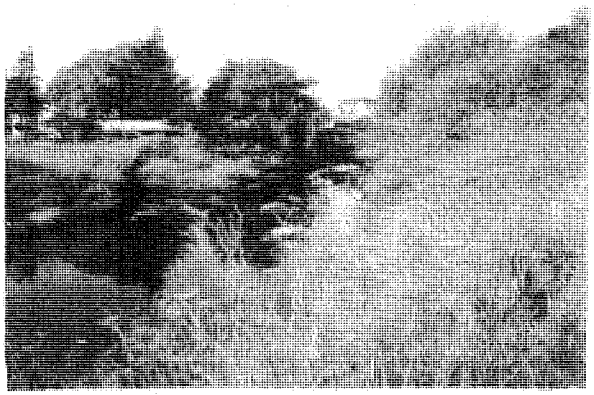
1. **Upstream Segment (Chapter 3.3)**
   The Upstream Segment, the largest of the six segments and the one most likely to change significantly in the near future, contains remnants of an extensive riparian forest that marked the river's course through the broad valley landscape. The remaining groves of trees are recognized as unique resources to be protected and enhanced, and will supply the stock from which a continuous riparian forest will be re-established along the greenway.

   The open rural/agricultural land uses in this area are gradually being replaced by higher density centers of employment, commerce, and residential growth. The River Plan acknowledges this pressure for change and recommends an integrated approach for new complementary development to occur with riverfront public access, flood mitigation, and habitat preservation/enhancement. Improvements in the greenway will become an integral part of each parcels' site design.

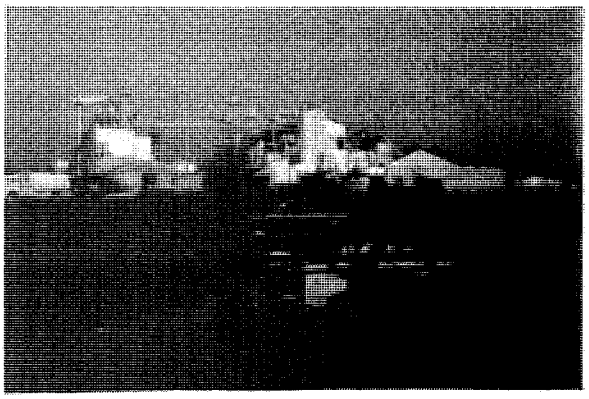
*Open land in the **Upstream Segment**, like this Corona Reach river frontage, is under pressure to change.*

*Preservation, restoration, and enhancement of the dense riparian forests, like this near Corona Road, will characterize the greenway in the **Upstream Segment**.*

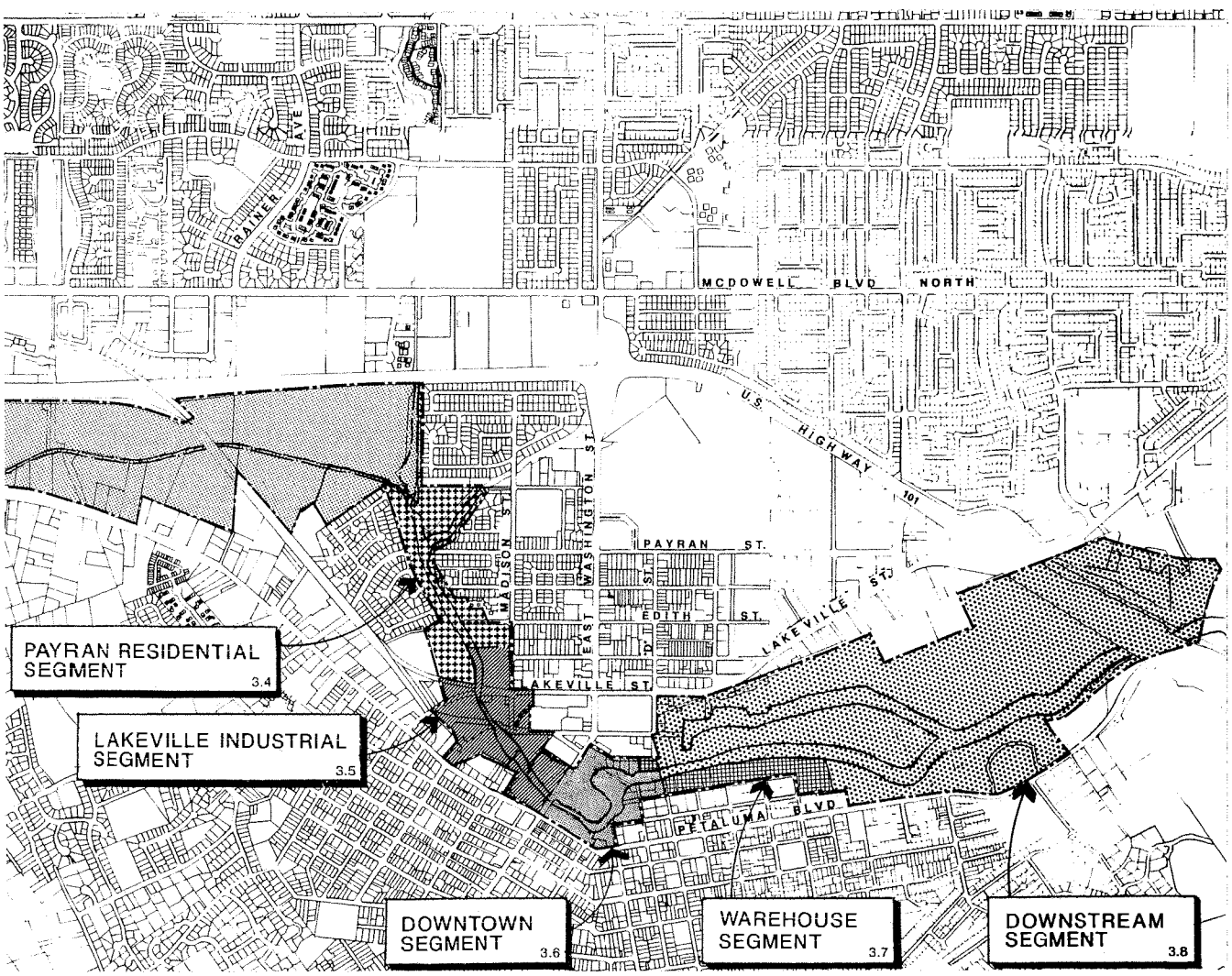




Flood protection for residences built very close to the river banks is recommended for the ***Payran Residential Segment.***



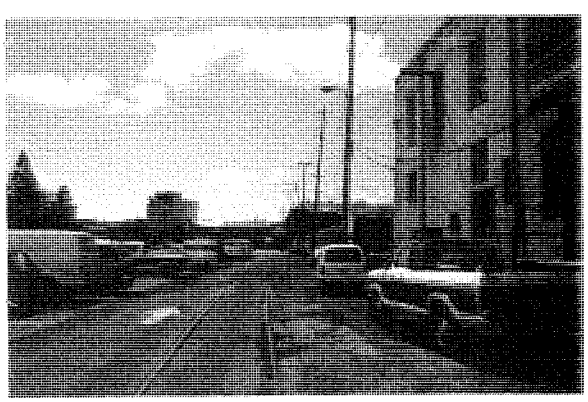
The prominent food processing industries such as Hunt & Behren's, as seen from Copeland St. in the ***Lakeville Industrial Segment****, characterize this portion of the riverfront.*



2. **Payran Residential Segment (Chapter 3.4)**
   Comprised primarily of residential properties with houses and yards very close to the river banks, this area has been repeatedly subject to extensive flooding. The U.S. Army Corps of Engineers (COE) has prepared Payran Reach flood control recommendations for the City. The River Plan is prepared with the COE flood control plans in mind. For instance, it is recommended that one maintenance road act as the trail route.

   At the former Cedar Grove Park there is evidence of a significant Coastal Miwok village and an old, intact farm complex that represents the town's earliest settlements. The Petaluma General Plan identifies this property as a potential park site. The River Plan recognizes the site for its potential public access to the water and historical/educational attributes.

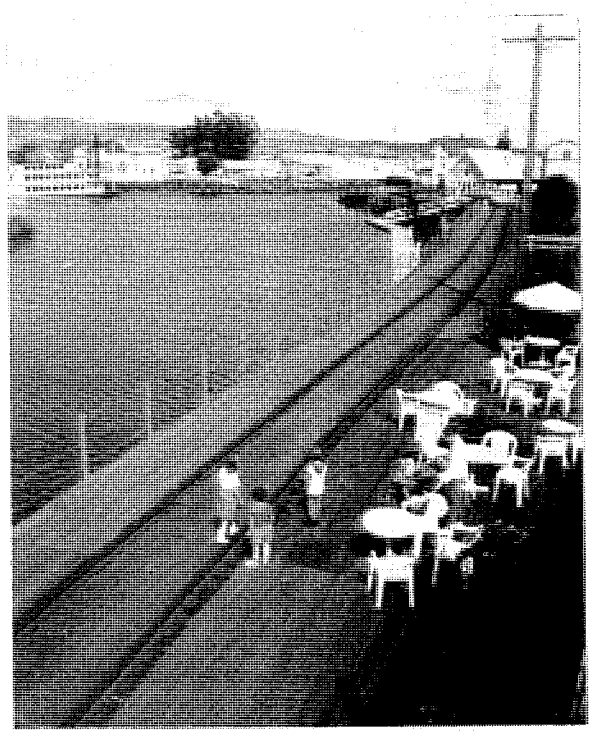
   This segment represents a transition between the forested freshwater riparian habitats upstream and the open brackish tidally influenced habitats downstream. The River Plan recommends integration of new development with riverfront public access, habitat preservation/enhancement, and flood mitigation activities.



*Historic buildings along Water Street in the **Downtown Segment** can re-orient to the river as a new riverfront pedestrian promenade replaces parking.*

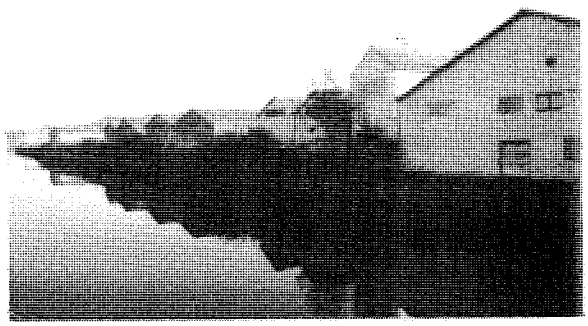
3. **Lakeville Industrial Segment (Chapter 3.5)**
   This segment is a transition between the residential areas upstream that still contain some riparian habitat, and the more urbanized, pedestrian orientated downtown area. It is primarily an industrial riverfront that, like the Payran Residential Segment, will be partially affected by the COE flood project.

   This area, with its prominent feed processing industries, illustrates the important role of agriculture in shaping Petaluma. The trail and greenway through this area will be secondary to maintaining these industrial activities. Habitat restoration and beautification through increased landscaping are encouraged, especially just upstream of the Washington Street bridge although the design of the greenway will emphasize the industrial character of this segment.



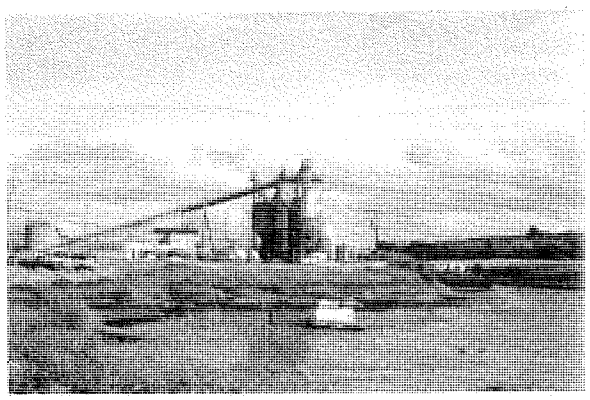
*Riverfront improvements around the Turning Basin in the **Downtown Segment** will make this the primary destination of the trail system and activity center of the river corridor.*

4. **Downtown Segment (Chapter 3.6)**
This segment covers the waterfront of the city's traditional and historic central business district. This is the primary destination of the trail system and activity center of the river corridor. Recommended in this plan is the completion the existing system of docks, boardwalks, and overlooks surrounding the Turning Basin in a way that builds upon the historic downtown development patterns and creates urban open spaces that are full of activity. It encourages further reorientation of the buildings toward the river to heighten the area's vigorous, bustling commercial and recreational activities. Downtown waterfront improvements are recommended as early components of this plan as a catalyst for improvements in other segments.



*The historic character of the commercial riverfront in the **Warehouse Segment**, as seen from the 'D' Street bridge, will be retained with riverfront boardwalks to replace the decayed wharves.*

5. **Warehouse Segment (Chapter 3.7)**
The downtown Warehouse Segment, located along the western side of the river from "D" to "H" Streets, provides a unique river frontage with the peaked roof warehouses at banktop and decaying wharf pilings at the water's edge. This plan calls for a new riverfront boardwalk to replace the decayed wharves of a bygone era, improved water access at the ends of "F", "G", and "H" Streets, and building ventures that accentuate the historic character of this mixed use neighborhood. Improved pedestrian access between this segment and downtown will spur rehabilitation and bring new economic vitality into this area.



*Retention of river dependent industries and their barge traffic is a priority in the **Downstream Segment**, as well as acquisition of McNear Peninsula (on the right) for a park and marsh restoration.*

6. **Downstream Segment (Chapter 3.8)**
Besides containing some of Petaluma's largest industries, this riverfront segment also has extensive undeveloped land, including the 32 acre planned city park on McNear Peninsula. In this segment the river is a broad tidal slough, periodically dredged for navigability, amid a landscape of commercial and heavy industrial establishments with barges, recreational, and commercial boat traffic. Greenway improvements such as bank stabilization, trails, and revegetation depend greatly on the nature of development along the river. Maintaining authentic industrial waterfront activities, visible from the trail, is a priority of the River Plan for this area. Early acquisition and improvements to McNear Peninsula for public use is a high priority.

City of Petaluma: General Plan 2025

MAY 2008

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MAY 2008

Prepared By:

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i

Introduction and Overview

i.1 PETALUMA GROWTH AND EVOLUTION

EVOLUTION OF THE CITY

Petaluma's historical evolution is closely tied to development along the Petaluma River. In 1850, a group of hunters established a primitive camp on the west bank of the river, and as the burgeoning city of San Francisco increased its demands on the surrounding region for food and supplies, a trading post was built in Petaluma. More permanent settlement soon followed, and in 1858, Petaluma incorporated with approximately 1,340 residents.

The city's downtown grew on the southwest bank of the Petaluma River along what is now Petaluma Boulevard North, south of Washington Street. Later, commercial and industrial uses grew on the northeast riverbank. The river, coupled with the arrival of the railroad in the 1870s, transformed the city into a thriving center of agricultural commerce for the region.

In Petaluma's early days, the riverbanks were crowded with piers, boat landings, and local manufacturing businesses such as tanneries, flour mills, carpentry shops, and wagon-making shops. With the growth of the dairy and poultry industries, the riverfront evolved into a thriving center of agricultural commerce. By 1917, the river channel was widened and deepened for steamship services to San Francisco.

Petaluma began to transform into a bedroom community after the Golden Gate Bridge was built in 1937 and post-World War II suburbanization swept the nation. The construction of US Highway 101 in the late 1950s provided improved automobile access to San Francisco, and diminished the importance of rail and river transportation. Residential neighborhoods and business parks expanded east of the new highway, where access was improved and land was flat and readily available. Commercial buildings and business parks were developed around thoroughfares close to highway interchanges in addition to those near the river and railroad corridors.

Petaluma has grown steadily since its incorporation in 1858, with a notable spurt following suburbanization from the 1950s to 1970s. Following the adoption of Residential Growth Management legislation, in the early 1970s, the city slowed its residential growth rate to not exceed 500 units per year through the turn of the century.

Petaluma, however, experienced growth spurts in the early 1980s and again in the early 1990s. As easily developed land inventory diminished, infill projects reflected a slowed growth rate during the first five years of the new century—to an annual average rate of just 0.8 percent, or an increase of 2,100 people. Between 1985 and 2005 Petaluma's population has grown at an average annual rate of 1.8 percent.

Figure i-1 illustrates the evolution of urban land development in Petaluma from 1865-2005, while Table i.1-1 shows population growth trends in Petaluma from 1985 to 2005.

In Petaluma's early days, the banks of the turning basin were crowded with piers, boatlandings, and local businesses; remnants of which still exist today.

The General Plan 2025 will guide development in Petaluma over the next 20 years.

Table i.1-1: Population Trends, 1985-2005

	1985	*1990*	*1995*	*2000*	*2005*	*Average Annual Growth 1985-2005*
Population	39,900	43,200	49,400	54,500	56,632	1.8%
Average Annual Growth (preceding five years)	2.5 %	1.6 %	2.7 %	2.0 %	0.8%	

Source: ABAG Projections 1990, U.S. Census 1990, U.S. Census 2000, DOF Table E-5 2005

i.2 SCOPE AND PURPOSE OF THE GENERAL PLAN

SCOPE AND PURPOSE

The Petaluma General Plan serves the following purposes:

- Its adoption, by the City Council, reflects a commitment on the part of the City Council and their appointed representatives and staff to carry out the Plan;
- Outlines a vision for Petaluma's long-range physical and economic development and resource conservation; enhances the true quality of life for all citizens; recognizes that all human activity takes place within the limits of the natural environment; and reflects the aspirations of the community;
- Provides strategies and specific implementing policies and programs that will allow this vision to be accomplished;
- Establishes a basis for judging whether specific development proposals and public projects are in harmony with Plan policies and standards;
- Allows City departments, other public agencies, and private developers to design projects that will enhance the character of the community, preserve and enhance critical environmental resources, and minimize impacts and hazards; and
- Provides the basis for establishing and setting priorities for detailed plans and implementing programs, such as the Development Codes, the Capital Improvement Program (CIP), facilities and master plans, and redevelopment projects.

PUBLIC PARTICIPATION

A critical component of the General Plan 2025 preparation process was soliciting and synthesizing input on community concerns and possibilities. During each phase of the process, community members were asked for ideas and input through public workshops, neighborhood meetings, newsletters and mailings, the City's website, and telephone surveys.

Through these forums, residents and other stakeholders identified issues, opportunities, and challenges relevant to the General Plan. The 2001 Evaluation Workbook of the 1987-2005 General Plan, the results of Fall/Winter 2001/02 community meetings and workshops, a July 2002 telephone survey of residents, and input on the *Existing Conditions, Opportunities and Challenges Report* (October 2002) as well as the *Land Use and Mobility Alternatives Report (*February 2004), have been collected to insure the issues most important to the Petaluma community are included.

Input from the community members and stakeholders was pivotal in formulation of the Plan's vision.

KEY ISSUES

Through discussions with the various elected and appointed City officials and numerous interested residents, five key issue areas emerged as the plan took shape; General Plan policies have been developed to respond to these topics in an integrated manner:

- ***Economic Health.*** Ensuring diversity and balance of economic activities is essential to the economic health and fiscal sustainability of Petaluma. Of particular concern is the need to provide opportunities for new retail businesses not presently available within the city. The Leakage and Sustainable Retail Strategy Study (June 2004), identifies specific occupancy types as the "missing pieces" in Petaluma's retail mix, such as electronics, furniture, appliance and upper-end apparel, mixed-use centers and walking access to neighborhood retail. The policies and programs in the Economic Health and Sustainability Element (Chapter 9) of the General Plan provide specific direction for ensuring that retail diversity and intensification, as well as continued development of a diverse employment base is achieved.

- ***Infill/Residential Growth Projection.*** Petaluma has been a pioneer in managed growth. This plan continues this practice by identifying land use designations and policies to provide an acceptable level of residential growth to complement the desired expansion of employment and retail opportunities. Providing for a balance of housing opportunities over the next 20+ years is a critical component of the new General Plan. Given the limited availability of land within the city's Urban Growth Boundary (UGB), an increase in residential densities in select areas of the remaining supply of vacant and under utilized lands and redefining existing uses are central aspects of this Plan. In addition, the General Plan, in conjunction with the Central Petaluma Specific Plan (June 2003), increases the amount of higher density mixed use projects, providing a significant amount of housing in the central area of the community with less consumption of land.

- ***Water Resources.*** Public workshops on water resources identified common themes regarding management of surface water systems (i.e., creeks and rivers), including restoring wildlife habitat, keeping rivers and channels clean and free flowing, providing bicycle and walking paths along creeks and rivers, and minimizing flooding potential by providing greater capacity within and adjacent to the river channel. The City has and continues to put forth significant efforts, including the adoption and implementation of the Petaluma River Access and Enhancement Plan (May 1996). The limited supply of water and the maintenance of an aging water distribution system were analyzed to insure the ability to meet the future demands of the community. In 2001, the City Council directed the preparation of Water Resource Master Plans in conjunction with the new General Plan. Those work efforts have framed the preparation of the Water Resources Element (Chapter 8) of the General Plan. The Element provides the general objectives to insure all city water systems meet the present and future needs of the community, in an environmentally sensitive manner.

- ***Mobility.*** The Petaluma River, Northwest Pacific Railroad, and Highway 101 traverse the city in close proximity to one another dividing the city into eastern and western segments. Cross-town connections between these two segments are extremely limited, and the connecting roadways are major points of congestion. The Plan focuses on new linkages, as well as on reducing automobile dependence by supporting alternative modes of transportation, such as walking, bicycling, and transit, while promoting utilization of infill sites for diversified neighborhood-serving land uses.

- ***Public Facilities and Parks.*** The Plan addresses the capability of existing city infrastructure (parks, community centers, cultural resources and amenities) to serve the 2025 community by weighing it against the physical and fiscal reality of providing expanded facilities, both passive and active.

- ***Sustainability.*** In recent years, we have confronted a range of challenges: worsening traffic, frequent flooding, limited supplies of fresh water, lack of landfill space, unstable energy prices, global climate change, and others. We acknowledge that we bear a responsibility to craft our policies for the next twenty years and beyond with consideration for the world that we will be leaving to future generations.

i.3 GUIDING PRINCIPLES

The unique challenges and opportunities Petaluma faces are reflected in the General Plan's 14 Guiding Principles, which provide the basis for the goals, policies, and programs included in the Plan elements:

1. *Maintain a close-knit, neighborly, and family-friendly city.* The General Plan envisions Petaluma as a city of strong neighborhoods. A guiding premise of the General Plan is that activities and facilities used on a frequent basis, such as stores and parks, should be easily accessible to residents. Land uses are designated to ensure balanced neighborhood development with a mix of uses, and provision of new parks and commercial centers in neighborhoods that presently lack them.

2. *Preserve and enhance Petaluma's historic character.* With more than 150 years of history, Petaluma offers a rich legacy of buildings and neighborhoods, left largely intact after the 1906 earthquake. The city's evolution along the Petaluma River has endowed it with a unique heritage of buildings, urban patterns, and landscapes afforded by a navigable waterway. Preservation and enhancement of the city's historic assets lends Petaluma a distinct identity, and helps sustain its small-town character. As future growth turns increasingly toward infill, efforts to guard the city's heritage need to be redoubled and are reflected in the Plan's policies.

3. *Preserve and enhance Petaluma's natural environment and distinct setting in the region—a community with a discrete edge surrounded by open space.* Petaluma's built environment is shaped and influenced by its larger natural setting, which has long shaped the community's image and sense of place. Views of Sonoma Mountain on the northeast and the hills on the west, The Petaluma River and creeks, and the Petaluma Marshlands to the south are all distinctive elements of this setting. Ensuring that the city's surroundings are maintained in open space is more than an aesthetic issue; given the history of flooding, it is vital to the city's survival. Petaluma's Planning Referral Area encompasses the entire 113 square-mile Petaluma River watershed within Sonoma County. The General Plan reinforces the City's commitment to sustainable development patterns by ensuring all future growth results from infill, and land outside the UGB is maintained primarily in agricultural and rural land uses, and open space.

4. *Enhance the Petaluma River corridor while providing recreational and entertainment opportunities, including through active implementation of the Petaluma River Access and Enhancement Plan.* The city's economic and development patterns have closely been associated with the river, and the River Plan acknowledges the central and multi-faceted role that the river plays in Petaluma's life. It also recognizes that the future economic, social, cultural, and environmental health of the city is intertwined with the river. The General Plan reinforces the city's identity as a river town, and incorporates the recommendations of the Petaluma River Access and Enhancement Plan, including accessibility, open space, habitat conservation, as well as riverfront uses, activities, and developments.

5. *Stimulate and increase public access and use of pathways as alternative transportation routes by providing a safe, efficient, and interconnected trail system.* Petaluma has an evolving pathway system centered on creeks, the Petaluma River and Urban Separator parcels. The General Plan calls for an expanded system of interconnected pedestrian and bicycle facilities to serve alternative transportation and recreational needs.

6. *Provide for a range of attractive and viable transportation alternatives, such as bicycle, pedestrian, rail, and transit.* With support for regional rail, an expanded trail and bikeway system, and conversion of two of the city's principal spines—East Washington Street and Petaluma Boulevard South—to pedestrian-oriented "boulevards," the General Plan seeks to increase alternative transportation choices. Establishment of minimum densities, promotion of infill development, and provisions for a mix of uses in all neighborhoods will also minimize auto dependency and support transit.

7. *Enhance Downtown by preserving its historic character, increasing accessibility and residential opportunities, and ensuring a broad range of businesses and activities.* The General Plan seeks to reinforce downtown's identity and role as the physical and symbolic center of the city by supporting continued intensification and diversity, linkages with the river and Central Petaluma, and improvements in use, intensity, and character along major thoroughfares leading to downtown.

8. *Foster and promote economic diversity and opportunities.* The evolution of Petaluma's economy, from river-dependent industry to high technology and "telecom valley" businesses, and the potential for increased tourism and retail are opportunities for the city to strengthen its economic base. Continued economic development is vital to accomplishing many of the General Plan's objectives. Its importance is underscored by the inclusion of an Economic Health and Sustainability Element (Chapter 9) that outlines the City's role in economic development and sets forth policies to implement these strategies.

9. *Expand retail opportunities to meet residents' needs and promote the city's fiscal health, while ensuring that new development is in keeping with Petaluma's character.* Expanding retail choices in Petaluma has been a top priority of residents in surveys and public workshops conducted for the General Plan. While growth in automobile dealers and supplies helped the City to increase sales tax revenues dramatically during the 1990s, Petaluma has a shortage of general merchandise and "big ticket" outlets, as well as convenience shopping in many neighborhoods. The General Plan identifies several new locations, accessible locally and regionally, to close the gaps in Petaluma's retail offerings, while underscoring the need to integrate larger developments within the city's overall urban fabric.

10. *Continue efforts to achieve a jobs/housing balance, emphasizing opportunities for residents to work locally.* The General Plan seeks to continue Petaluma's past efforts to maintain a balance between job growth opportunities and housing inventory. This is further defined by policies to support local business incubation and home-based working. Transportation benefits can be derived if local residents can work and shop in the community.

11. *Foster a sustainable community in which today's needs do not compromise the ability of the community to meet its future needs. Enhance the built environment, encourage innovation in planning and design, and minimize environmental impacts through implementation of green development standards.* The General Plan offers a broad vision of community quality of life and provides goals, policies, and programs toward that vision over time. In effect, the principles of sustainability are woven into each element of the General Plan—whether water resources, transportation, natural resource conservation, or housing. Policies and incentives to promote green development practices, promote infill and reuse, and sensitive site development practices are also included.

12. *Ensure infrastructure is strengthened and maintained.* Land use planning in the General Plan is complemented with a full assessment of the city's public infrastructure. Standards for capital facilities and public services—such as streets, parks, storm drainage and fire/safety—are established to ensure that growth does not exceed carrying capacity. To maintain the quality of public services for residents, development would be required to meet specific standards established by the Plan. In addition, the Annual Report on the General Plan will include progress made toward implementing the mitigations contained in the Plan's Environmental Impact Report (EIR).

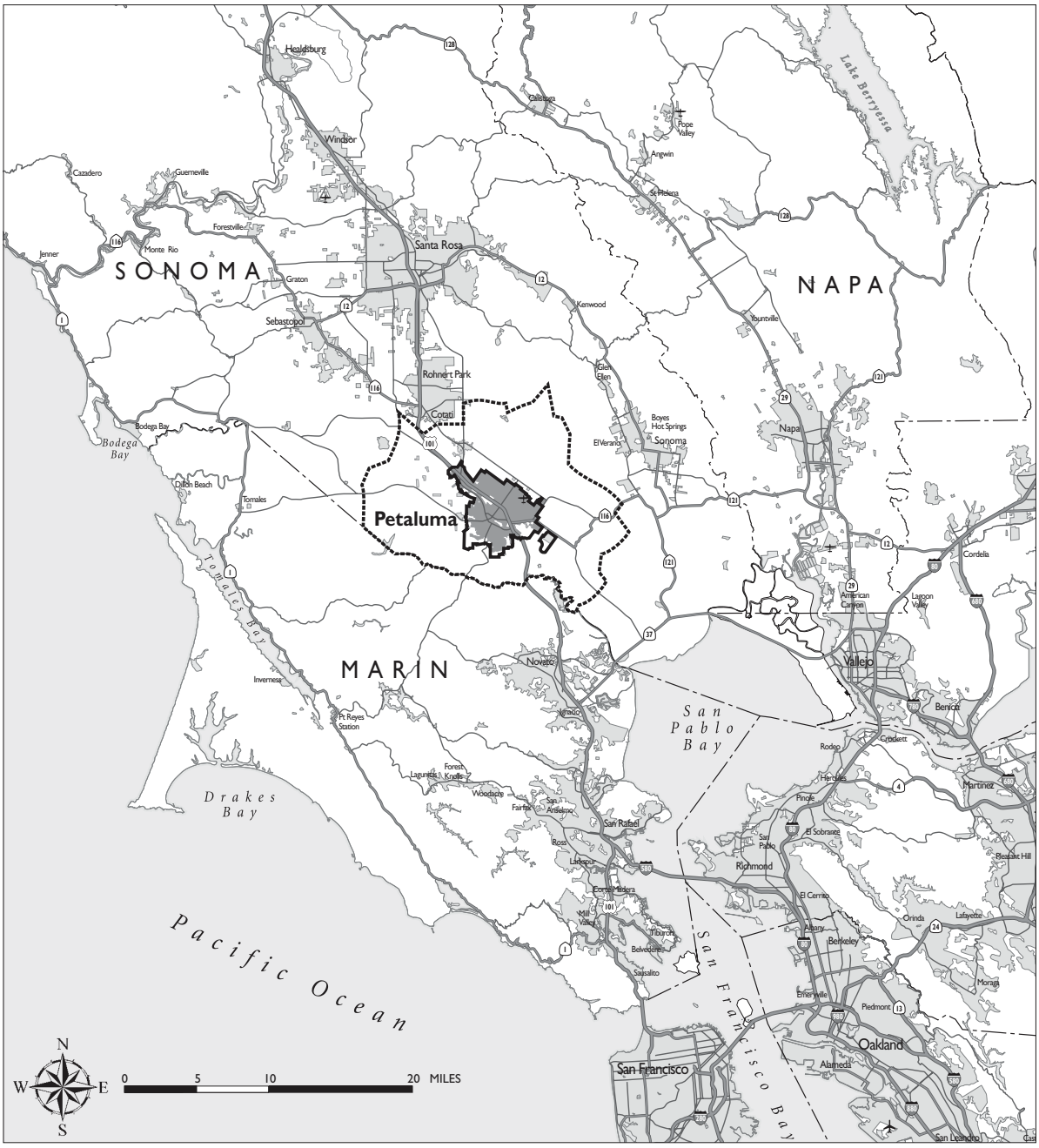
The construction of Highway 101 in the 1950s spurred development of new residential neighborhoods in the eastern parts of Petaluma (shown above, Maiden Lane).

The Central Petaluma Specific Plan addresses land development potential, as well as preserving industrial lands to the east of McNear Peninsula (pictured in the foreground).

Figure i-2

REGIONAL LOCATION

Petaluma General Plan 2025



Planning Referral Area

Urban Areas

City of Petaluma
11 English Street
Petaluma, CA 94952
generalplan@ci.petaluma.ca.us

13. *Integrate and connect the east and west sides of town.* The Petaluma River, the railroad tracks, and Highway 101 present barriers between the eastern and western portions of the city. Integration of different parts of the city is a theme that is reflected in several Plan policies. Roadway improvements and new streets are also proposed to link different neighborhoods, including two major east-west connections—the Rainier underpass/interchange and the Caulfield Lane "southern crossing"—to better integrate the east and west sides of town.

14. *Encourage cultural, ethnic, and social diversity.* The General Plan reinforces the city's diversity by providing a range of housing choices—from large-lot hillside homes to urban units adjacent to downtown or the Petaluma River—and opportunities for a variety of large and small-scaled business establishments.

15. *Recognize the role Petaluma holds within the region and beyond.* This General Plan identifies the City's willingness and dedication to participate in the collective solutions to adverse changes in the global climate. Policies and programs are identified to protect the community and reduce the community's impacts to regional and global resources.

i.4 PLANNING AREA

Petaluma is located in southwestern Sonoma County; Figure i-2 illustrates the city's regional location. Petaluma's boundaries are defined by the surrounding landscape—the city originated along the banks of the Petaluma River, then spread outward over the floor of the Petaluma River Valley. The Valley itself is defined by Sonoma Mountain on the northeast and by the hills extending northward from Burdell Mountain on the west. To the south are the Petaluma Marshlands and beyond, the San Francisco Bay.

The planning boundaries for the General Plan 2025 are illustrated in Figure i-3. The Planning Referral Area—unchanged from the 1987 General Plan—covers the 113 square-mile Petaluma River watershed within Sonoma County. The 20-year Urban Growth Boundary (UGB), the Sphere of Influence, and the city's municipal boundary are all contained within the Planning Referral Area.

URBAN GROWTH BOUNDARY (UGB)

The UGB was established by voter approval as part of Measure I in November 1998. The measure ensures that urban development and provision of city water and sewer services are contained within the UGB through December 31, 2018. Although four possible expansion areas were identified as locations where development could occur before the UGB expires in 2018, the General Plan assumes that all growth through 2015 will occur within the current UGB, reflecting community sentiment. Further information on the UGB and detailed policies related to growth management are included in Chapter 1: Land Use, Growth Management, and the Built Environment.

i.5 THE PLANNING PROCESS

The City's planning process includes monitoring and updating the General Plan, the preparation of specific and area plans, and implementing resource management plans, neighborhood and special plans. Master Plans may also be prepared to address specific multi-parcel needs. Appendix documents go into far greater detail on topics such as the Petaluma River Access and Enhancement Plan, the Bike Plan, and utility Master Plans. Adopted Specific Plans further define the City's vision for defined areas, those include the Corona-Ely and Central Petaluma Specific Plans.

AMENDMENTS TO THE GENERAL PLAN

As the City's constitution for development, the General Plan is the heart of the planning process. It is intended to be a living document, and as such, will be subject to more site-specific and comprehensive amendments. Amendments may also be needed from time to time to conform to State or federal law passed since adoption, as well as to eliminate or modify policies that may become obsolete or unrealistic due to changed conditions (such as completion of a task or project, development on a site, or adoption of an ordinance or plan).

State law limits the number of times a city can amend its general plan. Generally, no jurisdiction can amend any mandatory element of its General Plan more than four times in one year, although each amendment may include more than one change to the General Plan. This restriction, however, does not apply to amendments that:

- Relate to optional elements (such as Community Design, Economic Health, and Water Resources);
- Allow development of affordable housing;
- Comply with a court decision; or
- Comply with the City's Airport Land Use Plan.

SPECIFIC PLANS

The General Plan includes policies for each of the planning subareas in Chapter 2: Community Design, Character, and Sustainable Building. The 2025 General Plan does not anticipate any new Specific Plans within the 2018 UGB. Expansion of the UGB could incorporate the use of a Specific Plan. Requirements for specific plans are spelled out in the State Government Code.

NEIGHBORHOOD AND SPECIAL AREA PLANS

The City may consider establishing neighborhood and special area plans for areas with unique planning needs. Adopted in 1996, the *Petaluma River Access and Enhancement Plan* is an example of such a plan. Although they must be consistent with the General Plan, neighborhood and special area plans need not necessarily address all the topics required by State law for specific plans. For several decades the City has used the Planned Unit District (PUD) method to define neighborhood specific development standards. Combining a PUD with an Assessment District, such as with the Sunnyslope area, has allowed public improvements and a systematic development pattern. The General Plan 2025 does not anticipate new neighborhood or special area plans but does not preclude their use, particularly for funding local serving amenities.

REDEVELOPMENT PLAN

In 2006, the City merged its two redevelopment project areas—the Central Business District Project Area (CBD) and the Petaluma Community Development Area (PCD). As shown in Figure i-4, the PCD Project Area encompasses a total of 2,965 acres and generally lies along US Highway 101, and includes the majority of the Central Petaluma Specific Plan Area. In redevelopment areas, the property tax increment from new development—whether through public improvements, economic development strategies, or other measures—is reinvested into the redevelopment area. The law requires that a city or county have an adequate general plan before it adopts a redevelopment plan, and any redevelopment plan must conform to the adopted general plan (California Health and Safety Code §33302 and §33331).

IMPLEMENTATION

In order to ensure that General Plan policies are incorporated in everyday City activities, the City will prepare an Implementation Plan. The Implementation Plan contains language that allows for technical changes to be made in the General Plan as well as methods to integrate the implementation of the Plan with annual budgeting and departmental planning efforts. Furthermore, implementing ordinances and standards required by the policies of this General Plan shall be adopted as soon as appropriate.

Rosamond Street is an example of a Planned Unit District constructed within the Corona-Ely Specific Plan Area.

ANNUAL REPORT

California Government Code §65400(b) requires that an annual report be submitted to the City Council on the status of the General Plan and its implementation. This report must detail progress made in meeting the city's share of regional housing needs as well as a summary of all General Plan amendments adopted during the preceding year, and an action list for the forthcoming year. The report will provide an overview of the status of the General Plan and its implementation program. In addition, mitigation monitoring and reporting requirements prescribed by the California Environmental Quality Act (CEQA) should be addressed in the annual report as they are closely tied to Plan implementation.

The Petaluma General Plan annual report will be prepared by City staff during the early stages of the budget process and submitted for review to the Planning Commission and City Council. Public comments on the annual report may be submitted in writing to the Community Development Department. The Planning Commission and the City Council will also hear public comments on the annual report at duly noticed public meetings.

i.6 RELATED DOCUMENTS

GENERAL PLAN DOCUMENTS

As part of the General Plan preparation, several technical studies were conducted to document environmental conditions, analyze prospects for economic development, community character and growth, and evaluate alternatives. Studies prepared include:

- Survey of Residents
- Existing Conditions, Opportunities and Challenges Report
- Surface Water Operations and Maintenance Plan (Technical Memo 2)
- Surface Water Facilities Review (Tech. Memo 1)
- Traffic Model Development Report
- Biological Resources Review (Technical Memo 3)
- Land Use & Mobility Alternatives Report
- Groundwater Feasibility Study (Tech. Memo 4)
- Leakage and Sustainable Retail Strategy Study
- Water Supply and Demand Analysis
- Water Distribution System Master Plan
- XP-SWMM Surface Water Model Calibration and Analysis Report
- Fiscal Impacts of the Draft General Plan
- Environmental Impact Report
- Implementation Plan and Mitigation Monitoring Program

CITY PLANS AND PROGRAMS

The City has adopted other planning documents to guide growth and development, which shall be consulted together with the General Plan (specific plan boundaries are shown in Figure i-4) in the review of any public or private project:

The *Central Petaluma Specific Plan* (CPSP) addresses land use, density and intensity, transportation, and community character in the Central Petaluma area. The Central Petaluma area contains extensive vacant and under utilized parcels surrounding the Petaluma River

and Turning Basin, a rail corridor with transit potential, and adjacent commercial and industrial uses. Adopted in June 2003, the Central Petaluma Specific Plan calls for a mix of housing and activities within a walkable core area, a variety of transportation alternatives, and a working industrial waterfront along the river. With a few amendments (see Section 2.2 Planning Subareas: 1. CPSP) the General Plan incorporates the land uses and planning concepts from the Central Petaluma Specific Plan. The CPSP EIR recognizes the impacts to traffic from the intensification of the expected infill development. Acceptance of these impacts is acknowledged through the adoption of statements of overriding consideration with regard to impacts to the Level of Service (LOS) of particular intersections and street segments.

The *Corona-Ely Specific Plan*, adopted in 1989, provides land uses and densities, transportation, neighborhood design and public amenities for the 675-acre area located at the City's northeast quadrant (Sonoma Mountain Parkway from E. Washington north to Corona Road). Key land uses in the area include the new Santa Rosa Junior College campus, a neighborhood serving shopping center, three elementary schools, a new junior high school, parks, and creekside open space and trails. By 2005, the Specific Plan area was nearly developed.

The *Petaluma River Access and Enhancement Plan* provides a framework for preservation and restoration of the Petaluma River corridor. Adopted in May 1996, the Access and Enhancement Plan addresses corridor improvements, land uses, and accessibility along the 6.5-mile section of the Petaluma River within the city limits. Its four major components include restoration of the river's natural resources, construction of a multi-use trail, a vibrant waterfront district adjacent to Downtown, and mixed uses along the river corridor. The Plan also introduced the concept of constructing flood terraces along the River to increase its carrying capacity and reduce localized flood levels. The General Plan assumes sensitive development patterns along the river corridor that allow integration of land uses, recreation, and preservation/restoration goals.

The *City of Petaluma Bicycle and Pedestrian Plan* (Bicycle Plan), developed by the Petaluma Pedestrian and Bicycle Advisory Committee, identifies and prioritizes bicycle and pedestrian improvement projects. Adopted in 2000 and updated for inclusion as part of this General Plan, the Bicycle Plan includes specific policies and programs for enhanced bicycle/pedestrian circulation, increased connectivity throughout the city, and improved safety.

PLANS AND PROGRAMS OF SURROUNDING JURISDICTIONS

The *Sonoma County General Plan 2020* is a revision of the previous General Plan which was adopted in 1989. The County Plan establishes a framework for protecting open space and agricultural uses, and limiting new development. The County Plan is generally compatible with the plans of its nine cities, and with plans or policies established by other governmental agencies. Although the County's plan does not regulate development within Petaluma, it is applicable to lands within the unincorporated portions of the Planning Referral Area. Consultation with Petaluma, however, is required for lands within its Sphere of Influence. In some instances, the policies of the County Plan establish larger "areas of interest" for cities in order to provide for their review and comment on proposed county actions. Sonoma County Area Plans, such as the West Petaluma Dairy Belt Area Plan, should be consulted for areas within Petaluma's Urban Growth Boundary, beyond the existing City Limits.

The *Penngrove Specific Plan,* originally adopted by the Sonoma County Board of Supervisors in 1984, identifies land use and open space goals for the long-term development pattern of this unincorporated community located adjacent to the northeast corner of Petaluma. Through agreements, the wastewater from a defined area within Penngrove flows into and is served by the City of Petaluma Wastewater Treatment Plant.

The Petaluma River Access and Enhancement Plan includes pedestrian trails and recreational access to the Petaluma River, as shown at Foundry Wharf (Petaluma Rowing Club).

i.7 PLAN ORGANIZATION

GENERAL PLAN STRUCTURE

The Petaluma General Plan is organized into 11 chapters:

i. *Introduction and Overview.* This includes General Plan Guiding Principles and, requirements for Plan monitoring, review, and amendments.

1. *Land Use, Growth Management, and the Built Environment.* This element provides the physical framework for development in the city. It establishes policies related to the location and intensity of new development, and citywide land use policies.

2. *Community Design, Character, and Green Building.* This chapter outlines policies to ensure that new development protects and enhances the community character. Urban form, edges, and views, and neighborhoods, streets, historic preservation and green building are all addressed. This chapter also includes detailed policies for each one of the 14 sub-areas that comprise the Planning Area.

3. *Historic Preservation.* This chapter outlines policies and programs to ensure the preservation, protection, and restoration of historical and cultural resources.

4. *The Natural Environment.* This chapter outlines policies relating to the Petaluma River, habitat and biological resources, air quality, energy resources, and solid waste.

5. *Mobility.* This element includes policies and programs to enhance opportunities, capacity, and circulation. It identifies future improvements and addresses alternative transportation systems and parking.

6. *Recreation, Music, Parks, and the Arts.* This chapter outlines the policies and standards relating to parks and recreation, including recreation and cultural programs and events.

7. *Community Facilities, Services, and Education.* This chapter outlines the policies and standards relating to public facilities and services, including public schools.

8. *Water Resources.* Establishes policies regarding water supply, wastewater and the use of recycled water, conservation, and surface water management.

9. *Economic Health and Sustainability.* This element establishes policies to promote economic expansion and job growth in the city, balanced to provide fiscal sustainability while maintaining the city's character.

10. *Health and Safety.* The chapter addresses the risks posed by seismic and geologic hazards, as well as other topics, including solid waste management and recycling, hazardous materials, and emergency management (Police and Fire).

11. *Housing.* To meet the delivery deadlines of California's Department of Housing and Community Development (HCD), the Housing Element update was adopted in December 2002, ahead of the remainder of the General Plan. The Housing Element has been reviewed for internal consistency, and is incorporated into the General Plan. The Element will be updated in 2009, then reviewed with the whole General Plan mid-term in 2015.

ORGANIZATION OF THE ELEMENTS; POLICY STRUCTURE

Each chapter or element of the General Plan includes brief background information to establish the context for goals, policies, and programs in the Element. This background material is neither a comprehensive statement of existing conditions nor does it contain any adopted information. Readers interested in a comprehensive understanding of existing conditions or issues related to a particular topic should refer to *Petaluma General Plan 2025: Existing Conditions, Opportunities, and Challenges Report* (October 2002). This background information is followed by:

- *Goals:* Statements of vision and philosophy toward which the City will direct its efforts and resources. Denoted by the element number, followed by a 'G', then in numerical order within that element (e.g.: 2-G-1 would be the first goal of the Community Design Element).

- *Policies* are a specific statement of principle to guide City actions. The term "shall" reflects mandatory policies, while "strive," "may," and "should" refer to intent but is not always mandatory. Denoted by the element number, followed by a 'P', then in numerical order within that element (e.g.: 2-P-2 would be the second policy within the Community Design Element).

Goals and policies in many instances are supplemented by:

- *Programs.* These represent implementation commitments to specific goals and policies. Language may refer to existing programs or call for establishment of new ones. Programs are denoted by letters under associated policies.

Together, the Elements articulate a vision for Petaluma that the General Plan seeks to achieve. They also provide protection for the city's resources by establishing requirements, thresholds, procedures, and criteria for project review.

Explanatory material accompanies some Goals, Policies and Programs (often in the form of bulleted lists). This explanatory material provides background information or is intended to guide Plan implementation. Where the same topic is addressed in more than one chapter, sections and policies are cross-referred, typically in italics for easy reference.

The Guiding Principles, Goals, Policies and Programs are 'adopted' while the supporting text is explanatory and shall not be considered adopted mandates.

The provisions of this General Plan shall not apply to the extent that they would violate the constitution or laws of the United States or the State of California. The purpose of this provision is to ensure that this General Plan does not violate any person's constitutional or legal rights.

Policy Numbering System

Policies in the General Plan are organized using a two-part numbering system that is intended to give each goal and policy a discrete, easily referenced number. The first part refers to the chapter/element (and the subsection within the chapter), followed by a letter identifying the Goal (G) or Policy (P), and finally by a second number referring to the specific policy. Thus, the first goal in Chapter 3 would be *3-G-1*, and subsequent implementing policies would be *3-P-1*, *3-P-2*, etc.

Programs are listed under each relevant goal and/or policy. For example, Policy 3-P-1 may have Program A, B, C, etc. Bullets within Programs offer additional direction regarding implementation.

Aerial view of Petaluma looking southwest toward San Francisco.

4

The Natural Environment

Petaluma is a city defined by the natural environment. The aquatic and riparian resources along the Petaluma River; the rich, ecologically diverse plant and wildlife communities; the area's precious water and air resources; and productive open space resources—contribute greatly to the city's quality of life. Protection, restoration, and enhancement of the natural environment are intrinsic components of fostering sustainability.

This element outlines policies related to the river, biological resources, air quality, energy, and solid waste. Detailed background information about the natural environment in Petaluma is provided in the *Biological Resources Review* (Appendix F-3, Volume 4 of Technical Appendices).

4.1 BIOLOGY AND NATURAL RESOURCES

THE RIVER ENVIRONS

The significance of the Petaluma River lies in its roles as a natural habitat, a carrier of storm waters, a centerpiece of urban identity and local history, a recreation resource, as well as a water-borne commercial/industrial transportation corridor. Today, the river is navigable from its mouth at San Pablo Bay to the Turning Basin in downtown Petaluma.

The river is also part of an ecological system that runs from the hills to the San Pablo Bay, linking fresh water with tidal zones. Urban development, however, has caused the degradation of the most significant natural resources within the Urban Growth Boundary (UGB)—the aquatic and riparian resources found along the river and its tributaries. Conserving and restoring the river's ecological system is essential to maintaining Petaluma's place-based character.

Aquatic and Riparian Resources

Aquatic resources in the Planning Area include the Petaluma River and its tributaries, vernal pools and seasonal wetlands, northern coastal salt marshes, coastal brackish marshes, and freshwater marshes. Riparian habitats are found in proximity to these aquatic areas, and act as a transition from the upland communities, providing habitat and cover for many species of aquatic and semi-aquatic animals. The General Plan seeks to protect these aquatic and riparian habitats as they play a crucial role in the preservation of sensitive species in the area, including the Chinook salmon and the Western Pond Turtle.

Petaluma River Access and Enhancement Plan

As mentioned in Chapter 1: Introduction, the 1996 Petaluma River Access and Enhancement Plan (the River Plan) describes the community's vision for the Petaluma River, including riverfront uses, activities, and developments. A central feature of the River Plan is the integration of the natural and built environment, recognizing that development and public access along the river must be balanced with protection of the few remaining natural areas located along this corridor. Equal in priority are the goals and policies of the Surface Water portion of the Water Resources Element, which identifies the need to preserve an adequate setback from the river to accommodate peak storm flows.

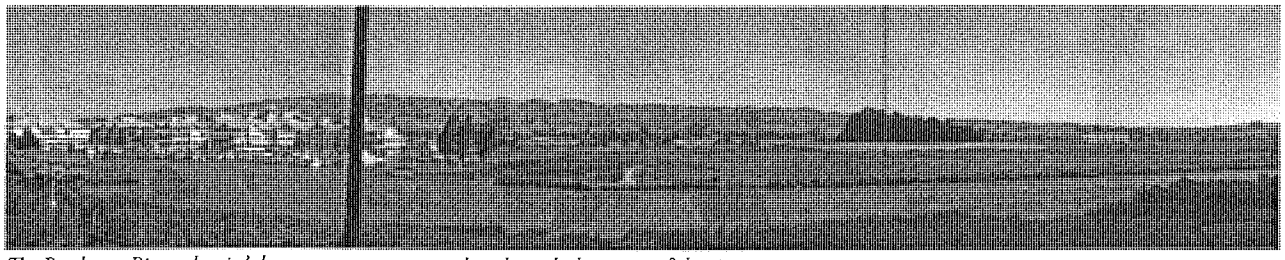
Incremental implementation of the River Plan has been underway since it was completed and this General Plan enhances its status as an integral part of the General Plan implementation. Since 1996, trail segments have been installed, land has been purchased as riverfront open space, flood reduction, habitat enhancement, and restoration projects have been completed. Design of new pedestrian improvements continues to be planned and constructed, riverfront properties have been developed, and funding for additional projects continues. The General Plan incorporates the River Plan as a proven effective tool for use by the City and property owners alike in achieving the goals set forth by the community.

VEGETATION

While the river environs contain areas of tremendous plant and wildlife diversity, there are other parts of the Planning Area that exhibit unique and valuable biological characteristics. A brief description of the Planning Area's common vegetation communities is provided below, followed by an identification of sensitive species and habitats that warrant additional protection and management strategies to preserve their features.

Vegetation types within the Planning Area—as described in Holland's Preliminary Descriptions of Terrestrial Natural Communities of California—may generally be classified into eight categories:

1. *Urban.* Includes ornamental landscaping, non-native



The Petaluma River, the city's largest waterway, meanders through the center of the city.

grass and weed associations in vacant lots (usually referred to as ruderal vegetation), and scattered agricultural crop and orchard plantings.

2. *Rural/agricultural.* Includes low-density residential/commercial areas, as well as row crops, orchards, and ruderal vegetation. A variety of agricultural products are grown in the Planning Area, including tomatoes, asparagus, corn, squash, walnuts, apricots, apples, cherries, and grapes.

3. *Grassland/oak savannah.* Non-native grassland vegetation occurs in the western and southern portions of the Planning Area while oak savannah occurs in the western portions. In many areas, severe levels of grazing have reduced these plant coverings to the extent that bare ground is visible.

4. *Fresh emergent wetlands.* These wetlands are among the most productive wildlife habitats in California. Fresh emergent wetland habitats occur in association with terrestrial habitats or aquatic habitats including Riverine, Lacustrine, and Wet Meadows.

5. *Vernal pools/seasonal wetlands.* These temporary ponds create a unique microclimate, which supports an assemblage of plants and wildlife. Vernal pools in the Planning Area are associated with the grassland and oak savannah communities. The California Department of Fish and Game (CDFG) classifies vernal pools and seasonal wetlands as a sensitive habitat.

6. *Riparian.* The Planning Area contains bands of riparian habitat along the Petaluma River and its tributaries.

7. *Northern coastal salt marsh.* These wetlands contain highly productive, herbaceous perennial plants up to 4 feet in height. The salt marsh wetlands located in the lower reaches of the Petaluma River are important habitat for sensitive species such as the salt marsh harvest mouse, California clapper rail, and California black rail.

8. *Brackish water marsh.* Found adjacent to coastal salt marshes, these marshes differ in that they are made brackish from freshwater input. Species composition is characterized as being intermediate between salt marsh wetland and freshwater marsh wetland communities, consisting of elements from both communities. As a result; the brackish marsh wetlands are located in the lower reaches of the Petaluma River and are important habitat for sensitive species also found in the coastal salt marshes.

SENSITIVE SPECIES AND HABITATS

Sensitive or special status species are those plant and animal species that are designated by Federal or State regulatory agencies as needing protection due to rarity or threats to their existence. Sensitive habitats are those areas in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in the ecosystem. Sensitive habitat areas within the Planning Area include vernal pools, northern coastal salt marshes, and coastal brackish marshes.

Special status species that have moderate to known occurrence within the Petaluma Planning Area are listed in Table 3.8-1 of the Final Environmental Impact Report.

Petaluma's river, creeks, and marshes offer a diverse biological and wetlands habitat for numerous species.

Open space areas like Shollenberger Park are an important component of Petaluma's natural environment.

GOAL 4-G-1: Biology & Natural Resources

Protect and enhance biological and natural resources within the UGB.

Policies and Programs:

4-P-1 Protect and enhance the Petaluma River and its tributaries through a comprehensive river management strategy of the following programs:

A. Fully adopt and incorporate the Goals, Objectives, Policies and Programs of the Petaluma River Access and Enhancement Plan as an integral part of the General Plan 2025. Implement the Petaluma River Access and Enhancement Plan including expanded improvements identified through project specific environmental assessment.

B. Institute and maintain public access to and along the entire length (on one or both sides), of the river while ensuring that natural resources and river dependent industry are protected.

C. Require design review to address the relationship and stewardship of that project to the river or creek for any development on sites with frontage along the river and creeks.

D. Create setbacks for all tributaries to the Petaluma River extending a minimum of 50 feet outward from the top of each bank, with extended buffers where significant habitat areas, vernal pools, or wetlands exist. Development shall not occur within this setback, except as part of greenway enhancement (for example, trails and bikeways). Where there is degradation within the zone, restoration of the natural creek channels and riparian vegetation is mandatory at time of adjacent development.

E. Facilitate compliance with Phase II standards of the National Pollutant Discharge Elimination System (NPDES) to improve the water quality and aesthetics of the river and creeks.

F. Work with the State Lands Commission, State Department of Fish and Game, the Sonoma County Water Agency, and other jurisdictional agencies on preservation/enhancement of the Petaluma River as a component of reviewing major development along the River.

G. Expand the planting and retention of trees along the upper banks of the river and creeks to reduce ambient water temperature and shade out invasive, non-native species.

H. Revise the Development Code to include:

- Standards for the four management zones that run the entire length of the river: 1) Restoration Zone, 2) Buffer Zone, 3) Preservation Zone, and 4) River Oriented Development Zone. These standards shall be based on the River Plan's text and sections A-A through O-O as augmented by the cross-section needs identified through the XP-SWMM analyses;
- Design review requirements as articulated in the River Plan for any development on sites with frontage along the river or within 300 ft. of the river;
- The use of transfer of development rights (TDR) from portions adjacent to the river to elsewhere on the parcel by allowing property owners an increase in residential densities or in allowable Floor-to-Area-Ratio (FAR) and/or smaller/clustered lots to compensate for the loss of development opportunity on land within the Restoration, Buffer, or Preservation zones of the River Plan. The overall development potential on a site shall be consistent with the General Plan. TDRs shall not be applied to lands within the Floodway as there is no development potential within the Floodway.

I. Develop a consistent design for site furniture, a wayfinding system, and educational signage in the PRC and along the creeks and tributaries leading to it to heighten the recognition and value of the river and its ecosystem.

J. Utilize the Parks and Recreation, Water Resources & Conservation, Public Works departments, property owners (e.g. Landscape Assessment Districts) and/or other appropriate public agencies (e.g. Sonoma County Water Agency) to manage the long term operations, maintenance responsibilities, and stormwater capacity associated with the river and tributary greenways.

K. Prohibit placement of impervious surfaces in the Floodway (i.e. Parking lots, roadways, etc.) with the exception of pathways and emergency access improvements.

L. Continue to implement, where appropriate, flood terrace improvements to reduce localized flooding in concert with habitat enhancement projects.

M. Cooperate with State and Federal agencies to address and/or eradicate issues and environmental problems associated with

Petaluma contributed 8,681 tons of recyclable waste (13 percent of the County's 64,596 tons) and 18,846 tons of composting waste (16 percent of the county's 115,000 tons) in 2000. The city's percentage of participation in County recycling slightly outweighed its proportion of population, at 12 percent of the County's total.

GOAL 4-G-5: Solid Waste

Meet Petaluma's solid waste disposal needs while maximizing opportunities for waste reduction, reuse, and recycling, in compliance with the California Integrated Waste Management Act of 1989.

Policies and Programs:

See also Section 10.3: Hazardous Waste Management for policies relating to Hazardous Waste storage and disposal.

4-P-21 Reduce solid waste and increase reduction, reuse and/or recycling, in compliance with the Countywide Integrated Waste Management Plan (CoIWMP).

A. Work with Sonoma County to identify environmental and economical means to meet the need for solid waste disposal.

B. Require new or remodeled residential and all non-residential development to incorporate sufficient, attractive, and convenient interior and exterior storage areas for recyclables and green waste.

C. Continue to encourage waste reduction and recycling at home and in businesses through public education programs, such as informational handouts, on recycling, yard waste, wood waste, and hazardous waste collection.

D. Develop a residential and commercial food waste composting program.

E. Purchase goods containing recycled materials for City use.

F. Continue to cooperate, require, and/or support the operation of resource recovery facilities by the City waste hauler and the disposal site operators.

G. Investigate and replace bottled water in City offices with alternate source of drinking water.

H. Ensure that all public facilities have adequate and accessible depositories for recyclables.

4-P-22 Require future waste contract negotiations to include the following:

A. Disposal of City waste products at a site with the least potential for environmental impacts.

B. Discussion on resource recovery services for Petaluma waste.

C. The identification of recycling and waste stream diversion goals.

D. Hazardous waste collection.

4.5 GREENHOUSE GAS EMISSIONS

Petaluma seeks to evaluate and lessen the impact of greenhouse gas emissions by reducing emissions, conserving resources and implementing the goals, policies and programs outlined in the General Plan 2025.

GLOBAL

Climate change is a shift in the average weather patterns observed on earth, which can be measured by such variables as temperature, wind patterns, storms and precipitation. The temperature on earth is regulated by what is commonly known as the "greenhouse effect." Naturally occurring greenhouse gases in the atmosphere, including carbon dioxide, methane, nitrous oxides, and water vapor, absorb heat from the earth's surface and radiate it back to the surface.

Human activities result in emissions of four principal greenhouse gases: carbon dioxide, methane, nitrous oxide, and halocarbons (fluorine, chlorine and bromine). Of all human activities, the burning of fossil fuels is the largest contributor in overall greenhouse gas emissions, releasing carbon dioxide gas into the atmosphere.[5]

The resulting increases in greenhouse gas emissions from human activities are leading to higher concentrations and a change in composition of the atmosphere. For instance, the concentration of CO2 in the atmosphere has risen about 30 percent since the late 1800s (National Assessment Synthesis Team [NAST], 2001).[6] Many sources and models indicate that temperatures on earth are currently warming and will continue to warm at unprecedented levels. The global mean surface temperature has increased

5 Intergovernmental Panel on Climate Change, Fourth Assessment Report (IPCC 4th), 2007, Working Group (WG) I, Frequently Asked Question 2.1, How do Human Activities Contribute to Climate Change and How Do They Compare with Natural Influences?

6 Climate Action Team, 2006, Climate Action Team Report to Governor Schwarzenegger and the Legislature, March.

by 1.1° F since the 19th century (IPCC Synthesis report, 2001), and the 10 warmest years of the last century all occurred within the last 15 years.[6]

The many effects of Greenhouse Gas Emissions are still being researched and are not fully known, but are expected to include increased temperatures which would: reduce snowpack, a primary source of drinking water; exacerbate air quality problems and adversely impact human health by increasing heat stress and related deaths; increase the incidence of infectious disease, asthma and respiratory health problems; cause sea levels to rise, threatening urban and natural coastlands; increase pests and pathogens; and cause variations in crop quality and yields.

This section of the General Plan is focused on the reduction of greenhouse gas emissions. To the extent that Petaluma is affected by global warming, for example rises in sea level, the issues are addressed in the Water Resources Element.

STATE OF CALIFORNIA

In California, the majority of human activity greenhouse gas emissions can be broken down into four sectors: transportation, industrial, electrical power, and agriculture/forestry. The largest source is from the transportation sector.[6]

In 2005, Governor Schwarzenegger issued Executive Order S-02-05, calling for statewide reductions to 2000 levels by 2010, 1990 levels by 2020 and to 80 percent below 1990 levels by 2050. The Executive Order also called for the creation of a state "Climate Action Team", which would report to the Governor every two years on both progress toward meeting the targets and effects of Greenhouse Gas Emissions on the state.

In the Fall of 2006, the Governor signed Assembly Bill 32 (AB32), the "Global Warming Solutions Act of 2006," committing the State of California to reducing greenhouse gas emissions to 1990 levels by 2020. The statute requires the California Air Resources Board (CARB) to track emissions through mandatory reporting, determine what 1990 emissions were, set annual emissions limits that will result in meeting the target, and identify a list of discrete early actions that directly address greenhouse gas emissions, are regulatory, and can be enforced by January 1, 2010.

CITY OF PETALUMA

Municipal Greenhouse Gas Emissions

On August 5th, 2002, the City Council adopted Resolution 2002-117 committing to participate in the Cities for Climate Protection. By doing so the City committed to:

- Taking a leadership role in promoting public awareness about the causes and impacts of Greenhouse Gas Emissions.
- Undertaking the Cities for Climate Protection program's five milestones to reduce greenhouse gas and air pollution emissions throughout the community by:

  1. Conducting a greenhouse gas emissions inventory and forecast to determine the source and quantity of GHG emissions.

  2. Establishing a greenhouse gas emissions reduction target.

  3. Developing an action plan with both existing and future actions to meet the greenhouse gas reduction target.

  4. Implementing the action plan.

  5. Monitoring to review progress.

In 2005 the City completed steps 1 and 2. On July 18, 2005 the City passed Resolution 2005-118, "Resolution to Establish GHG Emission Reduction Target(s) for the City of Petaluma". Resolution 2005-118 established greenhouse gas emissions reduction targets of 25% below 1990 levels by 2015 for community emissions and 20% below 2000 levels by 2010 for municipal operations. The City's reduction targets are more stringent than those passed by the State. The City is currently working on Step 3, development of the action plan for municipal emissions.

Also, the City signed the U.S. Mayors Climate Protection Agreement calling for participating cities to meet or surpass the Kyoto Protocol targets, and the resolutions above do surpass the Kyoto targets.

Since 2005 the City has implemented, or is in the process of implementing, many programs to reach the municipal operations goal. These include: a major lighting retrofit at City Hall, the Police Department and the Lucchesi Community Center; replacement of four traditional fuel fleet vehicles with one zero emission electric vehicle and three hybrid vehicles; retrofit of nine "off-road" vehicles (dump trucks, vacuum trucks, etc) to

Table 4.5-1: Petaluma Community-wide 1990 and 2005 Greenhouse Gas Emissions and Projected Emissions for 2025

	1990				2005				2025			
	Electricity (kWh)	Natural Gas (Therms)	CO_2e Emissions (tons)	Percent of Total	Electricity (kWh)	Natural Gas (Therms)	CO_2e Emissions (tons)	Percent of Total	Electricity (kWh)	Natural Gas (Therms)	CO_2e Emissions (tons)	Percent of Total
Buildings	335,233,026	9,083,718	172,200	40%	455,792,623	12,245,736	237,400	39%	554,183,117	15,572,117	292,800	40%
Municipal Services - Water & Sewer	6,184,009	209	2,100	0%	6,786,555	209	2,400	0%	10,146,879	6,000	3,600	1%
	Population	Waste Generated (tons)			Population	Waste Generated (tons)			Population	Waste Generated (tons)		
Solid Waste	43,200	49,567	22,500	5%	57,085	29,144	12,500	2%	72,707	37,178	15,900	2%
		Vehicle Miles Traveled				Vehicle Miles Traveled				Vehicle Miles Traveled		
Transpor-tation		305,992,640	238,100	55%		544,710,305	358,100	59%		662,392,145	409,200	57%
TOTAL			434,900	100%			610,400	100%			721,600	100%
Percent Increase							2.7% increase per year from 1990 to 2005				0.9% increase per year from 2005 to 2025	

Notes: Columns may not add due to rounding.

comply with the California Air Resources Board lower vehicle emission regulations[7]; replacement of 99 percent of the incandescent traffic lights with LED lights; and replacement of three of nine 1989 diesel buses with four, 2007 Gillig models, which are equipped with clean burning diesel engines that meet the 2010 CARB regulations. As standard procedure, the Public Works Maintenance & Operations staff replaces older lighting fixtures with energy efficient units, as the original fixtures burn out.

The Green Team, a Council sanctioned group composed of City staff members and interested citizens, was formed to analyze City procedures and processes to identify areas of improvement, educate staff and the community, and sponsor the Going Green Expo.

The City is currently preparing a Climate Action Plan (CAP) for its municipal activities per Resolution 2002-117. The purpose of the municipal CAP is to identify and prioritize programs, projects, and procedural policies that will help the City achieve the municipal greenhouse gas emission goals of Resolution 2005-118.

7 California Environmental Protection Agency, Air Resources Board, November 1998, EV II – Amendments to California's Low-emission Vehicle Regulations.

Community Greenhouse Gas Emissions

As stated above, Resolution 2005-118 established greenhouse gas emissions reduction targets of 25% below 1990 levels by 2015 for community emissions. The primary sources of community greenhouse gas emissions in Petaluma are identified in Table 4.1-1 on the following page. In summary, residential and commercial buildings are responsible for about 40 percent; transportation is responsible for about 55 to 59 percent; and municipal services and solid waste management account for about 2 to 5 percent of emissions.

Emissions have grown from about 434,900 tons in 1990 at about 10.1 tons per person to 610,400 tons in 2005 at about 10.7 tons per person. Without benefit of the policies in the General Plan, emissions in 2025 are estimated to be 721,600 tons at about 9.9 tons per person. Although emissions would continue to increase, the rate of increase is expected to slow in the future based on implementation of the General Plan policies and State measures.

Throughout this General Plan, many far-reaching goals and policies are identified to promote the vision

for Petaluma's long-range physical and economic development and resource conservation. These policies, in such key areas as land use, conservation, systems efficiency, safety, mobility and housing, serve a dual purpose to implement the City's long-range goals and also require that growth occurs in ways that reduce the City's contribution of greenhouse gas emissions, see the following chapters:

1. Land Use, Growth Management and the Built Environment
2. Community Design, Character, and Green Building
5. Mobility
6. Recreation, Music, Parks, & the Arts
7. Community Facilities, Services, and Education
8. Water Resources
9. Economic Health and Fiscal Sustainability.

Goal 4-G-6: Greenhouse Gas Emissions

Reduce the contribution to greenhouse gases from existing sources and minimize the contribution of greenhouse gases from new construction and sources.

Policies and Programs:

4-P-23 **Fund and/or designate a Green Program Manager to oversee implementation of all Greenhouse Gas Emissions policies and programs identified in the Greenhouse Gas Emissions section as well as the City's Climate Action Plan. The policies and programs will need to be reviewed and updated periodically as new information, regulatory standards, and technologies develop. A report shall be provided to the City Council biannually, reporting on the status of the City's efforts to reduce green house gases, and recommendations for any changes that are deemed necessary.**

4-P-24 **Comply with AB 32 and its governing regulations to the full extent of the City's jurisdictional authority.**

4-P-25 **To the full extent of the City's jurisdictional authority, implement any additional adopted State legislative or regulatory standards, policies and practices designed to reduce greenhouse gas emissions, as those measures are developed.**

4-P-26 **Implement all measures identified in the municipal Climate Action Plan to meet the municipal target set in Resolution 2005-118 (20% below 2000 levels by 2010).**

4-P-27 **The City shall prepare a Community Climate Action Plan to identify and prioritize programs, projects, and procedural policies that will help the City achieve the community greenhouse gas emission goals of Resolution 2005-118 (25% below 1990 levels by 2015).**

4-P-28 **Prepare a feasibility report for the City of Petaluma forming a Community Choice Aggregation (through AB 117, permits any city or county to aggregate the electric loads of residents, businesses and municipal facilities to facilitate the purchase and sale of electrical energy) as a way of supplying renewable energy to the community.**

4-P-29 **Train appropriate City staff on new technology and look for opportunities to improve energy efficiency in public facilities.**

4-P-30 **Continue to monitor new technology and innovative sustainable design practices for applicability to insure future development minimizes or eliminates the use of fossil fuel and GHG-emitting energy consumption.**

4-P-31 **Provide information and tips on reducing greenhouse gas emissions to the community.**

A. Advertise "Green Tip" in the local newspaper.
B. Work with utilities to offer Green Tips with the utility bills.
C. Continue sponsoring Petaluma's green programs, including, but not limited to, the Going Green Expo.
D. Create a program of on-going community education.
E. Support the efforts of the Sonoma Green Business Program.

4-P-32 **Develop and implement a municipal Environmentally Preferable Purchasing Program.**

4-P-33 **Investigate the feasibility of developing a City sponsored program to subsidize or assist home-owners in purchasing solar water heating or passive solar systems, or other forms of renewable energy, through low-interest loans or property tax assessments.**

Goal 8-G-6: Groundwater Supply

Preserve and maintain the City's groundwater resources.

Policies and Programs:

8-P-19 Ensure adequate water supply during emergency situations by developing potential groundwater resources and aquifer storage capacity, combined with management of surface water, to meet overall emergency water supply objectives. The City's groundwater resources shall be preserved to meet emergency needs and to offset peak demands.

A. The City will develop additional wells to supply the average minimum month water demand.

B. Work cooperatively with the County of Sonoma to protect and preserve Petaluma groundwater resources, including the preservation and enhancement of significant recharge areas within the watershed.

C. Evaluate the need and feasibility of developing limited wellhead treatment facilities to insure water quality requirements.

D. Preserve oak woodlands, upland native grassland, and wetland areas identified as contributing to groundwater recharge; at a minimum for areas identified within the Groundwater Feasibility Study, Technical Memo 4, dated February 2004 (Technical Appendix Volume 4).

8-P-20 Manage groundwater as a valuable and limited shared resource by protecting potential groundwater recharge areas and stream sides from urban encroachment within the Petaluma watershed.

See, at a minimum, those areas defined as possible recharge areas set forth in Technical Appendix Volume 4, Groundwater Feasibility Study, 2004, or revisions thereto.

A. Control construction of impervious surfaces in groundwater recharge areas. Potential recharge area protection measures at sites in groundwater recharge areas include, but are not limited to:

- Restrict coverage by impervious materials;
- Limit building or parking footprints;
- Require construction of percolation ponds on site.
- Require surface drainage swales

B. Urge the County when reviewing development applications, to examine the combined impacts of new septic tanks placed in proximity to wells and the ability to maintain adequate protection of groundwater resources. The County should examine the cumulative impacts of the allowed development densities in the West Petaluma Specific Plan area and compare the results to established water quality standards. Test wells should be required prior to issuing any building permits.

8-P-21 Protect groundwater quality from surface contamination by requiring 100 foot sanitary seals on all new municipal water supply wells.

8.3 SURFACE WATER MANAGEMENT

INTRODUCTION – EXISTING CONDITIONS (2006)

The Petaluma River watershed includes an area of approximately 146 square miles. The City lies within the watershed along the Petaluma River and is located approximately 12 miles north of San Pablo Bay. The City constitutes 13.6 square miles with approximately 16.1 square miles within the Urban Growth Boundary. The City's surface water drainage system includes the Petaluma River, open creek channels, conduits, culverts, bridge openings, detention ponds, and control structures such as weirs. At locations throughout the City, these elements act to convey storm water runoff toward the Petaluma River and eventually to San Pablo Bay.

The topography of the area also plays an important role in surface drainage. The City is located in a broad bowl, bounded by the Sonoma Mountains to the east and a range of low hills to the west. The ground surface elevation in the City varies from essentially sea level in the area around the Petaluma River to approximately 400 feet above sea level in the hills within the City limits.

CHARACTER OF SURFACE WATER DRAINAGE SYSTEM

The hills that surround the City drain via numerous creeks and streams that make their way through the City on their way to the Petaluma River. Drainage ways that convey these flows have been modified as the area around the Petaluma River has developed. At many locations within the City these creeks and streams have been converted to buried conduits. The addition of impervious areas within the City has also changed the local hydrology. Runoff conveyed over paved streets, parking lots, and rooftops into open channels or pipes that carry flows to the Petaluma River will reach the River more quickly, generally creating higher peak flows than runoff conveyed through natural streams or through native vegetation.

Important characteristics to consider when analyzing a surface drainage system include the climatic conditions of the local area; the most important climatic characteristic is precipitation, which generates runoff.

Open/Natural Channels/ Biological Resources

Approximately 10.85 miles (57,300 linear feet) of open channels and natural creeks exist within the City of Petaluma. The Petaluma River separately consists of approximately 7.14 miles (37,700 feet) of channel inside the City limits. The riverbank composition varies greatly as the River meanders through the City. An inventory of this environment was undertaken in 2002 to include natural waterways, piped sections, biotechnical and bioengineered banks, riprap banks, floodwalls, and structures (see Biological Resources Review, TM3, GP EIR Appendix).

Preservation and enhancement of the natural channels offers an excellent opportunity to improve the flood conveyance capacity and enhance habitat values. Utilizing and implementing the River Access and Enhancement Plan (1986), setting aside the Petaluma River Corridor, and utilizing the Restoration, Design and Management Guidelines for maintenance activities will ensure the protection of the natural environment while meeting the flood flow capacity needs for the Petaluma Watershed Basin.

Existing physical and natural constraints may limit the ability to achieve containment of the 100-year design storm within the Petaluma River Corridor. The intent is to maximize the carrying capacity of the river corridor while reducing depths within the surrounding floodplain to the greatest extent possible. Implementation of the River Access and Enhancement Plan establishes and/or enhances the river corridor primarily through the introduction of flood terraces and low-flow channels, along with habitat restoration and associated vegetation management. The flood-terraces and low-flow channels are envisioned to be sized and situated for compatibility with the existing topography and describable landscape features, while still allowing for future adjacent development where appropriate. Under the 1% (100-year) design flow conditions, the flood terraces are expected to vary in width up to 200' from centerline in order to provide the desired beneficial effects on hydraulic capacity, floodwater elevation, and water quality improvement.

Engineered/Piped System

The City's piped storm water drainage system ranges in size from less than 6 inches to greater than 6 feet in diameter. A total of approximately 4,480 pipe segments exist in the City (2006). Of these pipe segments, approximately 3,260 are less than 24 inches in diameter and approximately 1,220 are 24 inches in diameter or larger (a pipe segment is defined as any pipe originating

and terminating at a manhole, catch basin or open channel). There are also approximately 70 locations within the City where open channel flows are conveyed under roadways via bridges or culverts.

Flows / Capacity

Floods in the Petaluma River Basin are normally of short duration, lasting 3 to 4 days, or less. Tributaries of the Petaluma River can begin to rise within hours after a heavy storm event has begun if antecedent soil moisture content is already high. Typically floods occur between December and March.

Flooding has taken place in the City, to the extent that at least some street flooding occurs, on average once per year over the past twenty or so years. Recent significant flooding events (meaning street and property flooding) have occurred in Petaluma in 1982, 1983, 1986, 1995, 1996, 1998, and 2005. The largest flood of record in the City of Petaluma occurred from January 3 through 5, 1982. A significant flood event occurred on December 30-31, 2005, over-taxing both piped and open channel systems.

Including the Petaluma River, there are approximately 18 miles of channels that have been studied in detail by the Federal Emergency Management Agency (FEMA) within the City. Based on the historic records of flood events and the detail to which streams have been studied and floodplains delineated within the City by FEMA, it is clear that flooding is a significant problem.

The City has put forth significant effort to address its flooding problems. Evidence of this is the City's involvement in the National Flood Insurance Program (NFIP) Community Rating System (CRS). Community participation in the CRS is voluntary. There are 10 CRS classes based on a point system that assigns a rating: Class 1 requires the most credit points and gives the greatest premium reduction; Class 10 receives no premium reduction. A minimum of 500 points is required to receive a CRS classification of Class 9. A table describing activities and their point values is included in Appendix D of this memorandum (FEMA, 1999). Petaluma is currently rated as Class 5. 6

The City of Petaluma maintains a NWS Automated Local Evaluation in Real Time (ALERT) emergency flood warning system which provides real-time water level conditions for the Petaluma River and Willow Brook Creek during flood events. The ALERT system consists of nine precipitation gages distributed throughout the watershed and eight river stage gages. Alarms are triggered if either the water surface elevation exceeds the set point or if the rate of rise exceeds the set rate for a particular gaging station location. Members of the Department of Water Resources and Conservation maintenance crews are paged when the trigger values are reached.

Surface Water Modeling/Floodway Mapping

The City utilizes a surface water management model (XP-SWMM) as a tool to provide hydrologic and hydraulic solutions for the Petaluma watershed. Future use of the model will include evaluation of changes to the watershed and conveyance system and the effects of those changes, model or simulate modifications or improvements to test their effectiveness or impacts, project review, verification of applicant submitted watershed impact reports, and prioritization of City capital improvement projects. The XP-SWMM model will also be used for the remapping of the regulatory Floodway and Floodplain through the Federal Emergency Management Agency (FEMA), when additional work is concluded to allow the remapping process to proceed. Until that remapping occurs, the 1989 FEMA Flood Insurance Rate Maps (FIRMs) will remain as the City's regulatory means to delineate the Floodway and Floodplain. The creation of the Petaluma River Corridor (PRC) within this General Plan provides for designating the area of concern for preservation of habitat and flood conveyance improvements.

Water Quality

The United States Environmental Protection Agency's (EPA) Clean Water Act regulates discharge from storm drain systems in order to reduce surface water pollutants and improve water quality. The Phase II National Pollutant Discharge Elimination System (NPDES) rule, adopted by the EPA and administered by the San Francisco Bay Regional Water Quality Control Board, requires operators of small municipal separate storm sewer systems to obtain a NPDES permit and implement programs and activities to reduce pollutants in storm water runoff. The City of Petaluma, as an operator of a municipal storm drain system prepared a Storm Water Management Plan and began implementation of this Plan in March 2003, in order to comply with the Phase II NPDES requirements. The Plan acts as the City's permit, describing actions that include best management practices, measurable goals, and timetables for implementation six minimum control measures, as

follows:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Storm Water Runoff Control
- Post-Construction Storm Water Management
- Pollution Prevention for Municipal Operations

Implementation of the Plan, as it relates to existing and future land uses, including the development of a dedicated funding mechanism, is necessary to ensure water quality is protected and improved through the planning period.

OPERATIONS & MAINTENANCE

Responsibility for maintenance of the open channels within the City is shared between the City and SCWA. SCWA has also previously been involved in planning efforts and produced the Petaluma River Watershed Master Drainage Plan, which was completed in 1986, updated in 2003 and is still used today as a guide for development of channel improvement projects within the watershed.

The open channels within the City range from heavily vegetated, as in the case of the Petaluma River downstream of the Corona Road Bridge, to concrete lined channels, as in the case of portions of East Washington Creek. Maintenance of these channels historically included clearing vegetation from the bottom of the natural channels by SCWA with heavy equipment to maintain hydraulic capacity. SCWA discontinued that practice in 1987 at the request of the California Department of Fish and Game (DFG). As a result of this reduction of in-channel maintenance work, hydraulic capacity has been reduced as the channels become choked with vegetation and debris, thereby exacerbating flooding problems. The change in maintenance practices for open channels has undoubtedly resulted in reductions in the conveyance capacities of those channels. There are numerous locations where the amount of vegetation in the main channel is as dense as that in the overbank areas. As proposed development and habitat enhancement projects continue, this change in character of the open channels will need to be addressed to ensure that the current true hydraulic capacity of these conveyances is taken into account for future planning, design and implementation.

Current City of Petaluma standards for storm drainage are as follows:

- 10-year storm - The entire area needs to drain into a pipe.
- 25-year storm - Runoff can pond in streets.
- 100-year storm (FEMA BFE) - Needs to stay out of habitable areas (finished floors must be above 100-year flood level). The 100-year storm is 6 inches of rainfall in 24 hours.
- Designated areas (upstream of Payran Street bridge) - Floors need to be 2 feet above 100-year flood. (Approach is similar to FEMA requirements.)
- There is an option to provide detention storage to offset increased runoff.

The City adopted a Storm Water Management Program on March 3, 2003 as part of its application for a National Pollution Discharge Elimination System (NPDES) Storm Water Phase II Permit. The City's application was accepted by the San Francisco Bay Regional Water Quality Control Board; therefore the City now operates under the Statewide General Stormwater Permit.

The City also maintains Storm Drain Design and Construction Standards and Specifications. These include guidance for design and construction of manholes, catch basins, sidewalk underdrains and other items appurtenant to storm drainage systems. The Restoration Design and Management Guidelines for the Petaluma River Watershed is to provide reference information, procedures and guidelines for the integrated management and maintenance of stream corridors and flood control channels within the Petaluma River Watershed. The goal of the document was to provide a reference document for those involved in day-to-day maintenance and management (Questa, 1996). In Volume I, "Restoration and Revegetation Design", vegetation, wildlife, and revegetation techniques within the Petaluma Watershed are described and an assessment and inventory of those resources is presented. Volume II, "Management for Stream Corridors", predominantly concentrates on riparian vegetation including landscape maintenance practices and streambank stabilization guidelines.

Dredging. Currently, the USACE dredges the Petaluma River from the head of the navigable waters located at

The Turning Basin in downtown Petaluma, on a four year cycle. The tonnage of commercial products moved on the River is the USACE method for determining if dredging for navigation is economically justified. Recreational use of the river, which is significant, is not a part of the Corps economic justification criteria. In the future, as property values increase, some industries may relocate away from the riverfront, thereby reducing the annual commercial shipping tonnage. Without industrial shipping there may not be enough justification for continued navigation maintenance dredging on the Petaluma River. If navigation channel maintenance dredging were discontinued, this would negatively impact the hydraulic capacity of the new Payran flood control project as sediment accumulates without periodic removal. The locations where dredging spoils are placed on the shore require periodic maintenance work to prevent erosion of the banks. Alternative funding, through the creation of an Assessment District, should be pursued to guarantee dredging is performed, in perpetuity.

CAPITAL IMPROVEMENT PROGRAM / RESTORATION

Sonoma County Zone 2-A funds pay for some storm water capital improvement projects within the City. The Southern Sonoma County Resource Conservation District, (RCD) the local component of the Natural Resources Conservation Service of the U.S. Department of Agriculture (USDA) also conducts small watershed restoration projects in the Petaluma watershed. The Petaluma Watershed Enhancement Plan is the guiding document for RCD's activities within the watershed. Completed in 1999 by the RCD, the enhancement plan did not use the 1986 SCWA master plan as a starting point, and is significantly different in nature. The following four goals are identified in the enhancement plan:

1. Goal A- Establish a local watershed council for residents and other organizations to fund and coordinate watershed enhancement activities and keep one another informed.

2. Goal B- Improve water quality and groundwater recharge in the Petaluma Watershed with the ultimate purpose of removing the Petaluma River from the RWQCB impaired water body list 303d.

3. Goal C- Support the viability of agriculture in the community.

4. Goal D- Conserve and enhance existing wildlife habitat.

A Surface Water Operation and Maintenance Plan (SWOMP) has been developed as a part of an overall Surface Water Master Plan. The SWOMP describes the requirements for personnel, equipment, materials and other budget expenditure estimates necessary to properly maintain the surface water system (System) and meet the requirements of the U.S. Environmental Protection Agency Storm Water Phase II Final Rule. Benefits beyond providing storm water conveyance systems will also be gained from the City's SWOMP. Improvements can be expected in overall water quality within the system and to downstream areas. Proper design of stream channels combined with the improved maintenance activities can also result in better protection of riparian habitats, provide necessary facilities for preservation of fish and other aquatic species, provide for recreational and groundwater recharge opportunities.

See Also Chapter 4: The Natural Environment for discussion on the Petaluma River, natural environs and preservation/restoration goals and policies.

Goal 8-G-8: Surface Water Management

Provide surface drainage and flood protection facilities to meet the community's needs of reducing flood hazards and potential property damage.

Policies and Programs:

8-P-28 The area upstream of the Corps weir, and below the confluence of Willow Brook Creek with the Petaluma River, located within the 1989 FEMA floodplain (and any amendments thereto) and adjacent to the Petaluma River, shall include a Petaluma River Corridor (PRC) set aside for the design and construction of a flood terrace system to allow the River to accommodate a 100-year storm event within a modified River channel, to the extent feasible given existing physical and natural constraints.

A. The Water Resources and Conservation Department shall work with the Community Development Department to insure the PRC is implemented.

B. Maintenance, in perpetuity, of the PRC and applicable flood terrace, storm water flow capacity, environmental habitat and public access improvements shall be maintained,

through a funding mechanism approved by the City.

8-P-29 The City of Petaluma, SCWA, Sonoma County and other responsible agencies shall be encouraged to work together in order to create and adopt a flood management plan, or plan amendment to the Petaluma River Watershed Master Drainage Plan (SCWA, June 2003), for the Petaluma River watershed implementing the following regional surface water solutions; or a reasonable segment thereof:

A. Establish a Petaluma River and creek corridor setback for the design and construction of a flood terrace system to allow the Petaluma River (Corona and Denman Reaches), along with Willow Brook, Marin, and Liberty Creeks to accommodate a 1% (100-year) storm event within a modified channel section to the extent possible given existing natural and physical constraints.

B. Work with Sonoma County to create interim development standards for that setback area until such time as studies are concluded and approved by Sonoma County, the SCWA, the City of Petaluma, and other responsible agencies. Thereafter all lands affected shall set aside the necessary river and/or creek corridor areas and, as development occurs, shall undertake the identified surface water containment enhancement improvements to accommodate improvements envisioned in Program A, above. The following components, at a minimum, shall be included in the interim development standards called for above:

- Compliance with No Net Fill.
- Elevation of finished floor at least two feet above Base Flood Elevation (BFE).
- Construction of a flood terrace in the setback area to convey the 1% (100-year) design storm, to the extent possible, in accordance with City and SCWA requirements.
- Payment of an hydraulic/hydrology model update fee for evaluating the proposed project, the cumulative impacts and the related mitigations, to the regional surface water conveyance system.
- Payment of a proportionate share of regional flood reduction mitigation costs.

C. The City will work with the County to ensure that zero net fill policies are enforced within the unincorporated area for areas within the regulatory floodplain of the Petaluma River and its tributaries.

D. Working with Sonoma County, the City shall develop a plan and identify funding opportunities to acquire and remove existing structures within the regulatory floodway of the Petaluma River and its tributaries. The Plan shall be updated as needed to maintain consistency with changes in regulatory mapping of the floodway.

E. Participate with the County in implementation of the regional components of the Petaluma River Watershed Master Drainage Plan (SCWA, June 2003), Petaluma River Floodplain Management Plan (City of Petaluma, October 2001, Petaluma River Access and Enhancement Plan (City of Petaluma, May 1006, Sonoma County General Plan 2020 (Public Safety Element) and the City of Petaluma General Plan 2025.

8-P-30 Within a 200' setback from centerline of the Petaluma River, within the UGB, no additional development shall be permitted on lands within that 400' wide corridor, given natural and physical constraints, unless the proposed development fully complies with the interim development standards as defined in 8-P-29 B, until such time as the study referred to in Policy 8-P-29-B is concluded and approved by the SCWA and City of Petaluma. Thereafter all lands affected shall set aside the necessary river and/or creek corridor areas and, as development occurs, shall undertake the identified surface water containment enhancement improvements.

A. The watershed model, XP-SWMM or updates thereto, shall be maintained, in cooperation between the City and SCWA, to assist in the evaluation of development proposals and in the design of regional watershed improvements to reduce flood elevations.

B. Proposed development applications may be charged a model update fee to cover costs associated with evaluating a specific proposal for project specific and cumulative impacts to the regional surface water system.

C. On-site and off-site improvements, deemed necessary by the City of Petaluma, to reduce the surface water impacts associated with a specific development proposal shall be designed, constructed, and maintained in perpetuity at the cost of the development associated with said impacts.

8-P-31 In accordance with the studies undertaken for the Corps Flood Protection Project, existing areas subject to periodic surface water inundation and containment, within the Corona and Denman Reaches (Lynch Creek confluence with the Petaluma River upstream to the Old Redwood Highway over-crossing of Willow Brook Creek), shall be preserved and enhanced where feasible to reduce localized flooding.

A. The Department of Water Resources and Conservation shall work with the SCWA and the Community Development Department to insure the protection afforded by the Payran Corps Flood Protection Project is not compromised by proposed development.

B. Continue to work with SCWA for the on-going efforts to maintain or improve historic channel capacity for flood waters.

8-P-32 Areas within the Petaluma watershed, outside of the City of Petaluma, which are subject to periodic surface water inundation and containment, should not be modified in any manner to reduce the historic storage characteristics and capacity.

A. Department of Water Resources & Conservation shall work with Sonoma County, SCWA, and other responsible agencies to preserve and expand detention basin capacity within the Petaluma River watershed and maintain or reduce peak discharge volumes from Willow Brook, Marin, Liberty and Lichau Creeks.

B. The City shall work with the County of Sonoma to establish a zero net fill policy for detention basins and areas within the regulatory floodplain within the Petaluma River watershed in order to preserve and enhance basin capacity and to ensure no detrimental impact to downstream flows, including the increase in peak discharge volumes in the downstream areas.

8-P-33 The City shall continue to implement mandatory zero-net fill upstream of the Payran transition weir, and when appropriate utilize zero-net runoff, to assess site-specific impacts and identification of mitigations.

A. The Development Code shall be amended to include the dirt, existing or fill, between the regulatory 100-year flood elevation and the required minimum elevation for the first finished floor in the calculation of zero-net fill displacement or placement. Any project within an area subject to inundation in a 1% (100-year) storm event shall include site specific analysis of impacts and identification of mitigations.

8-P-34 Utilizing XP-SWMM, the City shall diligently pursue the remapping and updating of the regulatory Floodway and Floodplain, through the Corps of Engineers.

Goal 8-G-9: Surface Water Management:

Preserve the design conveyance capacity of the surface water drainage system.

Policies and Programs:

8-P-35 Protect private and public properties and capital investments including those designed to minimize flooding potential.

A. Work with SCWA, regulatory agencies, and/or property owners, as appropriate given maintenance authority, to insure maintenance of the engineered channels, natural creeks, and enclosed surface water system.

B. Support continuation of Zone 2A parcel tax for funding regional surface water improvements.

C. Work with regulatory and advisory agencies to facilitate preservation and environmental enhancement of the natural corridor for species of importance and native to the area.

D. Promote public education and stewardship of the riparian corridors.

E. Work with the U.S. Army Corps of Engineers to dredge the river channel downstream of the transition weir to maintain the 100-year design conveyance capacity and navigable channel.

F. Initiate the formation of an Assessment District, or other funding mechanism, to ensure periodic dredging occurs and the dredge materials disposal site is maintained.

G. The City shall continue to inspect and maintain the conveyance capacity of open channels and the piped system within our authority.

H. The City shall facilitate and advise property owners to ensure the maintenance of privately owned creeks and channels (e.g. Kelly Creek). Assistance may include facilitation of regulatory permitting and design standards.

I. Continue to evaluate, and take appropriate action, to monitor and maintain the adequacy,

safety, and strength of existing berms and levees and other flood protection/reduction facilities.

J. The Development Code shall require the identification of any disposal site for excavated soil and require that any disposal be located outside the regulatory floodplain within the Planning Referral Area.

K. Monitor changes in tide elevations and related effects on Petaluma River tidal levels over time in order to determine if there is a trend that increases the level of Mean Higher High Water, as determined by the Corps of Engineer.

- Assess the effect of any such trend or changes on habitable structures in the regulatory floodplain.

L. Require flood protection of new or significantly remodeled first floor habitable structures within the regulatory floodplain.

M. Continue to monitor precipitation data in order to maintain current data in the XP-SWMM model.

N. Improve the data available for the XP-SWMM model. Add stream level gages at the following locations:

- Petaluma River at Petaluma Blvd. (southbound bridge)
- Petaluma River at the railroad trestle bridge downstream of Corona Creek
- Corona Creek at McDowell Blvd.
- Capri Creek at McDowell Blvd.
- Adobe Creek at Lakeville Road
- Lynch Creek at Maria Dr.
- Lynch Creek at McDowell Blvd. or HWY 101 (northbound)
- Washington Creek at McDowell Blvd. or HWY 101 (northbound)
- East Washington Creek at Washington St.
- Petaluma River at HWY 101 (southbound bridge)

8-P-36 Require development on sites greater than 1/4 acre in size to demonstrate no net increase in peak day stormwater runoff, to the extent deemed practical and feasible.

8-P-37. No new inhabited structure or development shall be permitted within that portion of properties containing areas of water depths exceeding one foot as illustrated in Figure 8-2, unless mitigation and/or on-site or off-site improvements are constructed to reduce the 100-year flood depth to less than one foot.

A. The City shall maintain a 2-D model of the Petaluma River within the City of Petaluma and continue to work with SCWA to achieve a 2-D model for the Petaluma Watershed.

B. Utilizing the 2-D model, the City of Petaluma will work with SCWA to identify, design, fund, and construct regional solutions to minimize the flooding impacts associated with historic and increasing out-of-bank flows which occur from increasing storm flow and velocity from out-of-City areas into the City.

C. Working with Sonoma County, the City will continue to ensure that zero net fill policies are enforced within the unincorporated area for areas encumbered by the regulatory floodplain of the Petaluma River.

D. Utilizing an approved modeling tool, the City shall diligently pursue the remapping of the regulatory Floodway and Floodplain, through the Corps of Engineers, following the completion of the Payran Reach Corps project.

E. Working with Sonoma County, the City shall develop a plan and identify funding opportunities to acquire and move, relocate, or demolish housing, which remain located within the regulatory Floodway, once remapping occurs.

F. Until remapping of the regulatory floodplain occurs, new residential development in the 100-year flood boundary area as illustrated in Figure 8-1, with depths of less than one foot of water during a 100-year storm event will be required to elevate the lowest floor two feet (2') above the BFE as determined by the City 2-D model.

G. New non-residential development in the 100-year flood boundary area, identified in Figure 8-1, with less than one foot of water depth during a 100-year storm event will be required to provide flood protection at least 1 foot above the BFE, or elevate the lowest floor two feet above the BFE.

H. Residential development shall be prohibited on the first floor of new structures within the regulatory floodplain after remapping of the FEMA floodway/floodplain.

I. After remapping the City should pursue acquisition of properties in the regulatory Floodway and seek funding

for implementation of surface water improvements and riparian habitat enhancements.

J. Consider development of a program whereby projects may acquire property(ies) and construct planned flood terracing and/or detention/retention facilities as mitigation for surface water impacts. The result of the improvements must result in an improvement to the pre-project conditions by way of a net reduction in storm water elevations and downstream flows.

Goal 8-G-10: Water Quality

Reduce pollutant load in surface water runoff, thereby improving water quality within the Petaluma River and its tributaries.

Policies and Programs:

8-P-38 All development activities shall be constructed and maintained in accordance with Phase 2 National Pollutant Discharge Elimination System (NPDES) permit requirements.

A. The Water Resources and Conservation Department shall review, and have the authority to conditionally approve, all development permits to insure compliance with NPDES Phase 2 requirements.

B. Maintain, update as needed, and implement the City's Storm Water Management Plan to retain a current storm water discharge permit with the California Regional Water Quality Control Board.

C. A funding mechanism, such as a storm water utility fee, shall be implemented by the City to insure a dedicated source of funds is available for all surface water drainage system maintenance and improvement needs.

Goal 8-G-11: Sustainable Site Planning

Improve natural hydrologic functions and water quality through sustainable site planning.

Policies and Programs:

8-P-39 Consider, to the extent practicable, requiring sustainable site design practices as outlined in the 'Sustainable Site Planning' text box contained herein.

City of Petaluma

Floodplain Management Plan

October 2010

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from another storm on February 29, 1998. State and Federal governments declared the winter storms and flooding a disaster, and FEMA designated the event as "FEMA – 1203 – DR". The greatest damage was to the homes in the Payran area and businesses in the Industrial Avenue/Auto Center Drive area. The oxidation ponds at the City of Petaluma's wastewater treatment facility were damaged once again. Considerable silt buildup in the Turning Basin required dredging, and many roads in the City suffered damages. On February 20, 1998 in an article titled "More Rain, More Havoc" the San Francisco Chronicle reported:

> *"A flash flood caused the Petaluma River to jump its banks and spill into the streets and homes of the hard-hit Payran area of Petaluma. It was the third time in three weeks that the low-lying community has been flooded. Nearly 50 homes were evacuated and cars parked by the river were nearly submerged. Petaluma firefighters used an inflatable boat to rescue a few stragglers. Others waded out of the neighborhood through streets that had as much as three feet of water.*
>
> *"Meanwhile, nearly 30 seniors were evacuated from the Leisure Lake mobile home park north of Petaluma when Stony Point Road flooded, cutting off automobile access to the community."*

Most recently, on December 31, 2005, the City again experienced significant flooding, particularily in the middle and northern areas of town. It is estimated that approximately 53 structures, not including mobile home parks, were damaged by flood waters at an approximate cost of $56,000,000. There was also damage to local streets and river channel banks as a result of the flooding. The greatest damage from this event was located within the Petaluma Factory Outlets, commercial structures and three of the City's mobile home parks. The Payran reach was not adversely affected by this flood, which is mainly attributable to a majority of the Petaluma River Flood Control Project being in place. The flooding event was declared a State and Federal disaster.

On December 29, 2006, the Press Democrat published the following excerpt from a year in review article:

> *"The New Year's Eve flood was the biggest news story of the year. The flooding - the most severe since 1997 - caused $56 million in damage, most of it in north Petaluma. In some cases, it took property owners months to recover. Hardest hit were businesses near the Petaluma River, including the auto mall, where hundreds of cars were damaged, and the outlet mall, where 1 to 2 feet of muddy water poured into many shops."*

(Aerial view of Factory Outlet Mall flooding, 12/31/05)

2.3 Designated Floodplains and Flood Data

Approximately 1880 acres of the City of Petaluma lie within the FEMA designated 100-year Special Flood Hazard Area (SFHA), shown in Figure 2. In addition, 112 acres of this area are a designated floodway.

In December of 2008, under the map modernization act, FEMA issued updated flood insurance rate maps known as D-FIRMS. The D-FIRMS are very similar to the 1989 FIRM's for Petaluma and are essentially an electronic version of the 1989 FIRM data. The D-FIRMS also include new information that the 1989 maps did not include such as aerial photography. The data is helpful in better determining floodplain locations. The D-FIRMS do not include revised floodplain boundaries based on post 1989 development and structural flood control projects. However, the City of Petaluma is currently in the application process with FEMA staff on the updated watershed wide hydraulic and hydrologic data, which will be used to modify the current D-FIRMS. Based on the remaining flood control project schedule and status of the remapping effort, it is anticipated that new D-FIRMS will be issued by FEMA in less than two years.

In addition to the FEMA FIRM maps, the City of Petaluma created and adopted "Figure 8.1, 100-year Flood Boundary General Plan 2005 build out." The exhibit with its defined

boundary was created to identify limits of the New Year's Eve 2005 flood event and develop policies within the General Plan 2025 that require new development to comply with higher regulatory standards than those defined by FEMA. The limits of this floodplain boundary were determined by a post flood aerial and ground high water mark/debris line survey.

Historically, there are two main areas of significant flooding along the Petaluma River. The first area, lying between Denman Flat and the confluence of the Petaluma River with Lynch Creek, consists mainly of commercial, industrial, retail and undeveloped properties. The second area, located between the Lynch Creek/Petaluma River confluence and the Lakeville Street Bridge, consists mainly of residential properties developed during the 1960's. This residential area is referred to as the Payran reach Floodplain. Significant flooding can occur in the urbanized "Payran Reach" between the Lynch Creek confluence and the Lakeville Street Bridge. However, as of October of 2010, over 90% of the Petaluma River flood control project has been constructed. The project consists primarily of a trapezoidal channel with steel sheet pile walls along the Payran Area of the Petaluma River. The flood control project was designed flood protection in the Payran Area for the 100-year event. The Payran Area did not flood during the December 31, 2005 event.

Most of the City has been mapped as AE areas, with determined base flood elevations. There are also two areas mapped as zones AO, which indicates sheet flow on sloping terrain. One area in the City has been classified as Zone AH, which represents an area of ponding. The floodplain area from Denman Flats to Lynch Creek consists of all three of these Zones, while the Payran Area Floodplain is fully zoned AE. The average depth in both Zones AO and AH is one to three feet:

1) AO - East of Rt. 101, bounded by Old Redwood Highway and Corona Creek;
2) AO - Slightly North along US 101 from the Old Redwood Highway intersection;
3) AH – Northwest of Capri Creek between US 101 and McDowell Blvd. North.

Characteristic floods in the Petaluma River Basin are normally of short duration, lasting a few hours to one or two days. Floods on the Petaluma River may develop within hours after the beginning of a flood-producing storm and begin to recede within hours of the end of the storm. Although floods have been recorded as early as November and as late as April, most occur between December and February after prolonged rainy periods, which fully saturate the soil, increasing runoff volume. Flooding can occur along the entire length of the River.

- Goal: Prepare and distribute to all real estate agencies a brochure that advises potential buyers to investigate flood hazards for properties they may consider purchasing;

  Status: The City has created a brochure, which is distributed as part of the City annual outreach program, that advises potential buyers to investigate flood hazards on properties they consider purchasing.

- Goal: Update Sonoma County Water Agency's Master Drainage Plan

  Status: The Sonoma County Water Agency updated its Master Drainage Plan in June of 2003, with input from City of Petaluma staff. The updated plan includes proposed flood control projects and associated cost estimates. The plan is available for public viewing at City Hall, in the Public Works and Water Resources Departments.

- Goal: Explore opportunities to fund the acquisition/relocation of properties in the repetitive loss areas of the floodplain;

  Status: The City participated with the Association of Bay Area Governments (ABAG) in creating a Multi Hazard Mitigation Plan as part of disaster mitigation (DMA 2000) requirements. The MHMP enables the City to apply for grants to acquire and/or relocate properties from the repetitive loss area within the floodplain. Additionally, the General Plan 2025 includes policies for the City to pursue acquisition/relocation grants.

<u>New Goals for the 2010 FMP:</u>

- Increase community outreach efforts to local development community by sponsoring floodplain management workshops in conjunction with the State National Flood Insurance Program coordinator.

- Continue to train new and update existing City Planning, Building and Public Works staff on NFIP, CRS and City floodplain management requirements.

- Continue annual stream and creek channel maintenance in accordance with established City, Sonoma County Water Agency and other regulatory requirements.

- Secure funding and complete the remaining Petaluma River Flood Control project. The project is currently scheduled to be completed by summer of 2011.

- Obtain certification from the Army Corp of Engineers for the flood wall and flood control project; complete acceptance of the project by the City.

- Pursue certification of existing levees that protect the City's waste water treatment plant and wetlands.

- Complete the City's XP-SWMM model and be cooperating technical partner with FEMA and the SCWA.

- Update the City's Flood Insurance Rate Maps once the flood control project is complete and certified by the Army Corp of Engineers.

- Pursue obtaining an A99 designation, from FEMA, for the Payran area until new FIRM maps are issued.

- Pursue the acquisition of McNear Peninsula as open space and natural and beneficial areas.

- Implement General Plan 2025 policies regarding Petaluma River Corridor terracing to accommodate a 100-year storm event, to all extent practicable.

- Coordinate the City's PH II Storm Water Management Plan update with requirements of the NFIP, CRS and the City floodplain ordinance.

- Coordinate flood control and maintenance projects with the Zone 2A Flood Advisory Committee.

- Convert the City's benchmark system from NGVD 1929 to NAVD 1988 to be consistent with the new FIRMS.

- Work with the Army Corp of Engineers to dredge the Petaluma River channel within the new flood control project area to preserve flood design capacity.

- Monitor and update the City's stream level gauge system and expand as needed to maximize the use and effectiveness of the data in the operation of the Flood Alert System.

- Encourage local, State and Federal agencies to fund stream maintenance programs; pursue grants for increasing flow capacity in conjunction with stream enhancement projects.

- Work with the Fire Department to update the telephone information hotline and notification system. Establish a more effective distribution system, such as a mailer in the City water bill, notifying residents of who to call for flood information.

and non-structural conveyance facilities. The results of the study have been incorporated into the General Plan 2025, and has enabled the City to develop and adopt new general plan policies and regulations for new development or redevelopment within City limits as well as to work with Sonoma County Water Agency through the Zone 2A Committee to address regulations for new construction in the Petaluma River watershed. City staff is currently working with FEMA, using the new XP-SWMM storm water model to update the Flood Insurance Rate Maps, which will include the Petaluma River flood control project structural improvements.

Lower threshold for substantial improvements The City currently maintains a 50% threshold for substantial improvements, which meets the minimum requirements of the National Flood Insurance Program, to properties in the floodplain.

Protection of critical facilities The TAC committee considered the preventive action of prohibiting new critical facilities from the 500-year floodplain and/or requiring new and substantially improved critical facilities to be protected from damage and loss of access as a result of the 500-year flood. These activities were determined to be infeasible due to the severe limitations they would place on infill development and commercial activity and because of the expense of required retrofitting for such facilities.

Low Density Zoning The TAC members briefly reviewed the basic requirements of this activity. The City's new General Plan has established new land use designations, which includes development intensities, for all properties with its influence. The plan creates a 400-foot wide "River Plan Corridor" land use classification which requires preservation of natural and beneficial functions, open space preservation, development setbacks, and allows for peak storm water flows. Also, since the City of Petaluma is fairly developed at this point in time, low density zoning, as defined by the CRS Program is not feasible in the floodplain. The General Plan prohibits first floor residential uses in the floodplain, which would be inconsistent with allowing low density residential development.

Public Maintenance of Required Facilities The City continues to require that Homeowner Associations (HOAs) or other private maintenance entities inspect and clean drainage facilities on private developments. However, the City does not inspect the facilities with its own crews. It was decided that it would be difficult to justify the additional City funding necessary to hire additional staff to perform such inspections. The City has the ability to enforce its storm water ordinance through an established code enforcement program. Also, the City and Sonoma County Water Agency do perform routine inspections and maintenance of open channel and piped storm drain systems within their respective jurisdictions. The City's new General Plan includes policies, 8-P-35(A, E and G), that requires storm water system inspection and maintenance. Additionally, the General Plan

contains policy 8-P-35(H) which is to advise property owners to ensure maintenance of privately owned creeks as well as facilitate necessary regulatory permitting and design standards for such maintenance. Other agencies within the City of Petaluma watershed, such as the County of Sonoma, SCWA and Southern Sonoma County Resource Conservation District have established creek maintenance and enhancement plans for their respective jurisdictions. Typical maintenance activities include removal of non native species and clearing of overgrown vegetation. All maintenance work is subject to regulatory agency permitting requirements.

The City Water Resources and Conservation District has created a creek stewardship program to facilitate increased resident participation and responsibility for maintaining privately owned creek corridors in a manner capable of conveying flood flows while preserving riparian habitat values.

5.2 Property Protection Activities

Property protection activities that have been conducted in the past by the City of Petaluma include:

- Removal of two residential structures from the special flood hazard area. These structures were located at 529 Madison Street, which is owned by Clover-Stornetta Farms.
- Acquisition / relocation of 11 other properties within the floodplain.
- Requiring elevation certificates for any new floor area built or substantial improvements to properties in the floodplain and;
- Participating in the CRS program to reduce the insurance premiums for floodplain residents.
- The City has incorporated elevation certificate data into a computer format using the software available from FEMA.

As part of this FMP update, the TAC discussed the following activities, which were identified in the 2001 FMP for property protection and agreed to continue to pursue as appropriate:

Removing Structures from the Floodway The Water Resources element of the new General Plan includes policy 8-P-29(D) which states that the City shall develop a plan and identify funding opportunities to acquire and relocate existing structures within the regulatory floodway. The City has recently adopted a Multi Hazard Mitigation Grant Plan, through the Association for Bay Area Governments, which enables the City to qualify for Flood Mitigation Assistance and Pre-Disaster Mitigation funding.

6.5 Structural Projects

The City of Petaluma is involved in both channel modification and local storm drain improvement projects. As mentioned in Section 6.3 of this FMP update, the City has a "Surface Water 2010-2014 Localized Flooding Reduction Projects" list that identifies and prioritizes flood reduction projects, cost estimates, funding sources and timelines. This list is hereby incorporated as part of this FMP update. The following local storm drain improvement projects are a sample from the flooding reduction projects list and will continue as part of this Floodplain Management Plan.

6.5.1 Petaluma River Flood Control Project The City of Petaluma is committed to completing this joint effort with the Army Corps of Engineers to provide 100-year level of flood protection in the Payran area. Timetable: the remaining work includes installation of a short section of sheet pile channel wall upstream of Lakeville Street, excavation of the transition channel downstream of Lakeville Street and installation of rock rip-rap along the river bank downstream of the Payran Street Bridge; Approx. Budget: TBD; Source of funding: Federal Funds; Schedule: Completion by summer of 2011.

6.5.2 Local Storm Drain Improvements The City of Petaluma currently has a Capital Improvement Plan (CIP) through Fiscal Year 2010-14. There are 23 projects that have been identified to expand the drainage system and alleviate local flooding by re-contouring creeks to increase flow capacity, adding or improving inlets to existing pipelines or installing new pipes. Some of the detailed improvements include:

- Capri Creek (North McDowell to Maria Drive); Re-contour Capri Creek between North McDowell Boulevard and Maria Drive, along Sunrise Parkway to reduce out of bank flooding of private property. Timetable: 2010-2014; Budget: $198,000; Source of Funds: Storm Drain Mitigation Fees, Zone 2A Assessments.

- Phase III/IV terracing projects (lower Denman reach, between the twin bridges at Petaluma Blvd. North and Corona Road); The purpose of these projects is to increase floodplain capacity in this reach while reducing localized flooding. Timetable: staff expects a decision in fall of 2010 on whether or not the City was awarded a grant; Budget: $1,400,000; Source of funding: Sonoma County Water Agency Zone 2A, State Department of Water Resources Grant and possible participation from private property owners.

- Kelly Creek (at Sunnyslope Avenue); Reconstruct confluence of Kelly Creek and utility lines at Sunnyslope Avenue and extend storm drain

pipe to nearest storm drain system with sufficient capacity. Timetable: 2010-14; Budget: $450,000; Source of Funds: Storm Drain Mitigation Fees and Zone 2A Assessments.

- Adobe Creek (Eastern most undercrossing of Casa Grande Road); Creation of a sediment and debris basin directly adjacent to Casa Grande Road, within the golf course, just upstream of the two box culverts and 90-degree bend. Timetable: 2010-14; Budget:$220,000; Source of Funds: Storm Drain Mitigation Fees and Zone 2A Assessments.

- Re-contour outfall and swale to reduce ponding on Copeland Street at entrance to park, install drop inlets on Copeland and East D Streets and connect to existing storm drain piping to reduce localized flooding on adjacent private properties. Timetable: 2010-14; Budget: $30,000; Source of Funds: Storm Drain Mitigation Fees.

- Lynch Creek (Upstream of Castle Drive); Stabilize bank and install rock rip-rap and backfill. Plant with vegetation to minimize future scouring and erosion. Timetable: 2010-2014; Budget: $38,000; Source of Funds: Storm Drain Mitigation Fees; and/or homeowner financed landscape assessment district funds.

- Zone 2A Flood Control Projects – There were seven new projects added to the Zone 2A CIP for FY 10-11 through FY14-15. These projects are included in this FMP update and are listed in detail in Appendix C. The projects include: Ellis Creek Channel Maintenance Project, Adobe Creek Sedimentation Basin feasibility study, Capri Creek flood capacity study, Petaluma River (Corona reach) overflow channel study, Kelly Creek at Sunnyslope Avenue pre-design, Lynch Creek check structure reconstruction, Washington Creek repair and enhancement project. Refer to the Sonoma County Water Agency Capital Projects Plan, dated FY 2010/2011 to 2014/2015. Timetable: 2010-15; Budget: $7,003,000; Source of Funds: Petaluma River Zone 2A assessments, pursuit of grants, when available.

6.6 Public Information Activities

The public's response to the City's questionnaire mailed to all the residents and property owners in the floodplain indicated that residents in the City's floodplain wish to be better informed of flood protection activities and flood awareness issues. The TAC members committed to continuing the City's current outreach efforts and expanding them, as presented below:

Pam Hull
DWR&C
City of Petaluma

Petaluma Watershed Enhancement Plan

An owner's manual for
the residents and landowners of
the Petaluma Watershed

Prepared by:
The Southern Sonoma County
Resource Conservation District
in conjunction with the people
of the Petaluma Watershed

Funding provided by:
The State Water
Resources Control Board

July 1999

SOUTHERN SONOMA COUNTY
RESOURCE CONSERVATION DISTRICT
1301 REDWOOD WAY, SUITE 170
PETALUMA, CA 94954

1.0 Executive Summary

The Petaluma Watershed Enhancement Plan was prepared through grant funding from the California Regional Water Quality Control Board (RWQCB). The Regional Board is currently focusing efforts on initiating watershed management planning for several counties, including Sonoma County. It is the RWQCB's belief that watershed planning and protection efforts will not be effective unless solutions are defined and implemented locally.

In compliance with the intent and purpose of the grant funding, the Southern Sonoma County Resource Conservation District (SSCRCD) issues this Watershed Enhancement Plan (Plan) in partnership with the many dedicated individuals from the AC established in 1997. During the Plan's two year planning process, the Advisory Committee determined the purpose, scope, and intent of the Enhancement Plan. The primary focus of the Enhancement Plan is the issues of concern of the agriculturists and landowners located outside of the Petaluma urban area.

The Advisory Committee met regularly to discuss their common issues and concerns and from these they identified goals for improving the watershed. One of the major issues for the landowners was the fact that the Petaluma River is not actually a river but is in fact a tidal slough or "tidewater estuary". This particular issue played an important part in the Committee's goal setting. See the History section 3.5 for more details. This particular issue played an important part in the Committee's establishment of future goals.

The majority of the landowners involved in this planning process are ranchers and farmers who care about the health of the watershed. They are interested in participating and contributing to the process of enhancing the watershed and sustaining agriculture in Sonoma County. The local landowners also realize that the criteria for water quality standards set for a river could be significantly more stringent than for a slough and could be unattainable. The main concern this created for landowners is the question of how to set water quality standards. With this in mind, the Advisory Committee realized that it would be prudent to remain involved in setting criteria for water quality standards within the watershed. Therefore, many of their goals reflect this interest.

At first, ten goals were identified and then through a process of strategizing and clarification, the Advisory Committee further refined and shortened the number of goals to four. These four goals and their accompanying objectives and recommended actions are described in detail with a time line for implementation in

Chapter 4.0. The four goals are listed as follows:

Goal A: *Establish a Local Watershed Council for Residents and Other Organizations to Fund and Coordinate Watershed Enhancement Activities and Keep One Another Informed.*

Goal B: *Improve Water Quality and Ground Water Recharge in the Petaluma Watershed with the Ultimate Purpose of Removing the Petaluma River from the RWQCB Impaired Waterbody List 303d*

Goal C: *Support the Viability of Agriculture in the Community*

Goal D: *Conserve and Enhance Existing Wildlife Habitat*

A fundamental assumption in attaining any of the goals in the Plan and/or following through with any of the recommended actions for enhancement in the watershed is the establishment of a Watershed Council. In turn, the success of the "Watershed Council" is directly related to the commitment and strength of the community and continuation of the existing Advisory Committee as it begins to evolve into a "Watershed Council." It is envisioned that the founding members of the Watershed Council would primarily consist of agriculturists and landowners from outside the urban community. Over time and with continued success, stakeholders from throughout the watershed would be invited to participate and work cooperatively on mutual goals.

Prunuske Chatham, Inc., an environmental consulting firm, specializing in ecological restoration and design, was hired to prepare supporting documentation on key technical subject areas such as erosion and sedimentation, land use, riparian enhancement, and marsh/bay habitats. These studies were originally entitled "summaries" and they are provided herein in their entirety and found as individual appendices of this document. Important information and analyses from these studies have been incorporated where appropriate, into the body of the Plan document.

2.0 Introduction

2.1 Purpose

The purpose of this document is two-fold: 1) to identify the existing conditions and issues from the perspective of the landowners and residents in the watershed, and 2) to state a set of goals, objectives and recommended actions that were collaboratively developed addressing specific issues and concerns. It is hoped that this Enhancement Plan for the Petaluma Watershed will serve as a guide for addressing the need for more information and outreach among stakeholders in the watershed and in identifying a focus of effort for a "Watershed Council" and it's recommended future actions.

The health of this watershed is affected by the many land use components making up our community. All activities within and beyond the City limits contribute to our watershed. This plan focuses primarily on the issues of concern related to the agricultural community of this watershed and lands beyond the Petaluma City limits. It is recognized, however, that urban land uses contribute significantly to water quality impacts such as erosion and sedimentation and the need for increased water supply and flood protection.

Representatives of the community and other entities came together to establish a collection of concerns for this watershed. In addition to issue identification, this group also established a number of actions and objectives to achieve major goals for the Petaluma Watershed. This plan was constructed primarily from the volunteer time and effort of the members of the AC. The issues and goals identified in this plan show the dedication and concern that members of the agricultural community have for the Petaluma Watershed.

2.2 Funding Source and Grant Objective

The funds to prepare the Petaluma Watershed Enhancement Plan were awarded to the Southern Sonoma County Resource Conservation District (SSCRCD) through a 205(j) grant from the California Regional Water Quality Control Board (RWQCB). The RWQCB's overall mission is to protect surface and ground waters of the San Francisco Bay Region. The RWCQB carries out this mission in many ways including regulation, enforcement, and pollution prevention. For example, RWQCB has administered a permit program for nearly two decades to control municipal sewage and industrial wastewater discharges. At the same time, urban and agricultural runoff discharges have continued mostly unchecked, and may contribute to the pollutant loading of rivers, streams, bays, lakes, and lagoons in the San Francisco Bay area. The RWQCB will be focusing much of their effort over the next few years on controlling pollution from these latter sources. The emphasis will be on preventing pollution before it occurs by managing resources more carefully, as opposed to cleaning up pollution "after the fact."

To help accomplish this, the RWQCB is focusing efforts on initiating watershed management planning for several counties, including Sonoma and Napa. In 1997, the SSCRCD prepared a similar Enhancement Plan for the Sonoma Creek Watershed. The RWQCB firmly believes that watershed planning and protection efforts will not be

effective unless solutions are defined and implemented locally. An effective watershed management plan requires formulating water quality goals and objectives for watershed protection and enhancement, and committing to specific tasks that will eventually allow the objectives, and ultimately the goals, to be met. Broad, local consensus on what preventative and remedial actions are needed and how they should be applied, are crucial to success of this Plan.

2.3 Stakeholders in Watershed Planning

This plan serves as a vehicle and voice for the local watershed residents and landowners. In general planning terms, the "stakeholder" is an individual or group entity such as a resident/landowner/agency/or other group who has a business, or other interest, responsibility, or jurisdiction regarding the health and well being of the watershed. Each stakeholder comes to the table and typically works on a level playing field with others. In a local work group setting, such as a "Watershed Council", the stakeholders would come together to share information and to work cooperatively on common tasks where they are united by a shared vision of watershed planning goals.

2.4 How to Use the Enhancement Plan

The Petaluma Watershed Enhancement Plan is a working document and represents the consensus of over two year's work. The Plan has been written as a guide for future watershed enhancement efforts in the Petaluma watershed. The Plan is broken into sections beginning with a summary, introduction, description of the watershed, the plan goals and objectives, and numerous technical appendices.

The Petaluma Watershed Enhancement Plan is designed for readers to reference in several ways. Some readers may have limited time and want only to absorb the main points, while others will be able to read every appendix. The list below identifies the most essential portions of the Plan, which should not be missed. In order to get the most out of your time spent with the Plan you should use the list below in conjunction with the Table of Contents to read the sections most appropriately fitting your time and needs. Many acronyms are used throughout the document and they are defined on Table 1.

For those readers who have limited time:

- Read Section 1.0, Executive Summary
- Read Section 2.1, Purpose
- Read Section 4.3, Enhancement Plan Goals, Objectives and Recommended Actions
- Review Table 4, Enhancement Goals - Potential Source of Funding and Technical Support
- Review Section 4.4, Summary of Appendices

"blanket" permit. This particular permit covers the regulatory authority of eight local, state, and federal agencies. This permit allows landowners to: 1) clean existing drain ditches (on their land only), and 2) take bayside earthen material to cap the existing levee on the bayside only.

Another permit is issued by the San Francisco Bay Conservation & Development Commission (BCDC). See section 5.0 Guide to Federal, State and Local Agencies & Permitting Requirements for BCDC permit information. The permits are typically renewable and the existing permit was issued for five years and is due to expire in March 2000. The SSCRCD is currently working to assist the Lakeville area levee landowners in the renewal of these permits.

4.2 Other Planning Efforts in the Watershed

The Petaluma Watershed Enhancement Plan has been written as a planning tool to be used and referenced for the enhancement of the Petaluma watershed. The Plan is a working document, which can be amended as the issues within the watershed change over time. Below is a summary of current planning efforts in the Petaluma watershed. Work conducted by the City of Petaluma within the city limits is referenced in the context of how it fits into other watershed enhancement work.

City of Petaluma

The City of Petaluma has several watershed enhancement projects including:

Petaluma River Access and Enhancement Plan. Adopted in May 1996, the Petaluma River Access and Enhancement Plan establishes policies for preservation, enhancement, and restoration along a 7.8 mile stretch of river from the urban limit line near Old Redwood Highway, through downtown, and to the marina. The plan calls for creating a continuous riparian corridor or "greenway" along the river, identifies restoration and enhancement opportunities, and designates appropriate access points.

Petaluma River Marsh Enhancement Plan. In 1992, the City of Petaluma completed a plan for 300-acres of undeveloped disturbed wetland south of the City marina. The plan includes recommendations for water quality protection, habitat enhancement and restoration, endangered species protection, public access, and public recreational opportunities. Most of the land is in the City limits and owned by the City of Petaluma.

Petaluma Demonstration Marsh and Effluent Management Plan. In 1992, as part of the City's Long-Range Effluent Management Plan, the City approved acquisition of approximately 170 acres adjacent to the Petaluma Marsh to create a demonstration marsh. The plan includes restoration of approximately 100 acres of tidal marsh and creation of a mosaic of seasonal wetlands, riparian areas, and freshwater ponds.

The Ellis Creek Watershed Enhancement and Wetland Mitigation Plan. In 1996 this Plan was developed by the City as a mitigation project for a proposed reservoir on Higgins Creek. The Ellis Creek Plan includes fencing, installation of cattle crossings, bank stabilization, and enhancement planting of approximately 8,100 lineal feet along Ellis Creek. Additional freshwater wetlands and enhancement are also proposed on Higgins Creek (a tributary to Ellis Creek) as mitigation for the reservoir impacts. The

City is continuing to evaluate discharge options, which may eliminate the need for a reservoir.

County of Sonoma

Sonoma County has policies and programs to protect agriculture and natural resources. Most of these are contained in the County's General Plan, which was last updated in 1989.

Agriculture. The Sonoma County General Plan reflects the desire of residents to manage growth and protect agriculture. Agricultural land use policies include stabilizing agricultural land use at the urban fringe, limiting the intrusion of new residential areas into agricultural areas by maintaining parcels large enough for farmers to lease or buy for their operations, and minimizing conflicts between agricultural and non-agricultural uses.

Open Space. The Sonoma County General Plan identifies open space as a limited and valuable resource. Policies to protect open space include: maintaining community separators between Petaluma and both Novato and Rohnert Park and protecting scenic resources such as the Sonoma Mountains between Petaluma and Sonoma, the grassy hills and ridgelines south of Petaluma near the Marin County border, and views of San Pablo Bay along Highway 37.

Natural Resources. Policies were developed to protect critical wetland, marsh, and oak savanna habitat that are highly sensitive to change. For example, the riparian corridor policy states that agricultural cultivation and grazing should occur 100 feet from the top of the streambank in flatland areas and 50 feet in upland areas. Policies are identified to control soil erosion, protect agricultural and domestic water supplies, maintain Sonoma County's diverse plant and animal communities, and protect fishery resources while balancing needs for agriculture, development, and mining.

Other Policies. In addition to the General Plan, Sonoma County has several other natural resource-related policies. The County's Valley Oak Ordinance specifies that when oak trees on particular soil types are removed, landowners must notify the County and indicate that they will either plant new oaks or implement measures to protect existing trees. Sonoma County, several cities, public agencies, and various organizations (both environmental and agricultural) have also worked on a Vernal Pool Preservation Plan. A general permit has been requested from the ACOE to manage or restrict development-related activities on lands with vernal pools.

The County of Sonoma has recently adopted a Vineyard Planting and Replanting Ordinance restricting vineyard development on steep slopes in order to minimize soil erosion and water quality impacts. The new ordinance goes into effect on October 1, 1999 and will require farmers to first register with the County Agricultural Commissioner before planting grapes. The ordinance prohibits vineyards on steep hillsides (50-percent grade or more) and requires erosion control plans on lesser slopes. It also requires that vineyards near streams, creeks, and rivers provide a 50-foot setback to preserve riparian corridors.

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal B - Improve Water Quality				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Improve water quality and ground water recharge in the Petaluma River and its tributaries with the ultimate purpose of removing the Petaluma River from the Waterbody List 303d.	Reduce accelerated soil erosion and manage sediment loads.	Ongoing	Maintain drainage ditches, spillways, culverts, etc. to avoid overtopping and delivery of sediment to the streams.	Landowners
			Improve upstream waterways for flood and sediment control by planting native species.	Landowners Petaluma A-A-W WC, RCD
			Maintain erosion control measures in the upper watershed.	Landowners WC
	Encourage natural stream morphology as a means of flood control and ground water recharge.	Ongoing	Collect information on ground water recharge and encourage recharge.	WC, County of Sonoma SCWA
			Promote water conservation throughout the watershed.	City of Petaluma County of Sonoma
			Reduce unnecessary diversions from creeks.	Landowners County of Sonoma
			Encourage maintenance of summer stream flow - for example, canopy cover.	City of Petaluma SCWA
			Maintain existing summer stream flow and avoid depleting instream pools of water in the summer.	Landowners City of Petaluma SCWA

Goal C - Support Agricultural				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Support the viability of agriculture in the community.	Support and seek funding for demonstration project to retain on-site and properly manage waste tires used historically for erosion control.	2 years	Seek funding for tire demonstration project on rural lands.	RCD, County Health, CIWMB
			Begin demonstration project for tires on rural lands.	Landowners WC, RCD

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal D - Wildlife Habitat				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Conserve and enhance existing wildlife habitat.	Protect, preserve and restore riparian corridors in the watershed.	5 years	Devise a plan to try to control invasive exotic plant species.	Ca. Exotic Pest Control
		Ongoing	Encourage the use of native species for riparian restoration.	WC, RCD
			Protect intact sections of the riparian corridor.	Landowners RCD
			Revegetate high and medium priority sites identified in *Riparian Plant Community* (Appendix H). Work with willing landowners. High and medium priority sites include the opportunity to provide contiguous riparian forest habitat between an upper and lower reach of a stream, expand existing habitat, fill out areas of sparse cover, and provide cover in areas with a potential for high erosion. Inform community about local endangered species.	NRCS, RCD AmeriCorps
			Avoid depleting instream pools of water during the summer.	Landowners SCWA
	Encourage community pride in watershed's natural resources.	2 years	Inform community about local wildlife enhancement potential with brochures and workshops.	WC, RCD, NRCS
			Conduct outreach about the importance and uniqueness of the Petaluma Marsh.	WC, RCD City of Petaluma
		5 years	Prepare and distribute information to the public about wildlife habitat needs, including steelhead and marsh species, and how residents can help enhance habitat. Include information on reducing summertime water diversions.	WC, RCD, NRCS USFWS
			Create manual on how residents can help enhance wildlife habitat.	RCD, NRCS, DFG, USFWS

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal D - Wildlife Habitat				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Conserve and enhance existing wildlife habitat.	Encourage community pride in watershed's natural resources.	5 years	Provide workshops or other written materials for residents about the importance of healthy riparian corridors to, wildlife, erosion control, and water quality; do-it-yourself revegetation with native plants; how to maintain creek habitats; and available resources and technical assistance.	RCD, NRCS
		Ongoing	Get community involved with observing and preserving anadramous fish habitat.	RCD, USFWS DFG
			Support efforts to improve habitat for steelhead, songbirds, waterfowl, pond turtles, and other native wildlife species in the watershed. Concentrate on improving riparian habitat.	WC, RCD
			Provide technical assistance to school and community groups working on revegetation projects.	RCD Petaluma A-A-W
	Work with agencies to establish criteria for steelhead habitat.	2 years	Incorporate steelhead habitat-related parameters into watershed monitoring (i.e., turbidity sampling, using aerial photographs to identify changes in riparian cover, etc.)	DFG, USFWS
		5 years	Use the Department of Fish and Game protocol to evaluate the quality of steelhead spawning and rearing habitat. Focus on reaches being restored by watershed residents.	DFG, USFWS
			Focus steelhead restoration efforts on tributaries that do, or potentially can, support steelhead. These are Lichau Creek, Adobe Creek, San Antonio Creek, and possibly Lynch Creek and Willow Brook Creek.	WC, RCD DFG, USFWS

CORONA/ELY SPECIFIC PLAN

PETALUMA

May 1, 1989

Prepared for the City of Petaluma by

Naphtali H. Knox & Associates, Inc.
TJKM TRANSPORTATION CONSULTANTS

Wagstaff and Associates
BROWN AND CALDWELL, CONSULTING ENGINEERS

Existing Neighborhood Parks

Existing neighborhood parks in the northeast quadrant include 7-acre Bond Park, Sunrise Parkway, McDowell Meadows Park in the McDowell Meadows subdivision, and a 3-acre park in the Meadow Park subdivision. Sunrise Park is a 3-acre strip of lawn adjacent to the east side of Capri Creek just north of North McDowell Boulevard. The one-acre McDowell Meadows Park—which includes a tot-lot and lawn area—would be joined by this Specific Plan to a new park on its north.

Public Parks

The Specific Plan calls for a total of 16 acres of public parks. The Land Use Plan, Figure 1-5, shows the four park sites. On the McDowell and Brody properties are parks of 4 and 2 acres, respectively, located adjacent to Lynch and Corona Creeks. The other two sites, designated by dashed circles, are 7 acres and 3 acres, respectively. The dashed circle denotes that the actual site is not fixed but will be determined by project design; however, it is intended that the 3-acre park straddle the property line of the adjoining Sonoma Associates and Cader parcels.

Facilities in Public Parks

The recreation facilities provided within public parks should be determined by age, income level, and preferences of the persons the park is intended to serve. If the surrounding area is primarily designed to house families, then it would be wise to include sections within the park that are specifically there to attract children—whether those be tot-lots, areas with extensive playground equipment, or areas for sports activities. However, if the immediately surrounding area is comprised of studios and one- and two-bedroom apartments, one can assume there will be fewer children, and the park should be designed to serve more adult populations. Facilities may then include tennis courts, squash courts, basketball courts, and (for seniors) a bowling green and/or horse-shoe pitching facilities. If additional facilities—particularly playing fields—are found to be needed to support the population in Corona/Ely, this plan recommends that the City's Park and Recreation Commission investigate the possibility of joint-use agreements with the various school districts, or park facility development within the urban separator.

Open Space

Petaluma's open space is essential to grazing, agriculture, and the dairy industry, but it also has value for recreational and aesthetic reasons, *e.g.*, preserving views of the Sonoma Mountains.

One of the City's objectives is to link open space to activity centers, other open space, and scenic routes in an effort to help define urban form. (See Appendix 1.) The Specific Plan will accomplish this linkage as follows:

a. The 2-acre neighborhood park north of McDowell Meadows will connect on its north with a 200-foot-wide band of riparian open space along Corona Creek, which in turn ties into the urban separator.

b. The 3-acre Sunrise Park will connect on its east to a 4-acre, 100-foot-wide band of open space along the north side of Capri Creek, which in turn will continue east and through the junior college to connect to the urban separator.

c. The 4-acre park at Lynch Creek will abut the recreation facilities now being developed on the 100-acre city property to the east; and via Lynch Creek's open space, both park areas will connect to Lucchesi Park on the west.

Thus, this Specific Plan will satisfy—for this particular Planning Area—the General Plan's call for the development of a network of trails and pathways throughout the city, including a trail system in or adjacent to the urban separator.

Land Use Plan

Figure 1-5 (the fold-out map following this page) presents the Land Use Plan which is an adopted part of this Specific Plan. The Plan carries out the General Plan's policies for "feathering"—which means gradually reducing residential densities as development moves from the center of the community toward Petaluma's "urban limit line." The Specific Plan does this by designating outlying ("edge") lands as lower density residential, while permitting higher density land uses nearer the center of the community.

In addition, within each land use category along the eastern edge of the Specific Plan area, development review procedures based on policies in this Specific Plan, will require larger lots (lower density) at the eastern edge of the Planning Area. Details are provided in Chapter 4 of this Plan. ❑

Transit

The Specific Plan area is served by Petaluma Transit, Sonoma County Transit, and Golden Gate Transit.

Policy 6. Opportunities for making more effective use of available transit services shall be encouraged through the following efforts:

a. Transit system input during individual project review to ensure that appropriate facilities (bus stops, bus turnouts, shelters, park and ride lots, *etc.*) are provided for potential riders.

b. Coordinating schedules and services in the Corona/Ely area.

c. Ensuring that major destinations in the Specific Plan area are properly served by transit (*e.g.*, Junior College, Retail Center, and park sites).

d. Ensuring that sufficient space and facilities are provided at the designated transit station along the Northwestern Pacific Railroad right-of-way in the event that that portion of the right-of-way becomes a regional light rail or exclusive bus/transit-way.

e. Continuing public information programs to attract potential new ridership.

Bicycles

The General Plan establishes a network of bicycle routes throughout the city to connect residential areas with recreational, commercial, and workplace activities. Routes already designated by the General Plan in the Specific Plan area include those along the urban separator; Lynch, Corona, and Capri Creeks; Maria Drive; Corona Road; and Ely Road.

Policy 7. Sonoma Mountain Parkway shall provide bike lanes in each direction.

Policy 8. Other road improvements associated with the development of the Specific Plan—e.g., Rainier Avenue Overcrossing, and widening the Corona Road and Old Redwood Highway overcrossings—shall provide for bike lanes to the extent feasible.

Policy 9. In addition, as facilities are developed at the high school and park sites, adequate bicycle parking and safe access for bicyclists shall be provided. Such features shall be reviewed during the project approval process. ❑

(2) The design character of the principal land use elements along the route. In particular, the commercial center, adjacent higher-density residential, and the junior college will become principal identifying features along the corridor.

In addition, the General Plan calls for public and private landscaping along all major streets and for construction of new arterial streets to improved standards. The General Plan specifically calls for deeper setbacks and/or special landscaping, and requires landscaped medians along all arterials.

THE CREEK CORRIDORS

These include the adjacent lands on either side of Lynch, Capri, and Corona Creeks which are designated on the Land Use Plan map as park and/or open space. **It is the goal of the open space designation to preserve the lush vegetation along Lynch Creek and to reintroduce a more natural appearance to the drainage channels that are Capri and Corona Creeks.** These creek corridors, which carry runoff from the Sonoma Mountains westward through the Planning Area, provide further opportunities to create a distinctive community identity as well as to introduce important design elements within individual neighborhoods.

THE CORONA ROAD CORRIDOR

This corridor includes Corona Road itself and the lands immediately adjacent to the route east of its intersection with Sonoma Mountain Parkway. The corridor is locally valued for its picturesque, country qualities. The route also provides a scenic transition between country and town. The narrow road is lined with distinctive, overhanging rows of California live oak and other specimen trees. Behind the trees are scattered country homes and farmsteads. **It is a goal of this Specific Plan to preserve the existing trees and the overall rural feeling of the Corona Road.**

THE INTERNAL RESIDENTIAL AREAS

The residential designations on the Corona/Ely Land Use Plan map are expected to accommodate at least one-third and possibly a majority of the city's growth over the next two decades. Thus, perceptions of the quality of life and overall future image of Petaluma will be determined in large part by the character of development in the area. The General Plan sets a number of objectives for these new residential areas: It calls for or encourages (1) residential developments to be well-designed and in harmony with the setting and the city's

living environment, establish a distinctive image and sense of identity for the area, and create a source of community pride.

Area-wide Identity and Unification

Policy 2. Consistent design themes for the area's key activity centers and principal common elements should be formulated—through use of consistent landscaping, building design, signage, street lighting, and other design standards and elements—to visually distinguish and unify the area.

Key activity centers and common elements to be included in the design themes are the Sonoma Mountain Parkway, the retail center and adjacent higher-density residential areas, the junior college center, the creek corridors, internal collector roadways, neighborhood parks, the urban separator, and the junior high and elementary schools.

Sonoma Mountain Views

Policy 3. In planning the development of Corona/Ely lands, special efforts shall be made to preserve and take advantage of views of the Sonoma Mountains wherever possible.

Special Features

Policy 4. The design and construction of future development in the Corona/Ely area shall incorporate and capitalize upon the area's special existing landscape features, visual attributes, and historic values whenever possible.

Lynch Creek

Policy 5. The permanent open space corridor shown on the Land Use Plan map along Lynch Creek shall be treated as a principal design and identity element for the area. In particular, riparian elements nearest the Sonoma Mountain Parkway shall be preserved, enhanced, and incorporated into a park.

Capri and Corona Creeks

Policy 6. Development of parcels traversed by Capri and Corona Creeks shall incorporate consistent linear park-like treatments—including natural-appearing drainage and landscaping along these channels specifically to tie together the various neighborhoods.

High Amenity Area

Policy 7. The special topographic, vegetative, and view features of the "high amenity area" should be capitalized upon to create one of the city's most desirable residential areas.

Preparation of design and construction specifications for the Lynch Creek Park should include a detailed landscaping plan for the entire creek corridor segment between the Sonoma Mountain Parkway and the Planning Area boundary. Creek corridor landscaping plan requirements (preparation and content) are described below.

CAPRI CREEK

Policy 130. The residential development plan submitted for the property which abuts the Capri Creek open space corridor shall include a detailed landscaping plan for the adjacent creek corridor.

The stretch of Capri Creek east of the Sonoma Mountain Parkway falls within the proposed junior college and is addressed in the master plan for that facility. Landscaping plan preparation and content requirements are described below.

CORONA CREEK

Policy 131. The first residential development plan to be submitted for a property which abuts the designated Corona Creek open space corridor shall include a detailed landscaping plan for the entire corridor between the eastern and western boundaries of the Planning Area. Creek corridor landscaping plan requirements are described below.

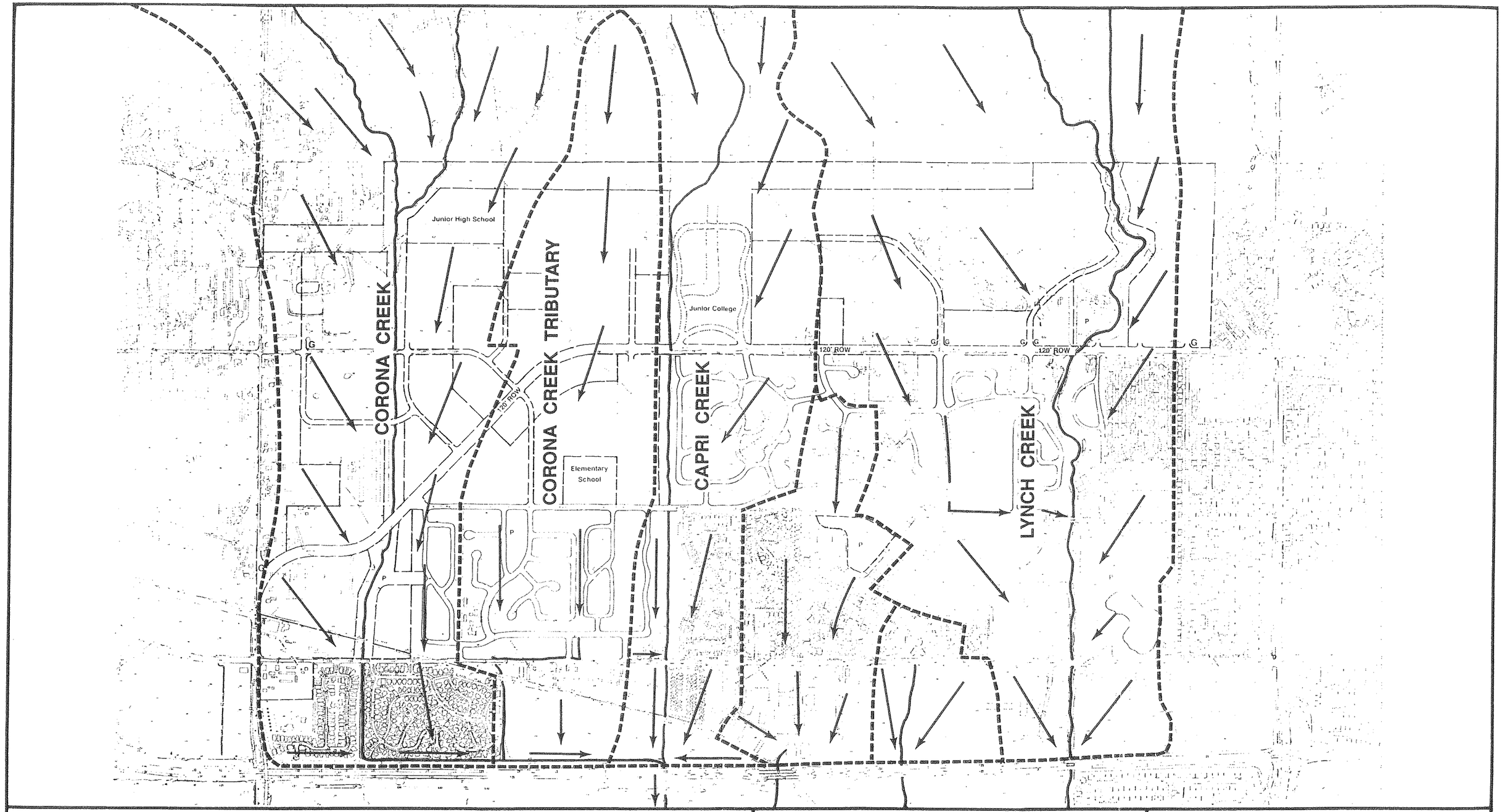
CREEK CORRIDOR LANDSCAPE PLAN PREPARATION AND CONTENT

Policy 132. The developer-prepared creek corridor landscape plans required above shall each be prepared by a qualified landscape architect.

The plans should specify in detail a high quality design for these corridors, including ground forms, plantings, pedestrian and bicycle pathway systems, benches, drinking fountains, trash receptacles, lighting, *etc.* Each new development constructed adjacent to the corridor will then be responsible for making all improvements specified in the corridor landscape plans for the corridor segment contiguous to that project.

Creek Channel Enhancement

The goal is to protect against channel erosion, while allowing vegetation to establish itself and achieve a more natural appearance. Concrete rip-rap along the banks may serve this purpose.



CORONA·ELY SPECIFIC PLAN

CITY OF PETALUMA, CALIFORNIA

Figure 3 - 1

Existing Drainage Patterns and Sub-basins

DRAFT

CAPRI CREEK FLOOD TERRACE HYDROLOGIC ANALYSIS REPORT

Maria Drive to N. McDowell Boulevard

Petaluma, CA

November, 2011

Report by: Tom Hammond

Review by: Pam Tuft

Capri Creek Flood Terrace Hydrologic Analysis Report

Reach: from Maria Drive to N McDowell Boulevard

Existing Conditions

Capri Creek, once inside the City limits, is a linear trapezoidal earthen channel that runs through a series of subdivisions collecting the runoff and discharging to the Petaluma River. The reach studied in this report is from Maria Drive to N McDowell Boulevard (See appendix 1 for site and location maps). It is approximately five feet wide at the bottom, varies from 4 to 5 feet deep at the lowest bank, varies from 40 to 60 feet width at the top of bank and is 1400 feet long. Average slope along the channel bottom is 0.5%. The channel is mostly filled with vegetation for the full depth and has 6-12 inch rock lining the bottom. At the top of the reach two elliptical 34"x54" concrete culverts discharge into the channel and at downstream the end two 55" circular concrete culverts collect through a course bar screen and discharge under the road 230 feet to the next reach. See appendix 2 for photos.

Access for regular maintenance uses a road located out of the floodway to remove brush that accumulates at the bar screen. A storm water model was designed and is maintained for the City by WEST Consultants, Inc. (WEST) and all hydrologic data was provided by them for this study. The calculations, report, HEC-RAS model, preliminary design and engineer's estimate were all done by City staff.

Out of bank flow has historically occurred at the lower end of the reach and flows due South into the adjacent street, Sunrise Parkway, and onto private property. Data from WEST and models run showed that a 10 year storm event will breach the banks and cause water to flow into the street then back into the stormdrain. The modeled out-of-bank flows calculated to be 253 cubic feet per second (cfs) and 41cfs for 100-year and 10-year storms, respectively. Total estimated flow in the creek is 500cfs and 288cfs for 100 and 10-year storm events.

Proposed Improved Conditions

One of the main purposes of this study is to reduce out of bank flow along this section of Capri Creek without adversely impacting other reaches. Creation of a flood terrace will reduce the peak flow, bring the hydrograph peak down by spreading it over a longer period of time, and retain more storm flows within the modified channel. Maximizing the flood terrace storage volume, to reduce out-of-bank volume, and the potential of flooding of private property, is the desired result. An important consideration to keep in mind is that this creek discharges to the Petaluma River and by changing the flow and hydrograph of this reach, the resultant design must avoid negatively impacting the peak hydrograph along the River. Coordination with WEST Consultants and the XP-SWMM model will be necessary for a feasible design to be achieved and before any final design preparations.

Another purpose of this project is the opportunity to enhance the creek frontage for both adjacent residents who enjoy the line and the wildlife that inhabits it. The reaches upstream of the project site are good examples of what the City would like to see for this reach in its function, aesthetic, and habitat.

Quick analysis proved matching the 100 year flood flow out-of-bank volume and the potential storage volume at the site is not feasible. The water volume would require an 11 foot deep section be excavated from the entire area designated for the flood terrace. Instead a combined flood terrace and creek enhancement design, similar to the reach upstream, was determined more feasible. Recognizing these multi-use benefits, cross sections were developed along with a HEC-RAS model to optimize storage capacity along with usability for the residents, and wildlife habitat enhancement.

Model

A HEC-RAS model was developed using the peak hydrograph data from WEST Consultants (See appendix 5 for the data) and the flood terrace preliminary design utilizing lands within Sunrise Park. The park was surveyed and cross sections developed from the data. This was then used to determine how much of a reduction in out-of-bank flow could be achieved with the extra storage volume. See appendix 3.

Calculations

Using the flood terrace boundary and a max flow rate of 250cfs, assuming headwall improvements at the discharge end of the reach, the volume of water to be stored was 16.6ac-ft. The area designated for the flood terrace was 1.27 ac. The depth of the basin required to store this water would need to be 13ft. The average depth of the creek is 6 feet deep. With an improved entrance structure for the downstream culvert the max flow through should raise to 300cfs. See appendix 3.

Results

Using the HEC-RAS model, data from WEST Consultants, and some calculations on static structures the amount of water that was able to be detained was from 6 to 12 acre feet depending on the improvements made. This leaves 10 to 4.6 acre feet that would flow out of bank in a 100 year storm event. This would result in a reduction of 6.6 to 12 acre feet of water that currently floods private property.

Improvements that decreased out of bank flows were:

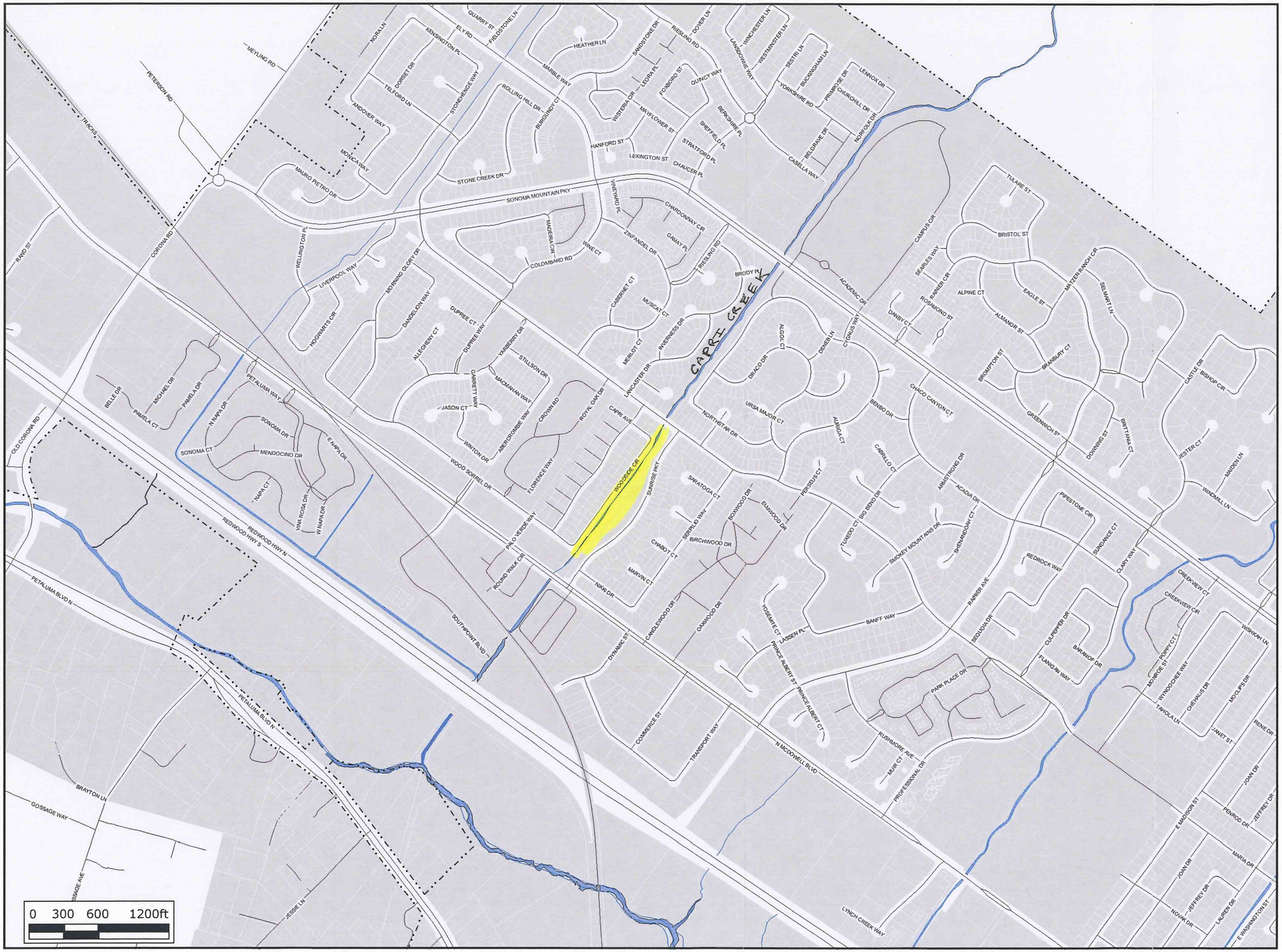
1. Inlet structure for the downstream culvert to achieve 300cfs flow through while also being able to use it as a bar screen for brush removal maintenance.
2. Modifying the downstream culvert for a shallower slope and deeper entrance.
3. A trapezoidal terrace section, 95 feet at the widest section, at the natural slope with a 2 percent slope back to the centerline of the creek at the section.
4. A widened basin at the lower section of the reach.

An Engineers estimate with all the improvements is in Appendix 4.

Appendix 1

Location Map and Site Map

Powered By GeoSmart



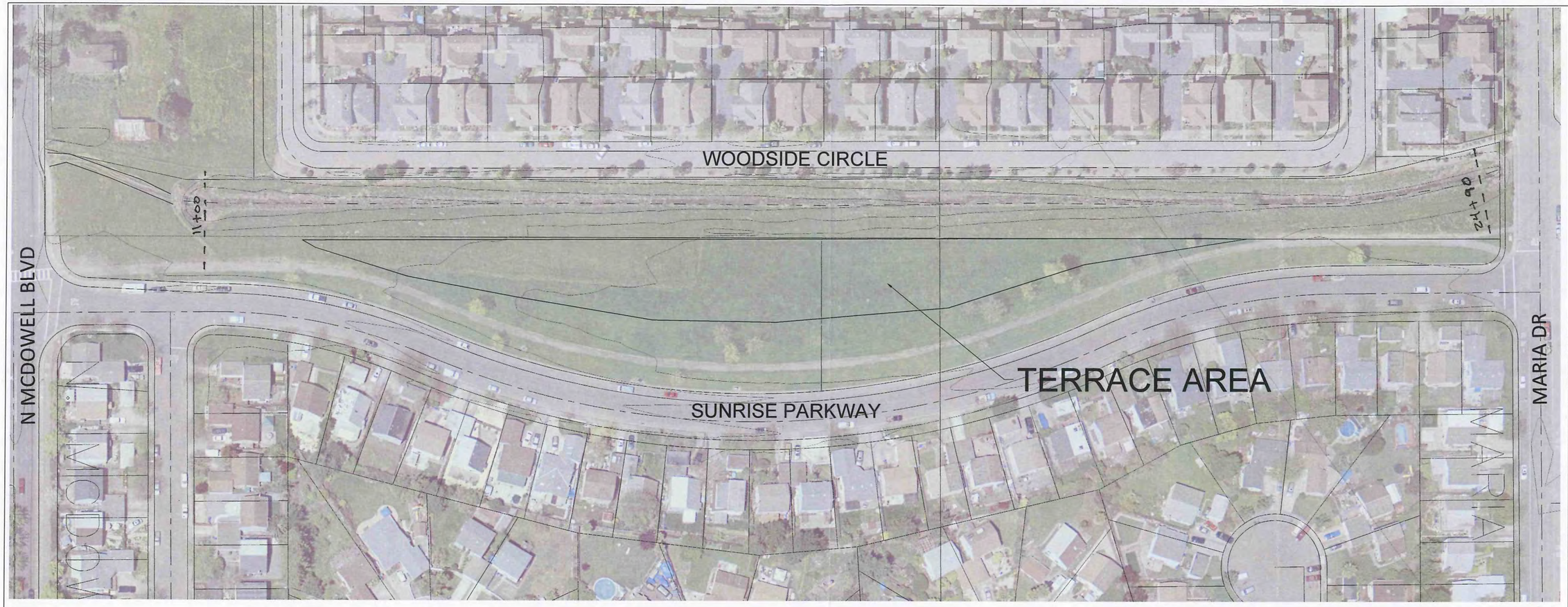
Site Map
Capri Creek

City of Petaluma
California

- City Limit
- Minor Waterways
- Major Waterways
- Parcels
- Street Names
- Parcels background - hide

GIS Division

DISCLAIMER:
These maps or plans were compiled and digitized via electronic means utilizing many source documents. It is intended to be representative of certain physical, legal and geometric features within the City of Petaluma, CA and its environs. The existence or location of facilities must be field verified and this document does not imply or guarantee neither adequate capacity nor the availability of service. The City of Petaluma assumes no responsibility regarding the accuracy of the information represented herein for legal documentation, representations of actual construction or for any other purpose for which this map was not intended



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DATE: NOV/2011
DESIGNED BY: TCH
DRAWN BY: TCH
CHECKED BY:

CITY OF PETALUMA
WATER RESOURCES AND CONSERVATION
202 N. MCDOWELL BLVD, PETALUMA, CA, 94954
PH. 707-778-4546 FAX. 707-778-4508

WR&C

SUNRISE PARK EXHIBIT

SUNRISE PARK, PETALUMA
EXHIBIT

SHEET
C1
1 OF 1

Appendix 2

Photos- Wet and Dry Conditions

Outlet (right side of picture) and out-of-bank flow path across trail to Sunrise Parkway

Storm flow outlet and bar screen (to catch debris)

Upstream discharge at Maria Drive

Slight bend facing downstream

Continuing downstream.

Inlet from adjacent subdivision around 1403 Woodside Circle.

Proposed river terrace excavation area.

Outlet illustrating bar screen and blockage by debris from upstream areas.

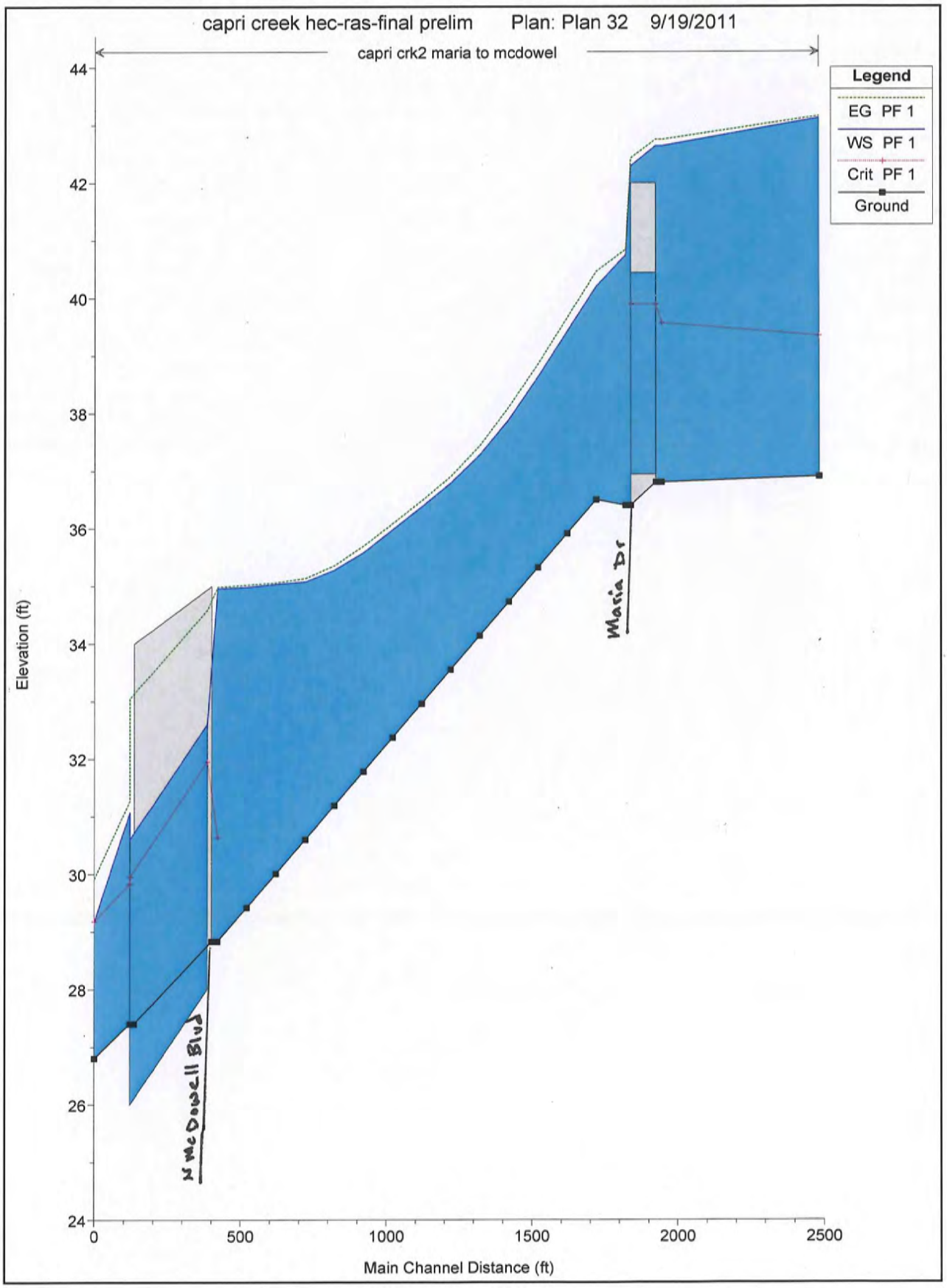
Maintenance access from N. McDowell Blvd. (looking upstream, East) Sunrise Parkway on right, Woodside Circle on left

Appendix 3

HEC-RAS Model Output

HEC-RAS Plan: Plan 30 River: capri crk2 Reach: maria to mcdowel Profile: PF 1 10 Year Flow

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
maria to mcdowel	3130	PF 1	350.00	36.90	43.12	39.34	43.15	0.000413	1.44	242.46	63.92	0.13
maria to mcdowel	2590	PF 1	350.00	36.80	42.64	39.56	42.75	0.001651	2.66	131.57	37.72	0.25
maria to mcdowel	2550		Culvert									
maria to mcdowel	2490	PF 1	350.00	36.40	40.74		40.84	0.002028	2.50	140.23	54.14	0.27
maria to mcdowel	2400	PF 1	350.00	36.50	40.20		40.46	0.008002	4.12	84.97	43.27	0.52
maria to mcdowel	2300	PF 1	350.00	35.91	39.42		39.66	0.007956	3.95	88.71	47.98	0.51
maria to mcdowel	2200	PF 1	375.00	35.32	38.63		38.85	0.008087	3.78	99.34	58.49	0.51
maria to mcdowel	2100	PF 1	375.00	34.73	37.89		38.11	0.006795	3.72	100.85	52.95	0.47
maria to mcdowel	2000	PF 1	375.00	34.14	37.28		37.43	0.006365	3.14	119.42	77.70	0.45
maria to mcdowel	1900	PF 1	375.00	33.55	36.79		36.90	0.004369	2.70	138.67	85.13	0.37
maria to mcdowel	1800	PF 1	375.00	32.96	36.37		36.48	0.004022	2.61	143.45	87.16	0.36
maria to mcdowel	1700	PF 1	375.00	32.37	35.98		36.08	0.003862	2.60	144.28	85.69	0.35
maria to mcdowel	1600	PF 1	375.00	31.78	35.58		35.69	0.003951	2.71	138.62	78.80	0.36
maria to mcdowel	1500	PF 1	375.00	31.19	35.27		35.35	0.002774	2.27	165.42	94.03	0.30
maria to mcdowel	1400	PF 1	375.00	30.60	35.08		35.13	0.001699	1.90	197.88	101.82	0.24
maria to mcdowel	1300	PF 1	375.00	30.01	35.03		35.06	0.000348	1.27	296.54	87.55	0.12
maria to mcdowel	1200	PF 1	375.00	29.42	34.98		35.02	0.000465	1.52	247.09	66.34	0.14
maria to mcdowel	1100	PF 1	375.00	28.83	34.96	30.63	34.98	0.000241	1.18	317.07	75.00	0.10
maria to mcdowel	970		Culvert									
maria to mcdowel	820	PF 1	375.00	27.40	31.07	29.83	31.26	0.005222	3.56	105.46	48.84	0.43
maria to mcdowel	700	PF 1	375.00	26.80	29.18	29.18	29.92	0.033128	6.91	54.28	37.22	1.01


capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011
capri crk2 maria to mcdowel
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
Main Channel Distance (ft)
N McDowell Blvd
Maria Dr
44
42
40
38
36
34
32
30
28
26
24
0
500
1000
1500
2000
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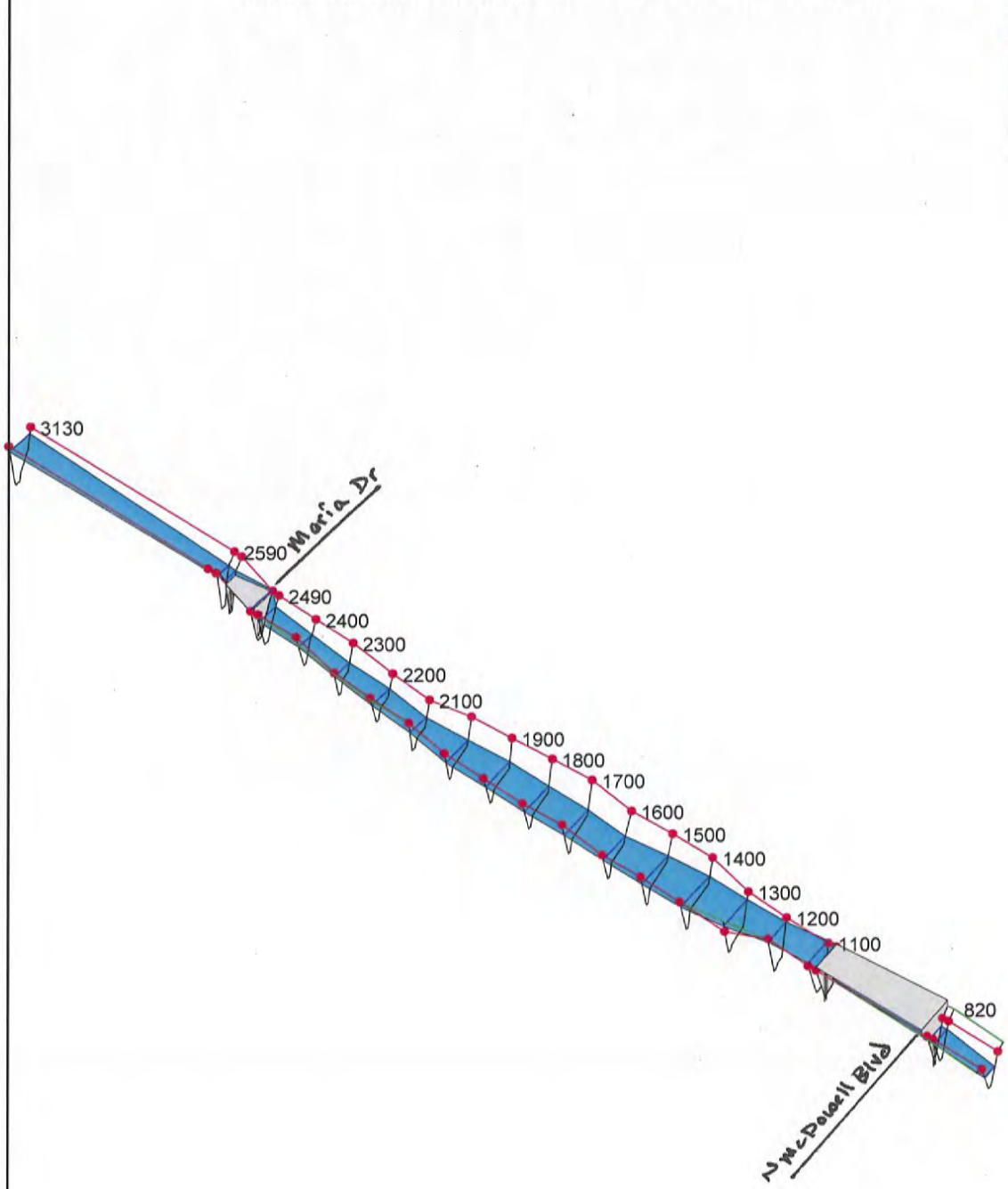
10 Year Flow

capri creek hec-ras-final prelim Plan: Plan 32 9/19/2011



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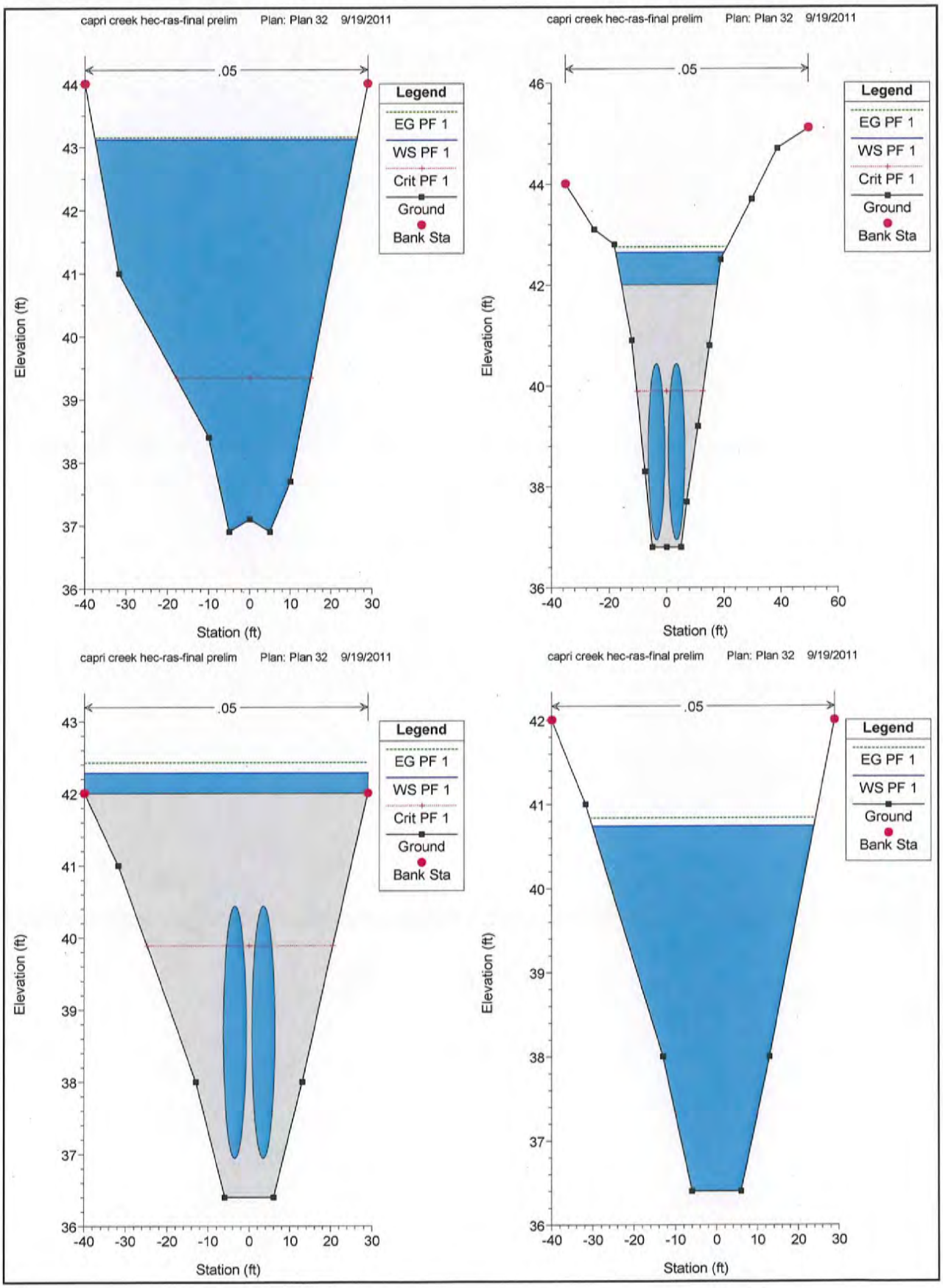
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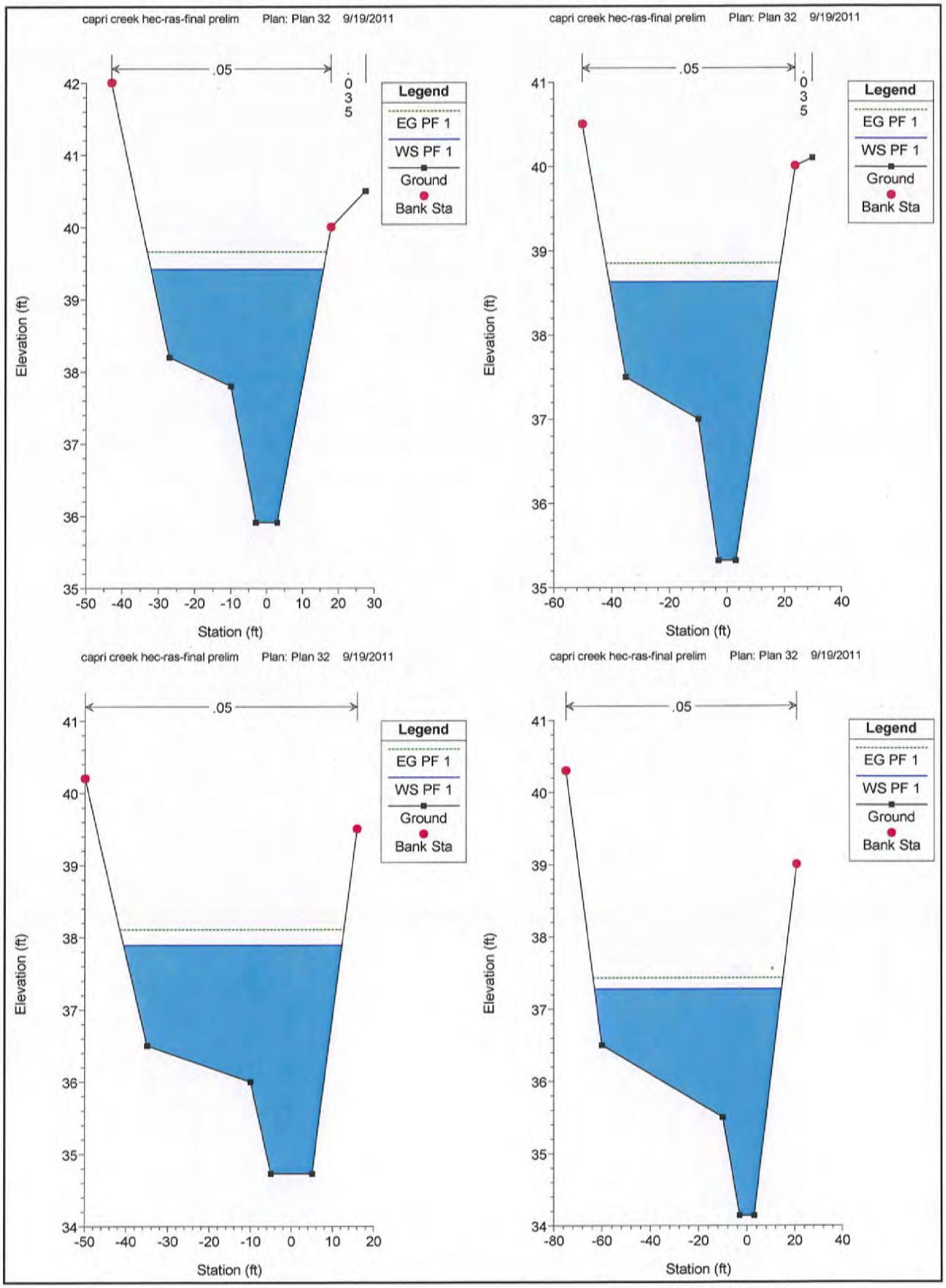
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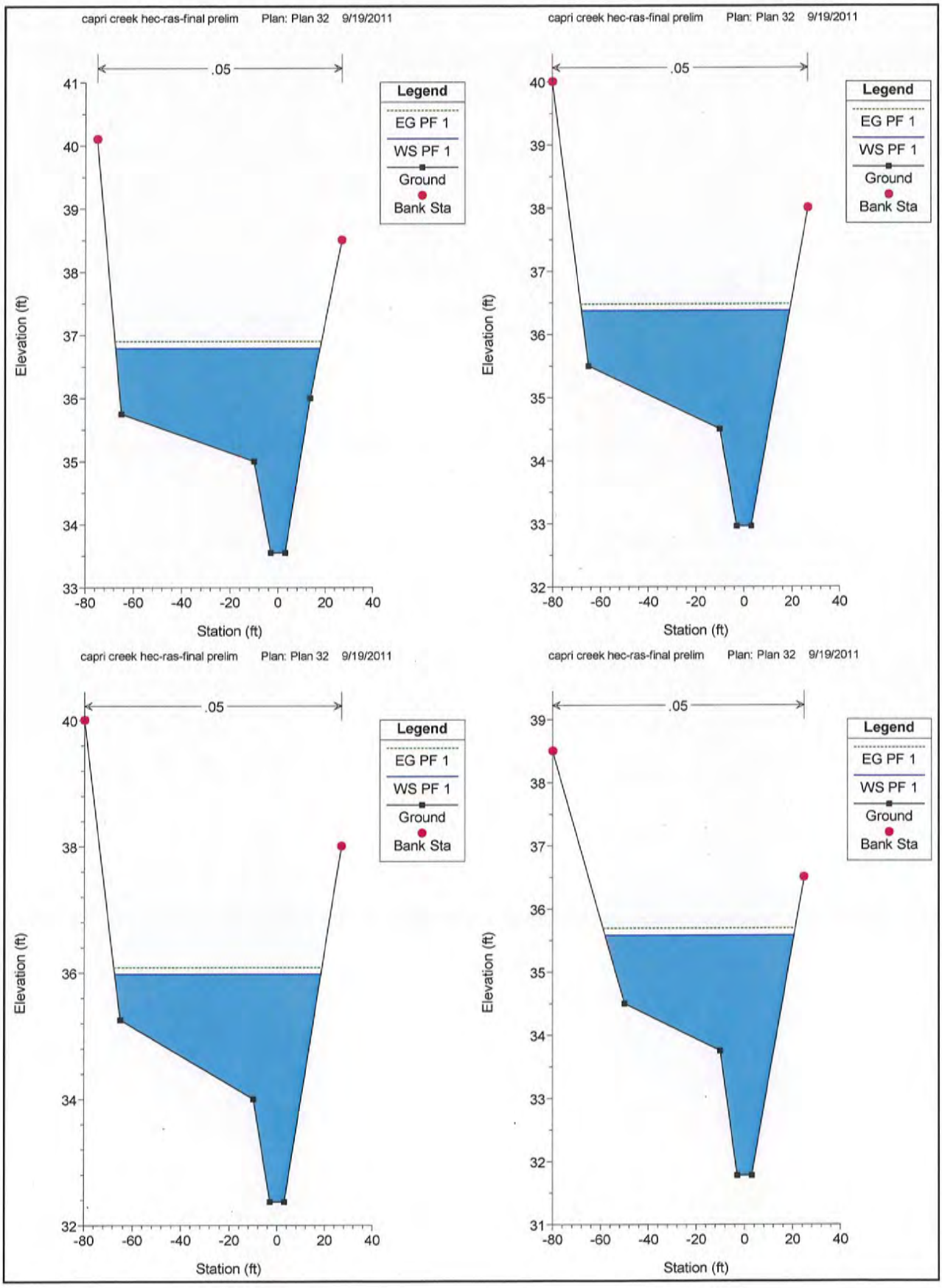
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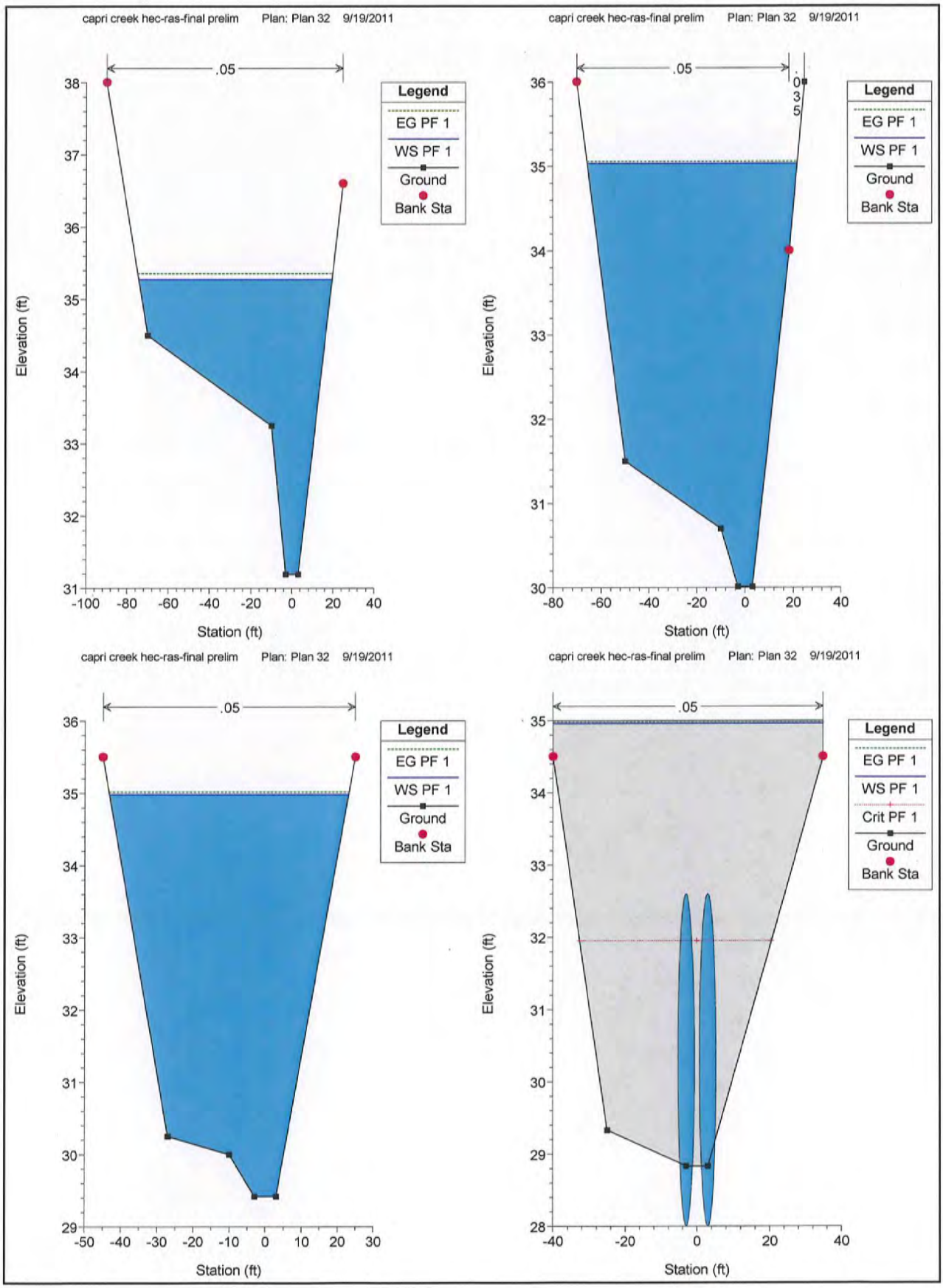
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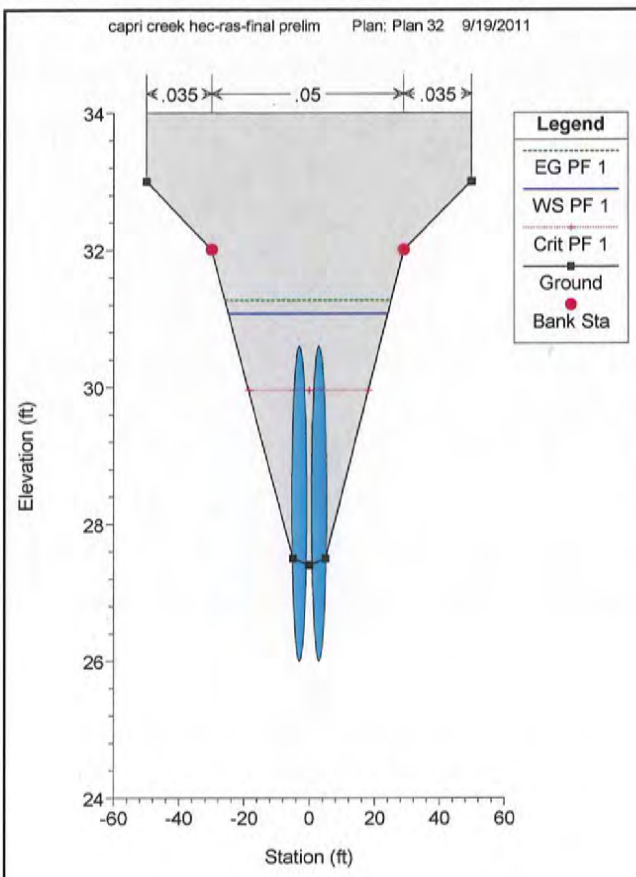
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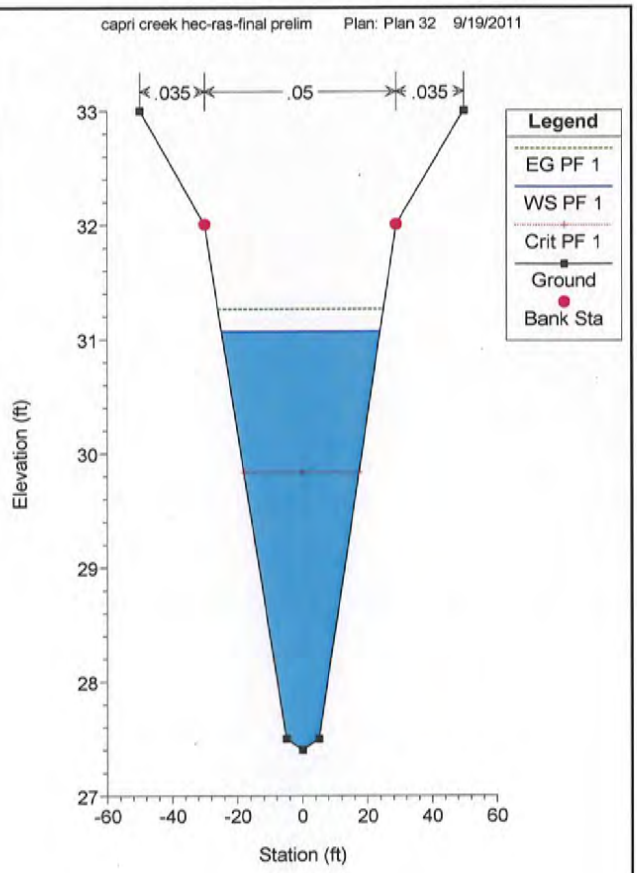
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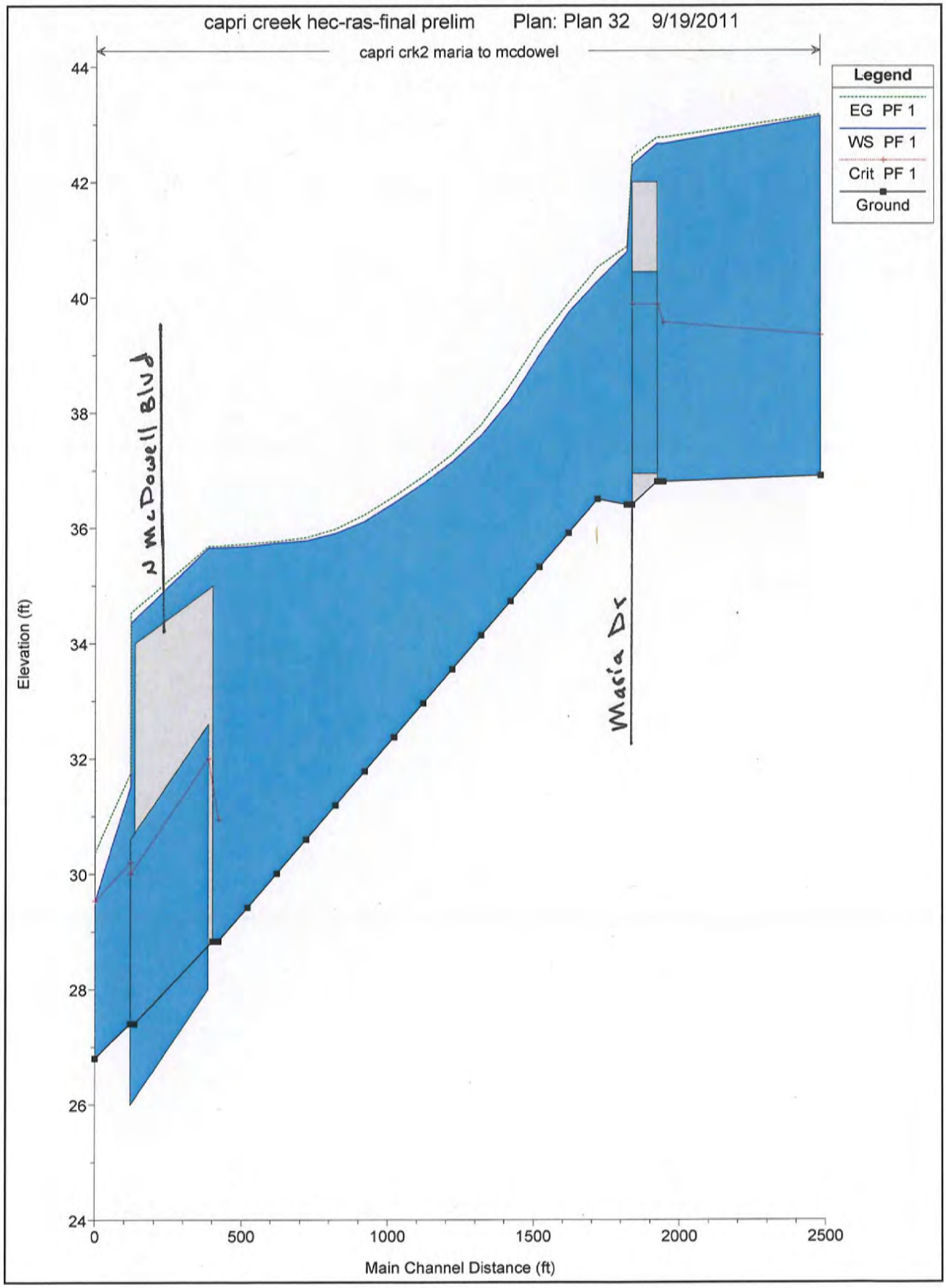
HEC-RAS Plan: Plan 30 River: capri crk2 Reach: maria to mcdowel Profile: PF 1 100 Year Flow

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
maria to mcdowel	3130	PF 1	350.00	36.90	43.13	39.34	43.16	0.000408	1.44	243.46	64.01	0.13
maria to mcdowel	2590	PF 1	350.00	36.80	42.66	39.56	42.77	0.001632	2.64	132.38	37.99	0.25
maria to mcdowel	2550		Culvert									
maria to mcdowel	2490	PF 1	350.00	36.40	40.78		40.87	0.001947	2.46	142.38	54.55	0.27
maria to mcdowel	2400	PF 1	350.00	36.50	40.28		40.52	0.007179	3.95	88.53	44.20	0.49
maria to mcdowel	2300	PF 1	350.00	35.91	39.74		39.91	0.004930	3.35	104.56	50.52	0.41
maria to mcdowel	2200	PF 1	500.00	35.32	39.00		39.27	0.007851	4.10	121.98	62.05	0.52
maria to mcdowel	2100	PF 1	500.00	34.73	38.22		38.50	0.007462	4.22	118.39	55.01	0.51
maria to mcdowel	2000	PF 1	500.00	34.14	37.61		37.79	0.006106	3.43	145.61	80.24	0.45
maria to mcdowel	1900	PF 1	500.00	33.55	37.15		37.28	0.004129	2.94	169.84	87.90	0.37
maria to mcdowel	1800	PF 1	500.00	32.96	36.77		36.89	0.003608	2.80	178.76	90.38	0.35
maria to mcdowel	1700	PF 1	500.00	32.37	36.43		36.55	0.003214	2.72	184.07	89.07	0.33
maria to mcdowel	1600	PF 1	500.00	31.78	36.12		36.23	0.003111	2.74	182.74	85.33	0.33
maria to mcdowel	1500	PF 1	500.00	31.19	35.91		35.98	0.001873	2.20	226.96	100.23	0.26
maria to mcdowel	1400	PF 1	500.00	30.60	35.78		35.83	0.001140	1.84	271.67	108.15	0.20
maria to mcdowel	1300	PF 1	500.00	30.01	35.74		35.77	0.000346	1.40	360.21	92.98	0.12
maria to mcdowel	1200	PF 1	500.00	29.42	35.68		35.73	0.000495	1.69	295.17	70.00	0.15
maria to mcdowel	1100	PF 1	500.00	28.83	35.66	30.94	35.69	0.000264	1.35	369.51	75.00	0.11
maria to mcdowel	970		Culvert									
maria to mcdowel	820	PF 1	500.00	27.40	31.51	30.19	31.75	0.005496	3.90	128.17	53.67	0.44
maria to mcdowel	700	PF 1	500.00	26.80	29.53	29.53	30.37	0.031907	7.34	68.10	41.42	1.01



100 Year Flow

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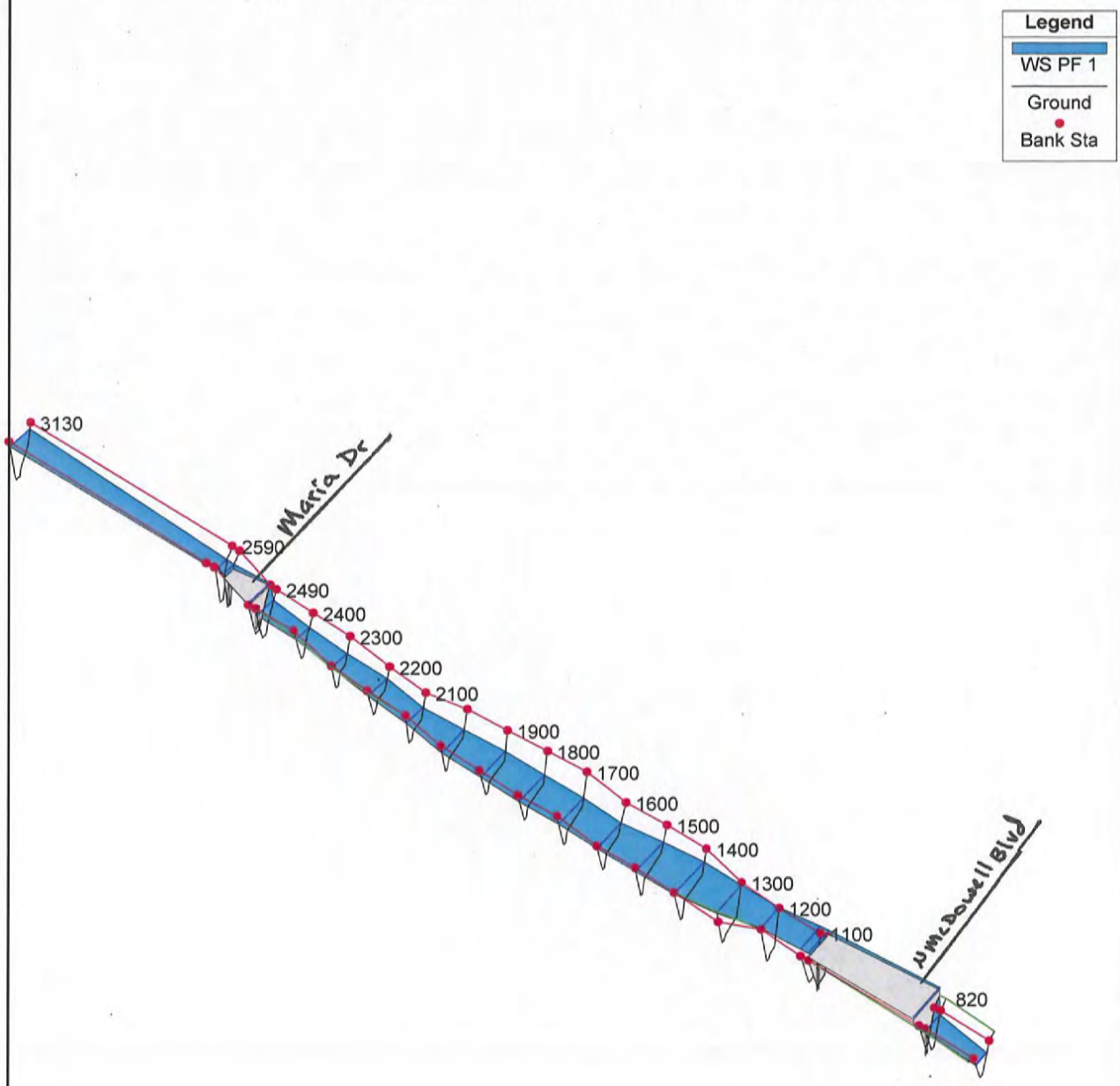

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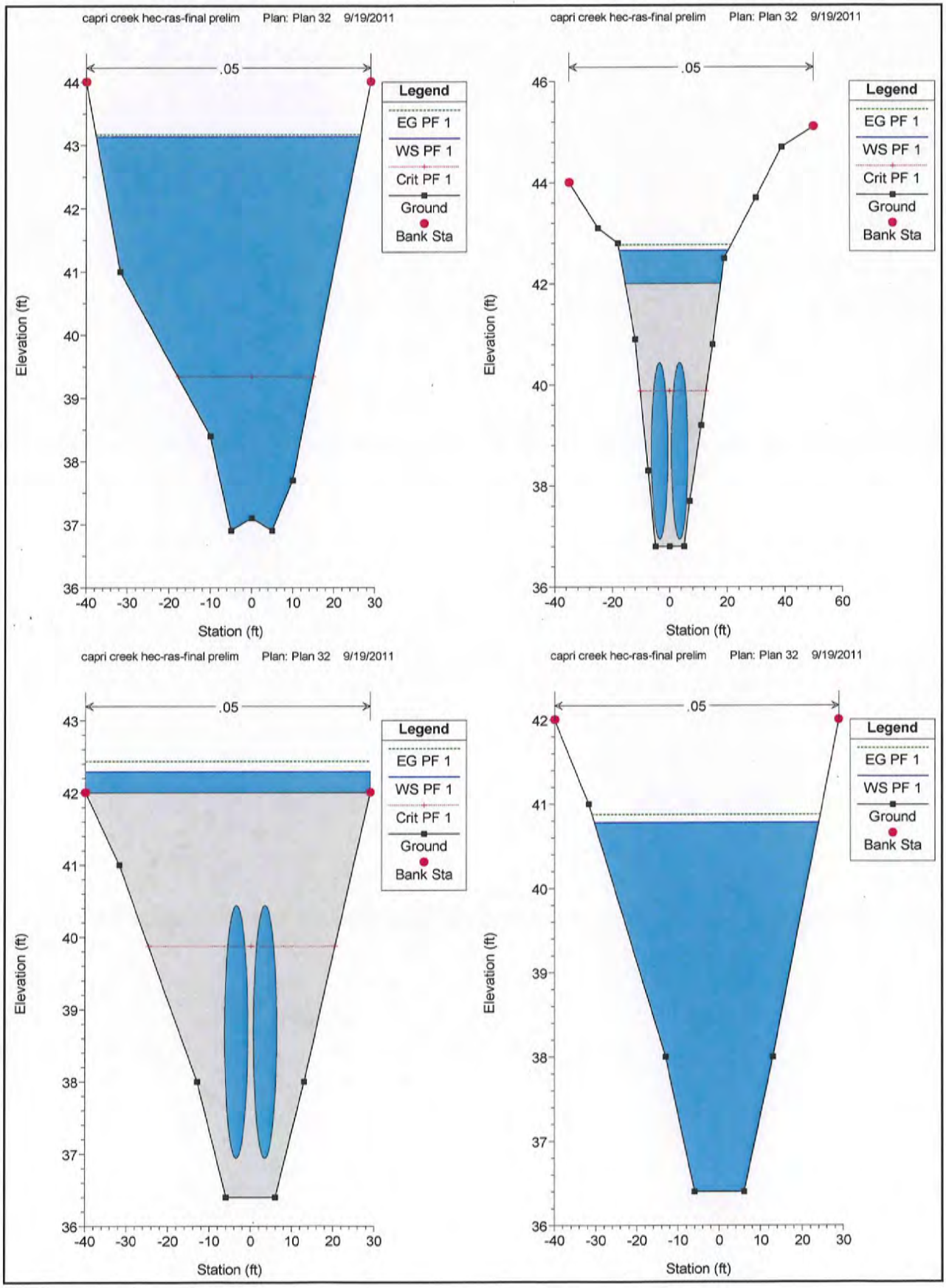
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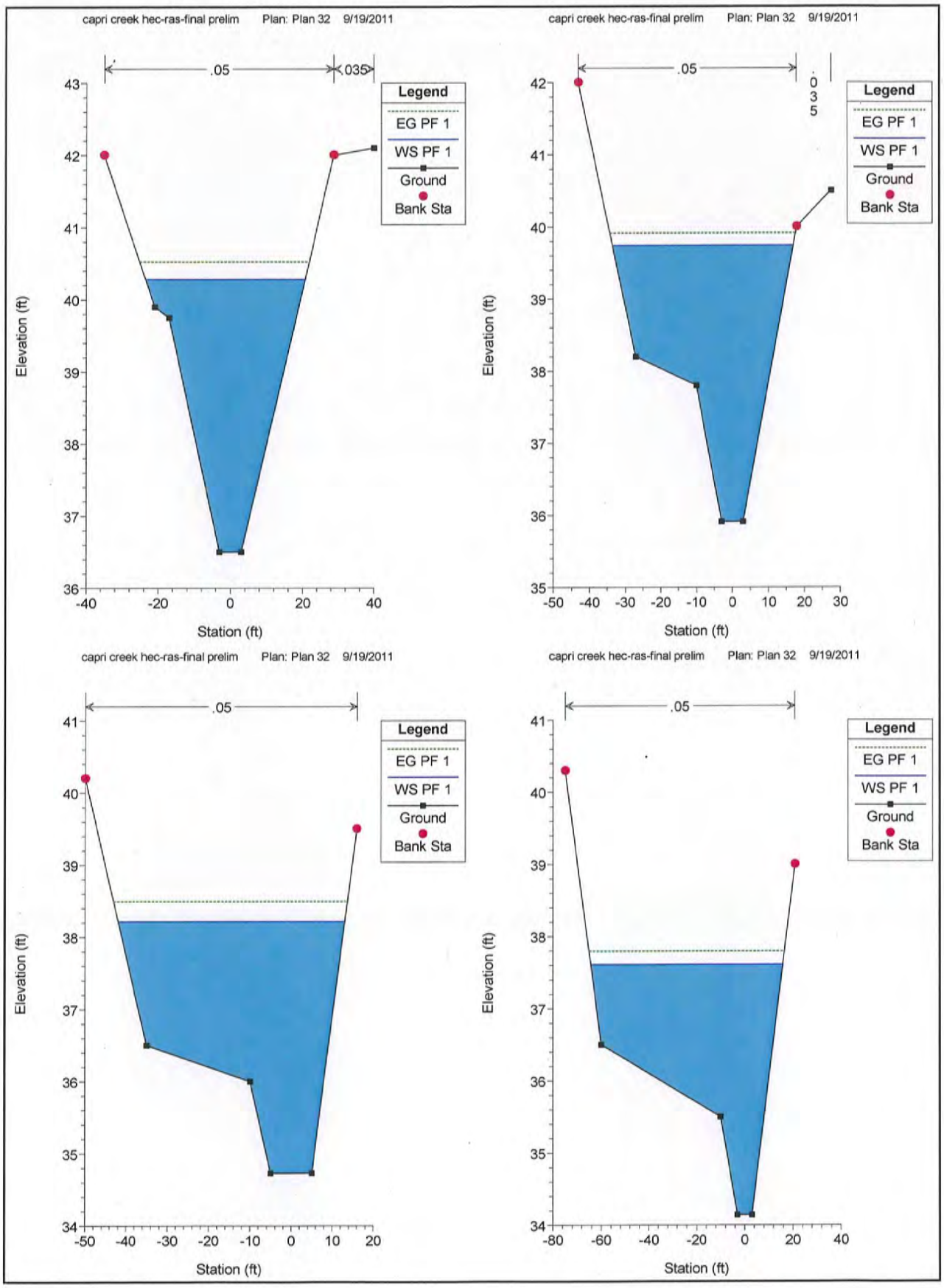
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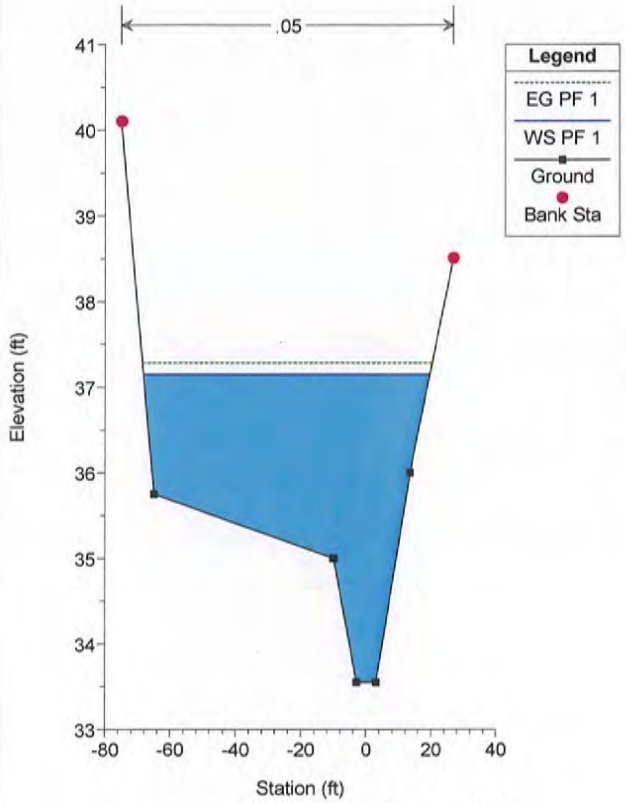

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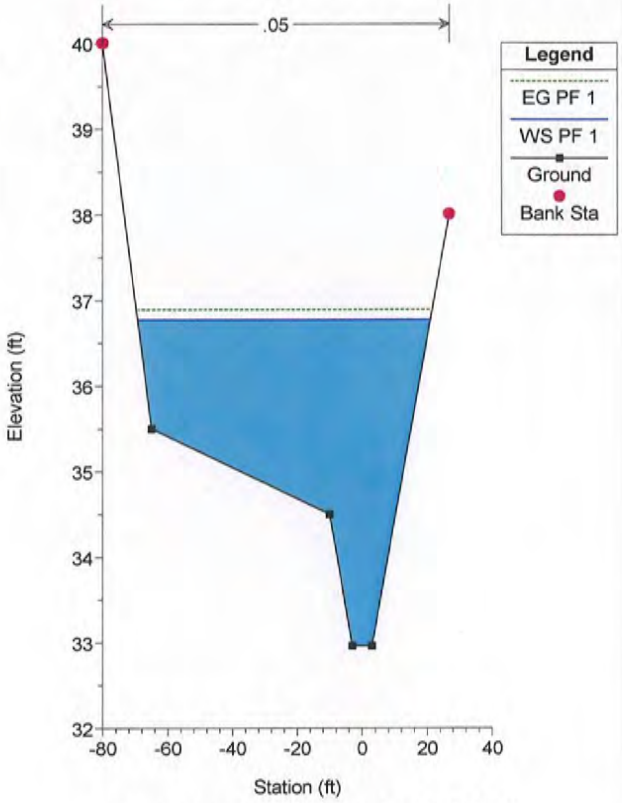

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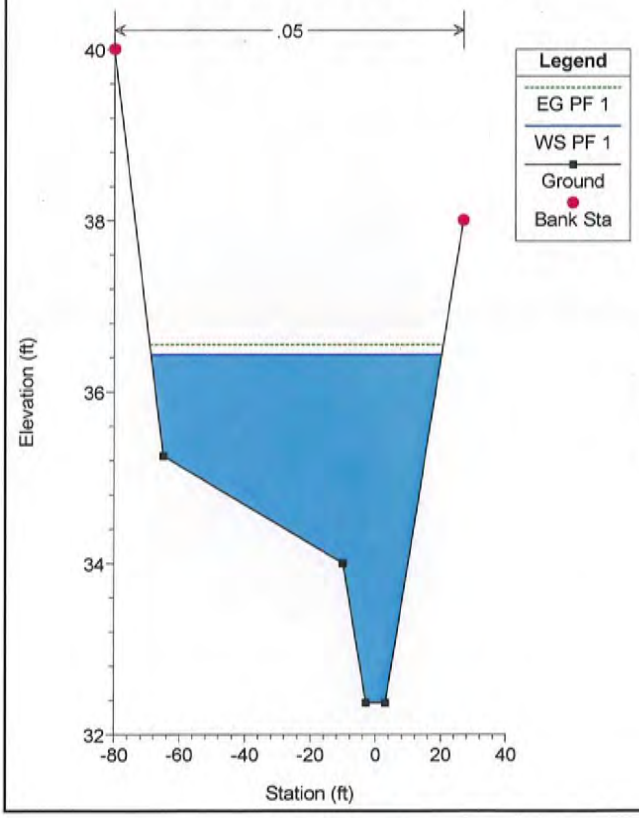

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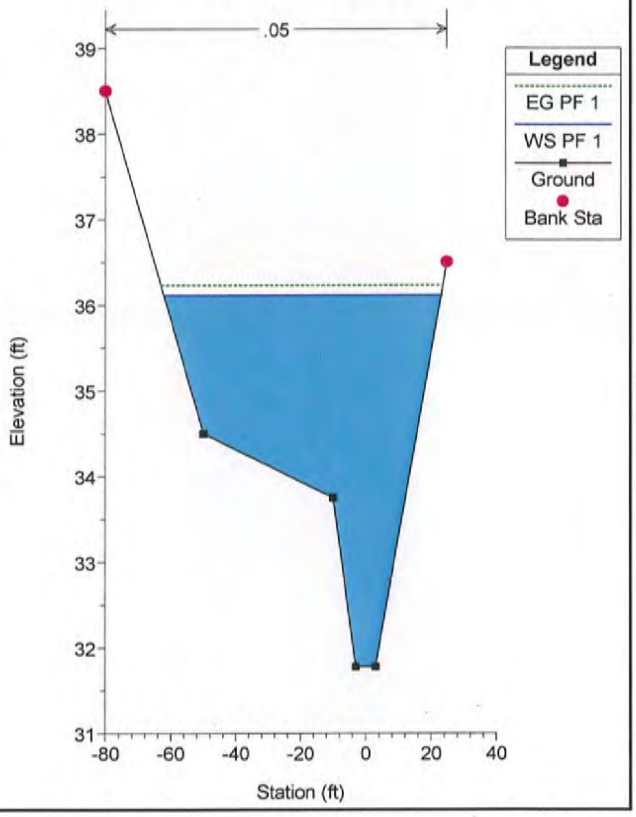

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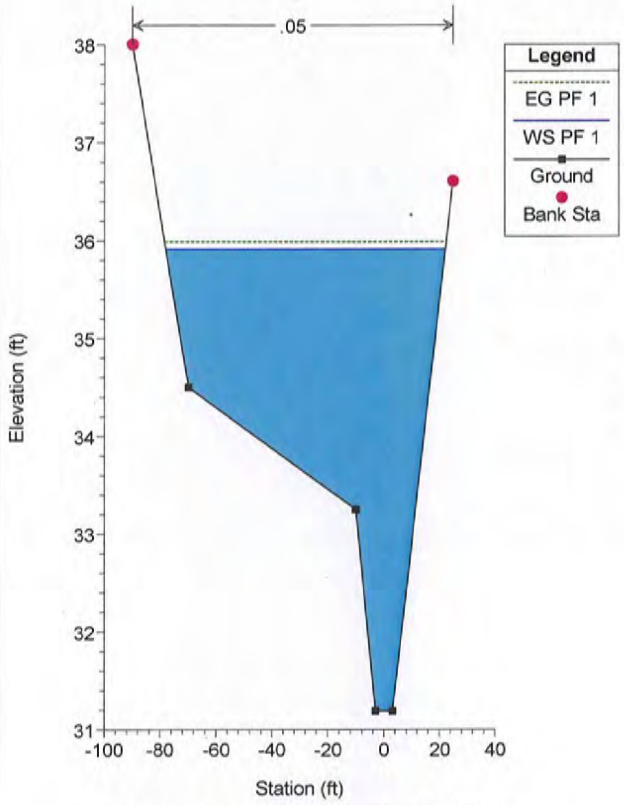

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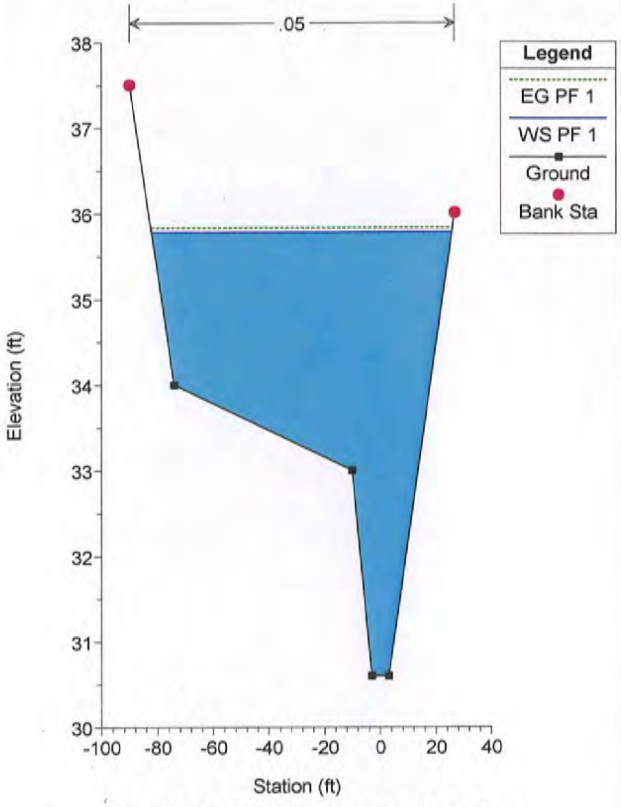

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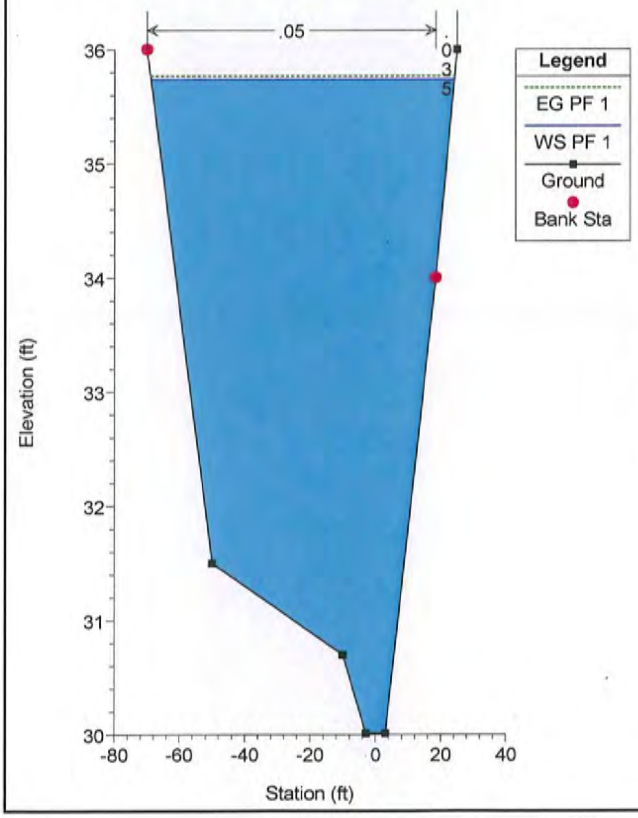

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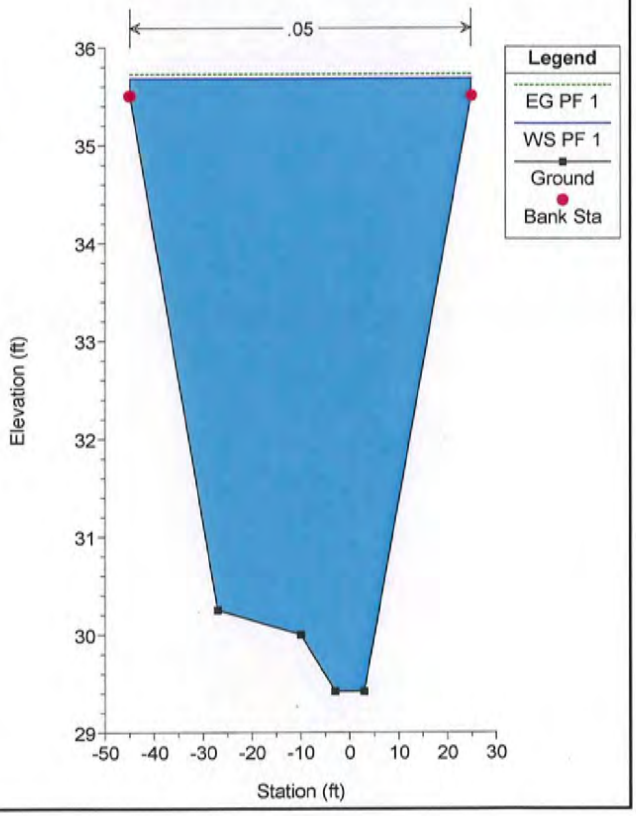

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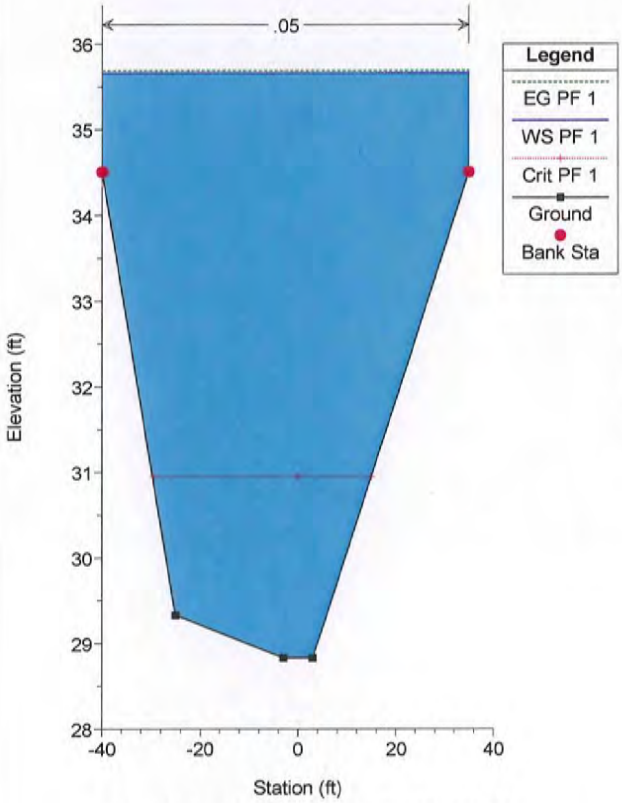

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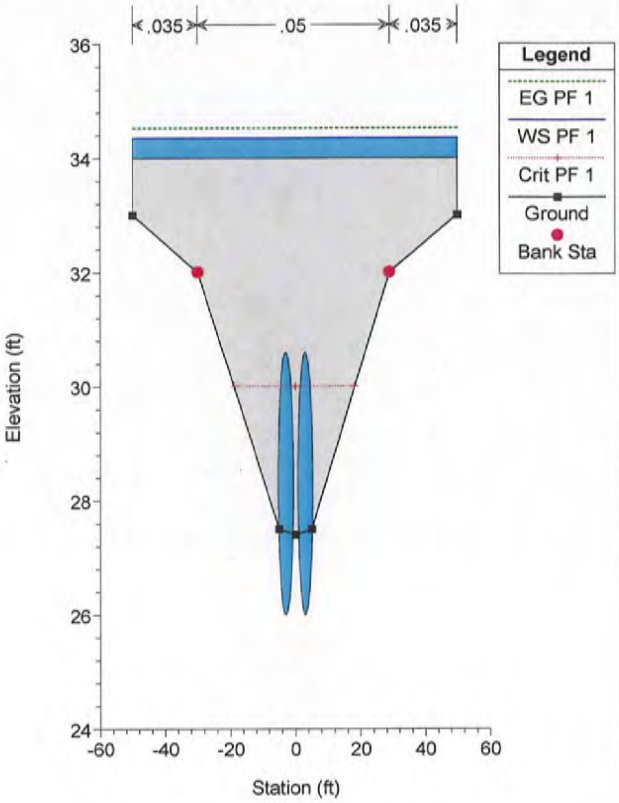

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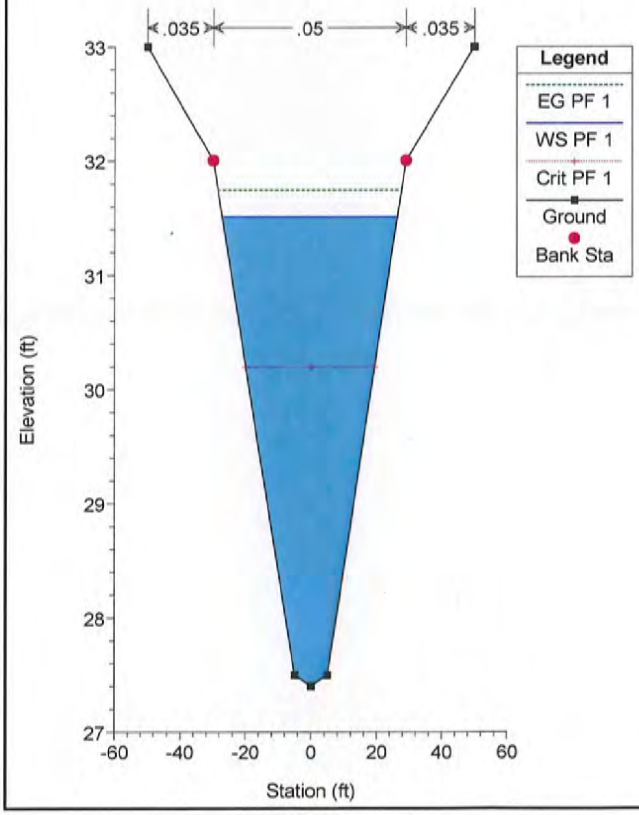

Appendix 4

Preliminary Engineer's Estimate

Preliminary
Engineer's Estimate
for
CAPRI CREEK FLOOD TERRACE

Description	Unit	Quantity	Unit Price	Cost
Design and Analysis				
City Staff	HR	350	$ 85.00	$ 29,750
Engineering Survey CM	LS	1	$ 74,625.00	$ 74,625
Agency Coordination	LS	4	$10,000.00	$ 40,000
Community Outreach	LS	1	$7,500.00	$ 7,500
Construction				
Off Haul	YD	10600	$8.00	$ 84,800
Grading	YD	10600	$25.00	$ 265,000
Planting	SF	150000	$0.20	$ 30,000
Concrete	YD	10	$120.00	$ 1,200
Berms	LF	550	$10.00	$ 5,500
Erosion Prevention	SF	150000	$0.40	$ 60,000
Irrigation	LS	1	$2,500.00	$ 2,500
Traffic Control	Day	60	$600.00	$ 36,000
SWPPP	LS	1	$10,000.00	$ 10,000
Outlet structure Re-Build	EA	1	$2,500.00	$ 2,500
Mobilization	LS	1	$49,750.00	$ 49,750

Subtotal (rounded to nearest whole num)	$	699,125
20% Contingency	$	139,825
Total	**$**	**838,950**

Date: 3/5/2012 march
Estimated by: TCH

Restoration Design and Management Guidelines for the Petaluma River Watershed

Volume 1
Restoration and Revegetation Design

July 1996

Prepared by:

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Petaluma, California

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Questa Engineering Corporation

Jennifer Barrett, Project Manager
City of Petaluma, Planning Department

Review, input and comments received from:

Bob Morrison
Randy Poole
Bill Stevens
Sonoma County Water Agency

Tom Furer
United Anglers - Casa Grande High School

Report Prepared Under a Grant from the
California Department of Water Resources
Urban Streams Program

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Volume II
Restoration and Revegetation Design

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MEMORANDUM

Project:	Capri Creek Terracing XP-Storm Evaluation
Subject:	Results Summary
Date:	February 13, 2013
To:	Pamela Tuft, City of Petaluma Kent Carothers, City of Petaluma
From:	David S. Smith, P.E., WEST Consultants, Inc.

REGISTERED PROFESSIONAL ENGINEER
David S. Smith
No. C056132
EXP. 12/31/14
CIVIL
STATE OF CALIFORNIA

This memo summarizes the analysis completed by WEST Consultants, Inc. (WEST) for the City of Petaluma (the City) for the Capri Creek Terracing project, located between McDowell Boulevard and Maria Drive (see Figure 1). The subject of this memo is the hydraulic impact of the proposed terracing.

Modeling and floodplain mapping completed by WEST for the recent FEMA map revision reflect flooding downstream of Maria Drive in the right overbank (looking downstream) along Woodside Circle and breakout flows in the left overbank to Sunrise Parkway, Nikki Lane, and the Capri Mobile Villa trailer park. The purpose of the terracing project is to reduce flooding along Capri Creek downstream of Maria Drive.

XP-Storm version 2010 (build May 20, 2010) was used in this evaluation. The methods used to evaluate the hydraulic effects of the proposed terracing are described below along with tabular results for the 10-year, 25-year, 50-year, and 100-year events.

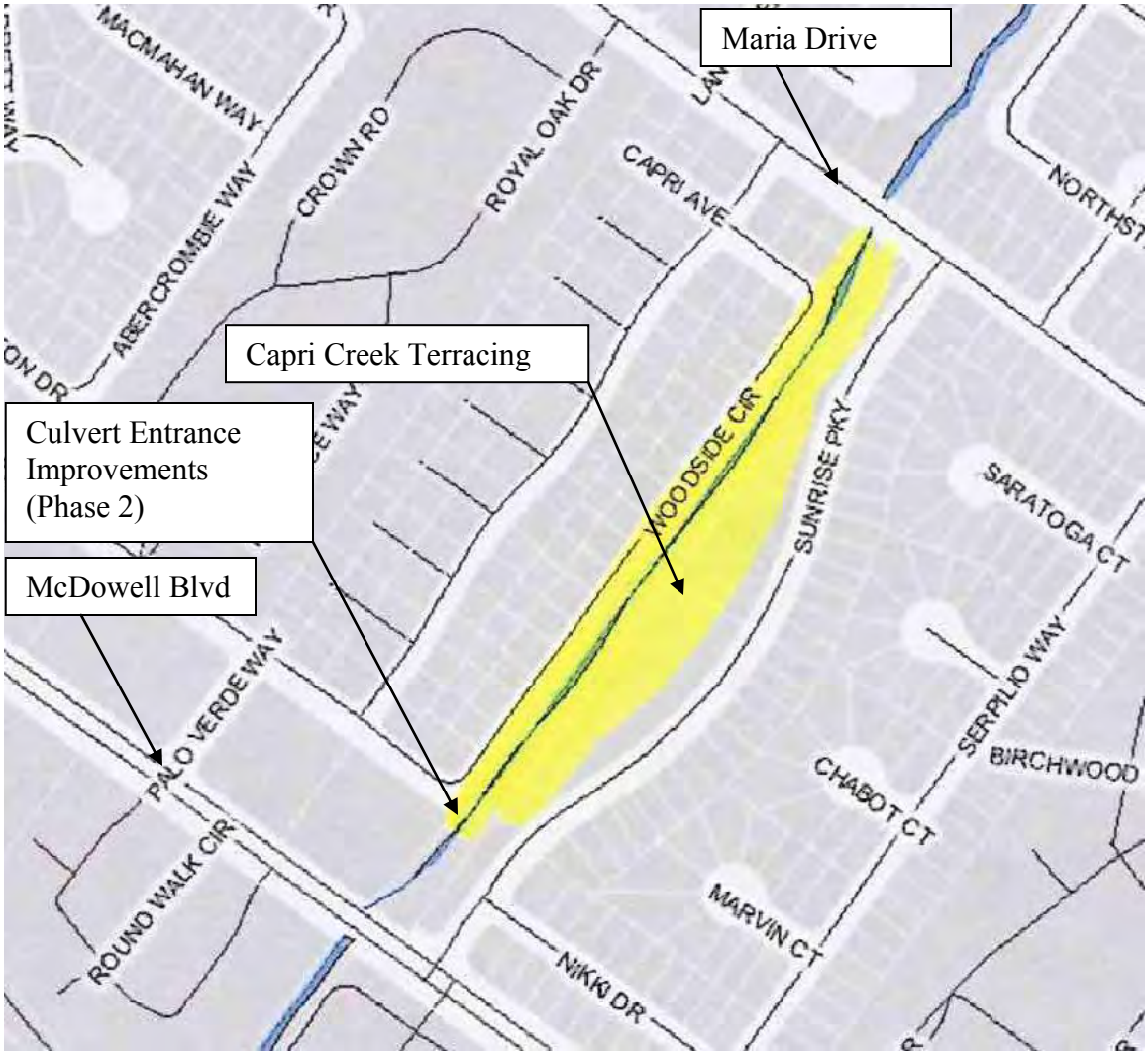


Figure 1. Capri Creek Terracing and McDowell Boulevard Culvert Entrance Improvements

Modeling Approach

The City's 10-year, 50-year, and 100-year XP-Storm models that were the basis of the FEMA remapping effort were used for evaluating the proposed improvements (filenames "10yr_9-27-10.xp", "50yr_9-27-10.xp", and "100yr_9-27-10.xp"). The 25-year XP-Storm model did not previously exist so WEST imported the 25-year rainfall data from the FEMA remapping project into the XP-Storm model. This rainfall data was generated during the FEMA remapping project but not specifically used for mapping purposes.

Three nodes were added to the existing conditions model in the terracing reach between McDowell Boulevard and Maria Drive: CaC_1050, CaC_1450, and CaC_1950 (see Figure 2).

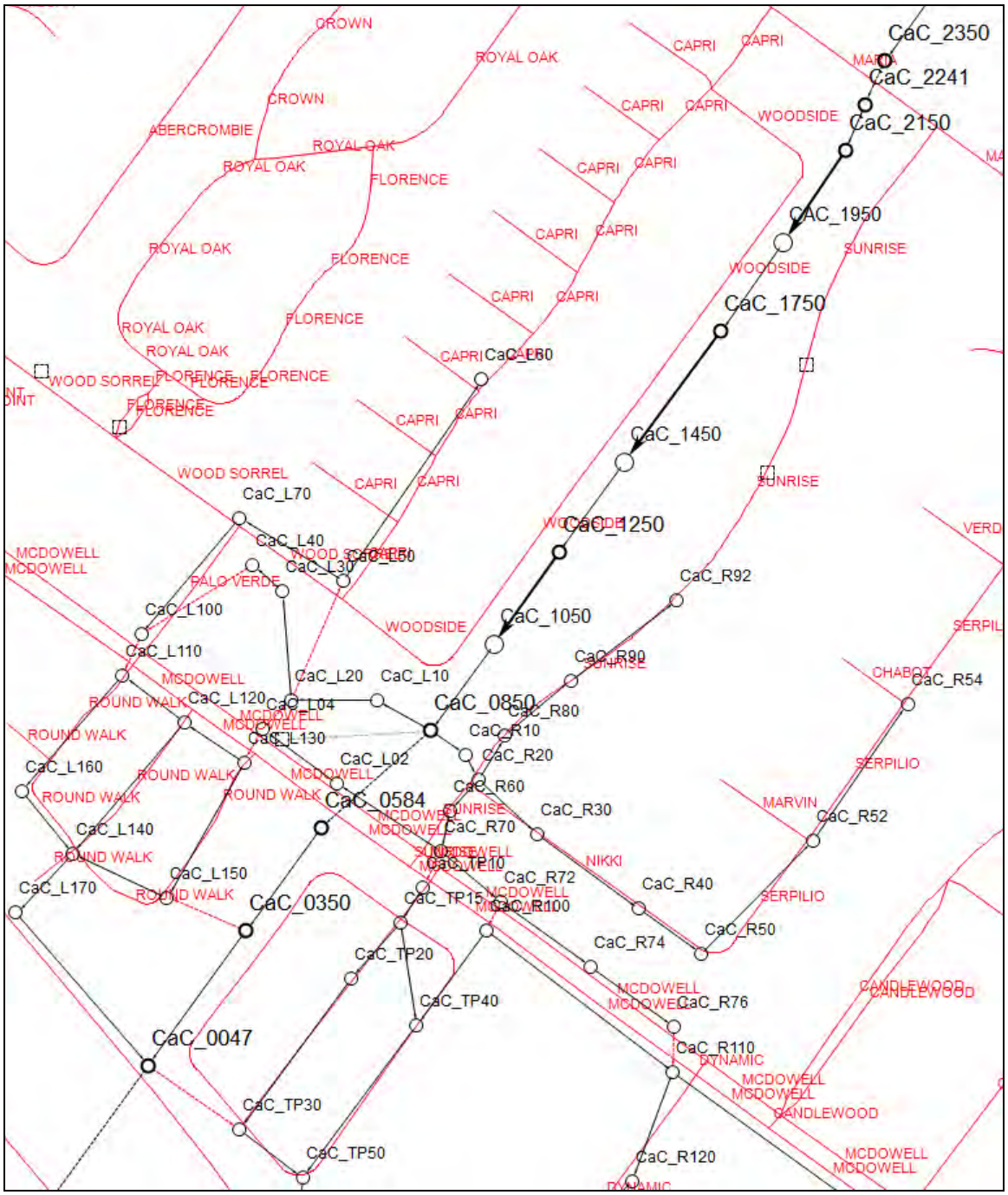


Figure 2. Capri Creek XP Model Detail

New cross section data was extracted based on the City's 2-foot contour topography at each node. The following XP-Storm model file names were used in the evaluation of existing conditions:

- 10yr_1-25-13.xp (10-year event)
- 25yr_1-25-13.xp (25-year event)
- 50yr_1-25-13.xp (50-year event)
- 100yr_1-25-13.xp (100-year event)

Cross section data for the proposed terracing was provided by the City in *Plan 32* of the HEC-RAS model with file name *capricreekhec-ras.prj*. Six XP-Storm cross sections were edited based on the proposed terracing between model nodes CaC_0850 and CaC_2150. Table 1 provides the HEC-RAS cross section ID that best represents each XP-Storm reach. The existing and proposed condition cross sections are illustrated in Attachment 1.

Table 1. HEC-RAS Cross Sections Used in XP-Storm

XP Storm Reach		HEC-RAS Cross Section ID
From Node	To Node	
CaC_0850	CaC_1050	1300
CaC_1050	CaC_1250	1500
CaC_1250	CaC_1450	1700
CaC_1450	CaC_1750	2000
CaC_1750	CaC_1950	2200
CaC_1950	CaC_2150	2400

The following XP-Storm model file names were used in the evaluation of proposed conditions:

- 10yr_1-25-13 Proposed.xp (10-year event)
- 25yr_1-25-13 Proposed.xp (25-year event)
- 50yr_1-25-13 Proposed.xp (50-year event)
- 100yr_1-25-13 Proposed.xp (100-year event)

Project Benefits

The Capri Creek terracing project will result in reduced flooding in the reach between McDowell Boulevard and Maria Drive. The maximum water surface elevation reduction occurs at model node CaC_1750 and is summarized in Table 2 for each modeled event.

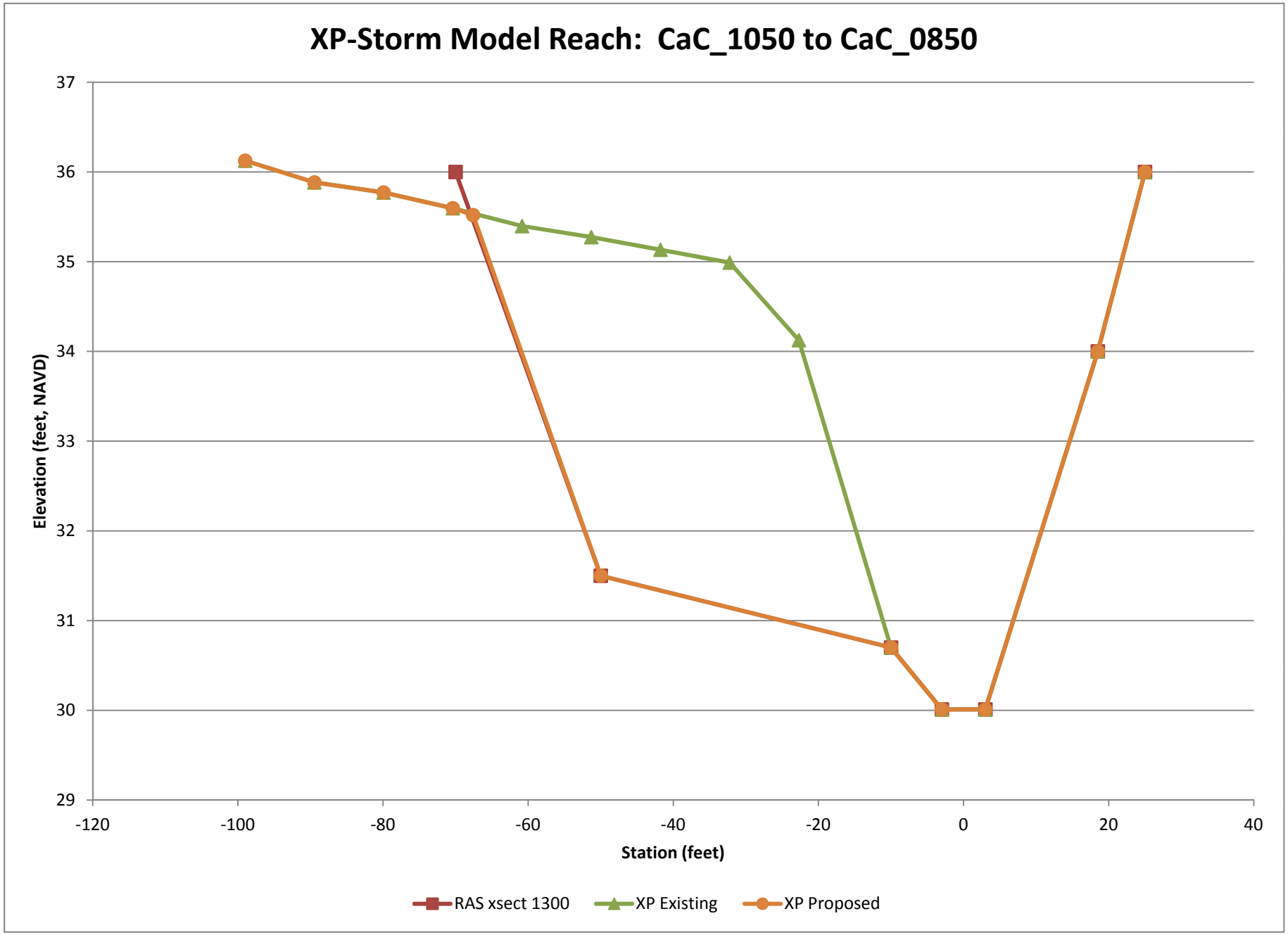
Table 2. Maximum Water Surface Elevation Reduction with Terracing at XP-Storm Node CaC_1750

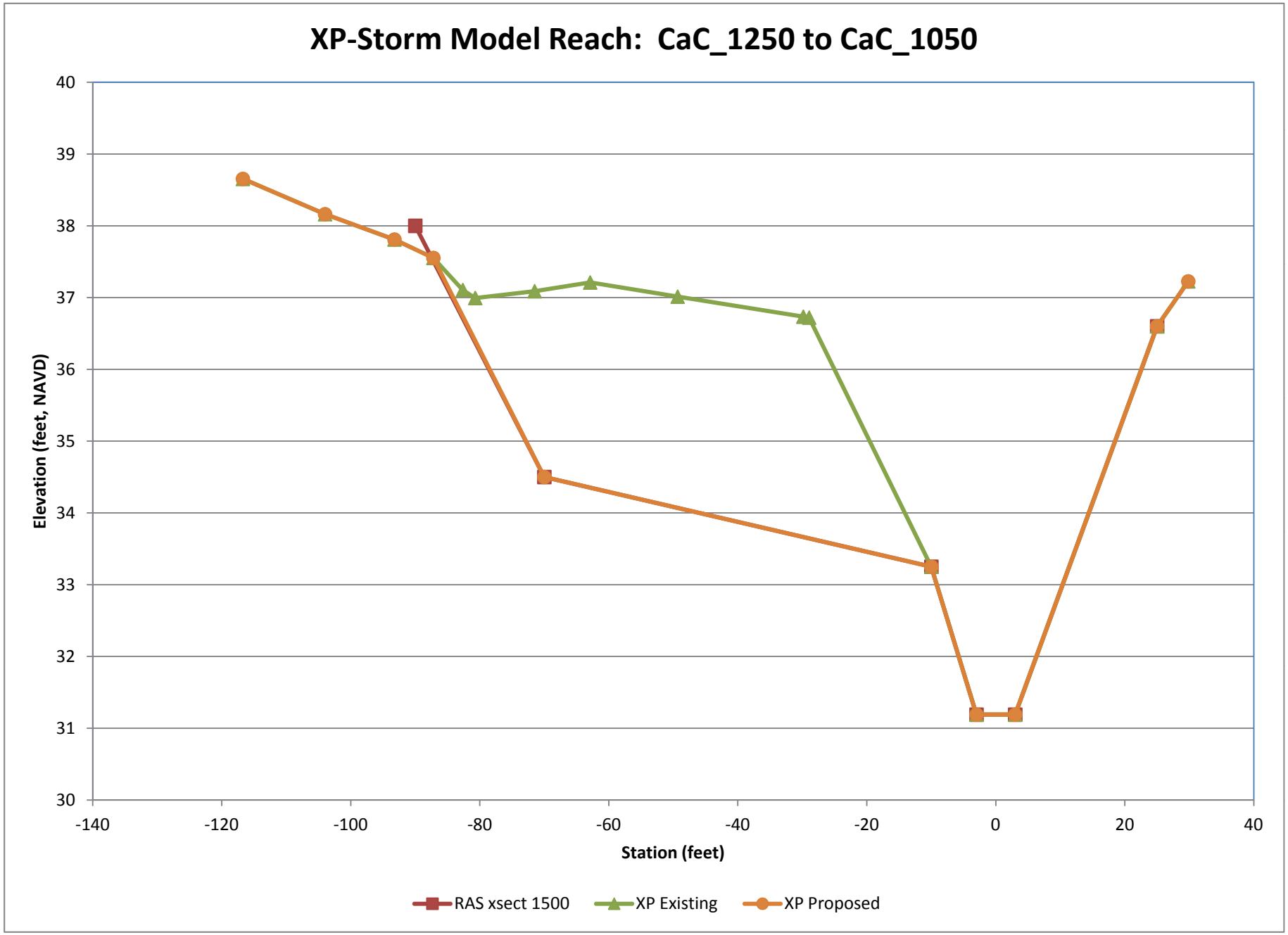
Storm Event Return Interval	Maximum Water Surface Elevation Reduction with Terracing (feet)
10-year	0.5
25-year	0.7
50-year	0.8
100-year	0.9

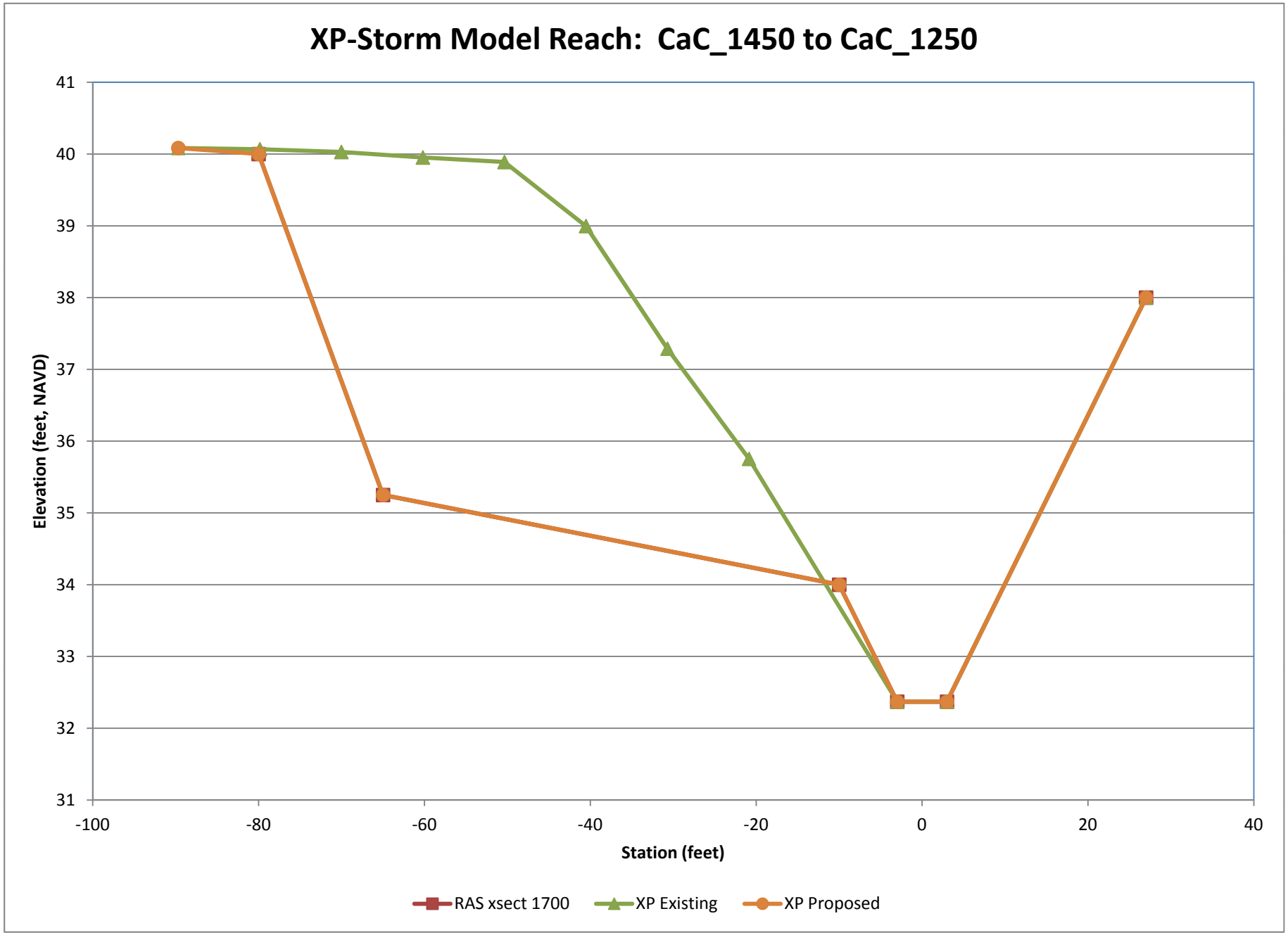
Tabular model results comparing existing and proposed conditions along Capri Creek and the Petaluma River are provided in Attachment 2 for the 10-, 25-, 50-, and 100-year events.

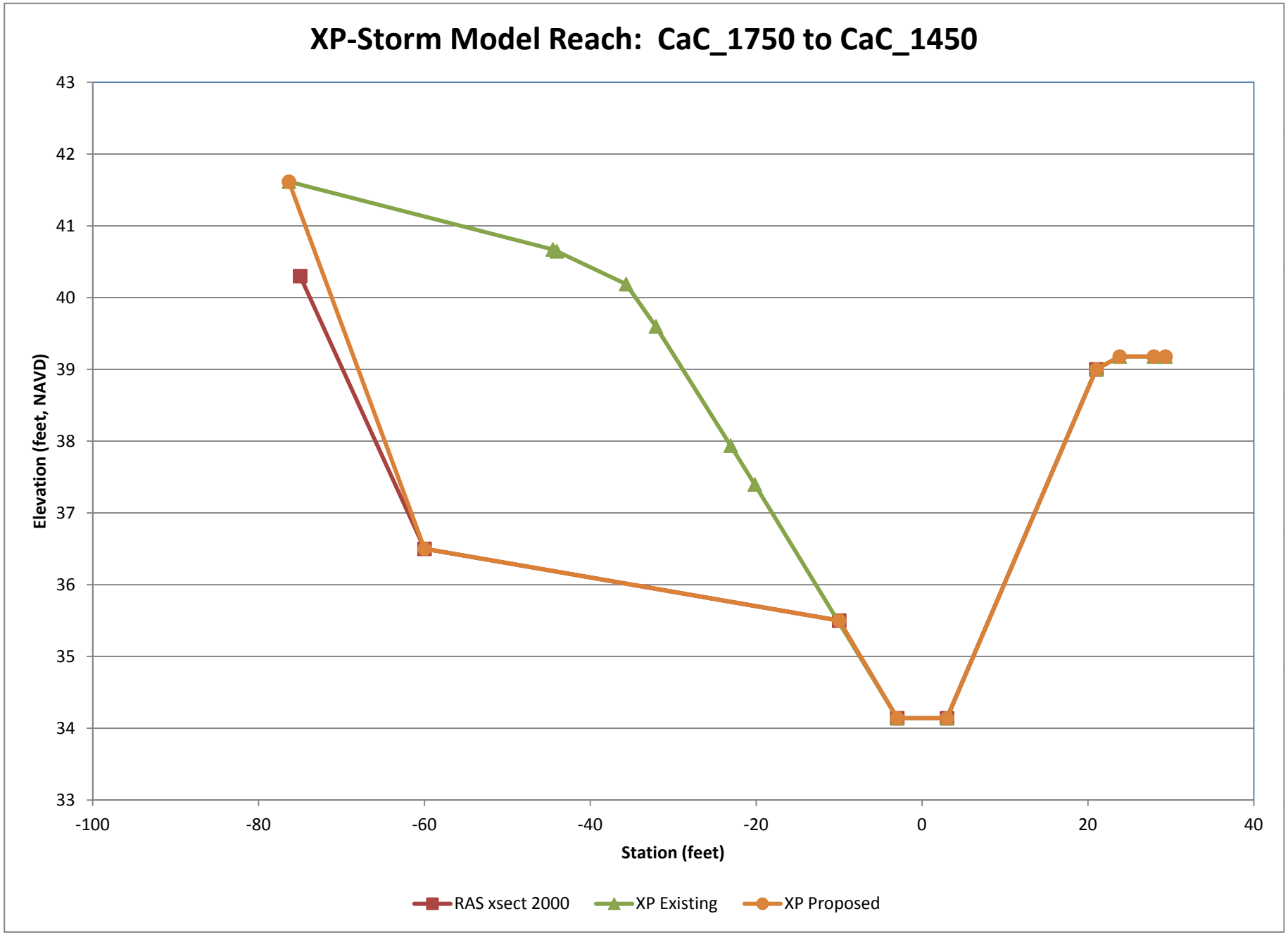
Attachment 1

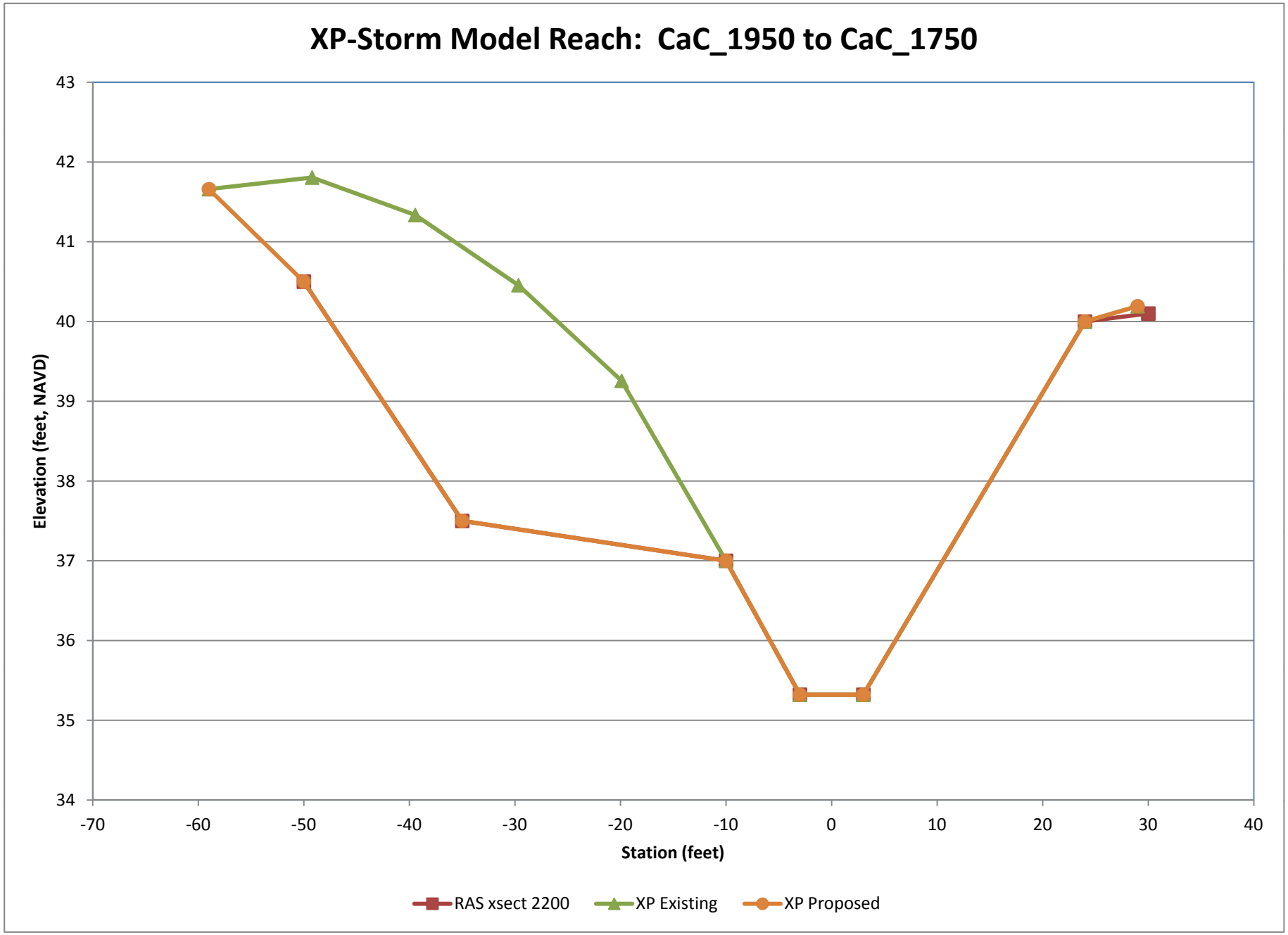
XP-Storm Cross Section Data for Capri Creek Terracing

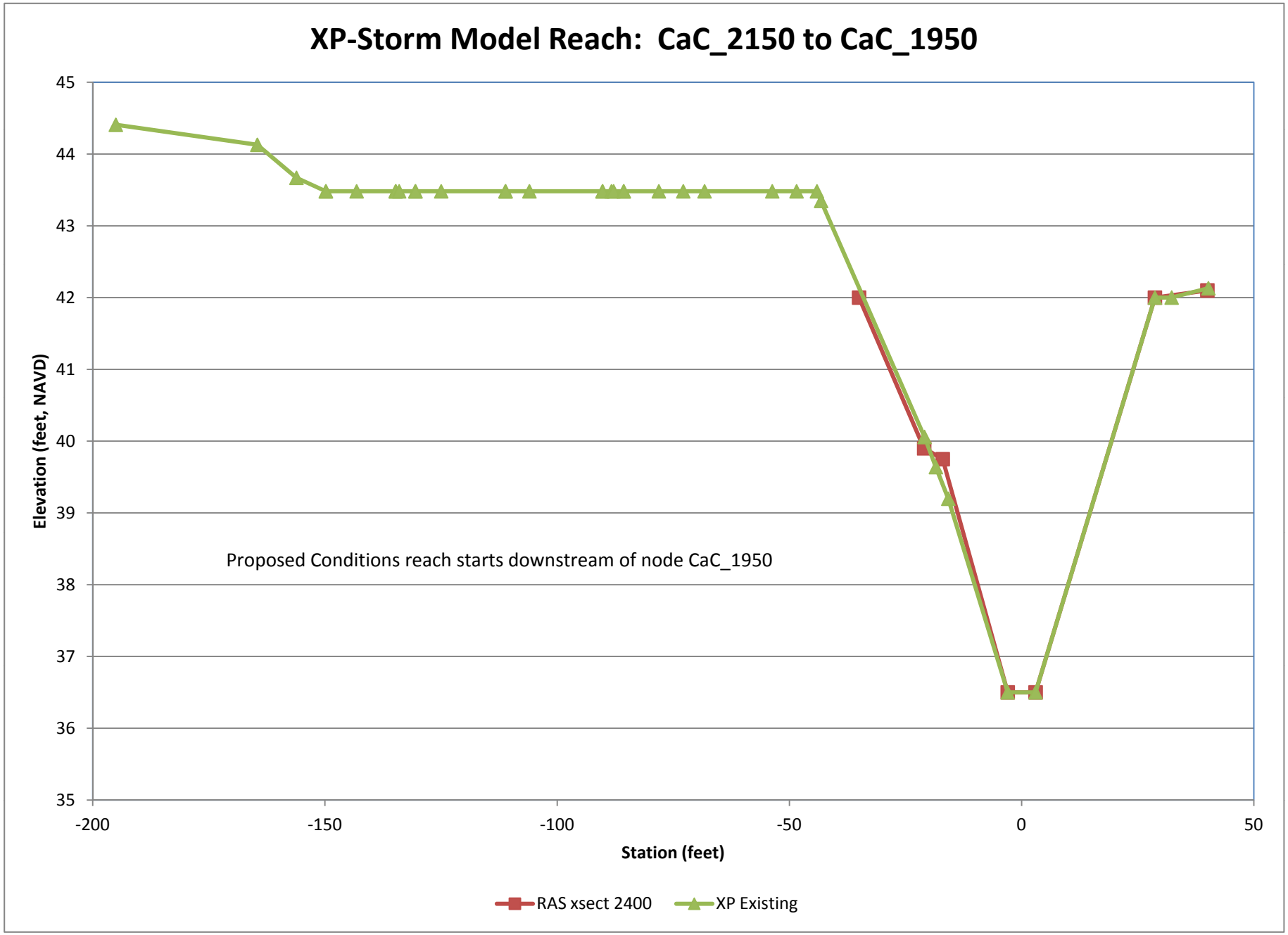

XP-Storm Model Reach: CaC_1050 to CaC_0850
Elevation (feet, NAVD)
37
36
35
34
33
32
31
30
29
-120
-100
-80
-60
-40
-20
0
20
40
Station (feet)
RAS xsect 1300
XP Existing
XP Proposed


XP-Storm Model Reach: CaC_1250 to CaC_1050
Elevation (feet, NAVD)
40
39
38
37
36
35
34
33
32
31
30
-140
-120
-100
-80
-60
-40
-20
0
20
40
Station (feet)
RAS xsect 1500
XP Existing
XP Proposed


XP-Storm Model Reach: CaC_1450 to CaC_1250
Elevation (feet, NAVD)
41
40
39
38
37
36
35
34
33
32
31
-100
-80
-60
-40
-20
0
20
40
Station (feet)
RAS xsect 1700
XP Existing
XP Proposed


XP-Storm Model Reach: CaC_1750 to CaC_1450
Elevation (feet, NAVD)
43
42
41
40
39
38
37
36
35
34
33
-100
-80
-60
-40
-20
0
20
40
Station (feet)
RAS xsect 2000
XP Existing
XP Proposed


XP-Storm Model Reach: CaC_1950 to CaC_1750
Elevation (feet, NAVD)
43
42
41
40
39
38
37
36
35
34
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
Station (feet)
RAS xsect 2200
XP Existing
XP Proposed


XP-Storm Model Reach: CaC_2150 to CaC_1950
Elevation (feet, NAVD)
45
44
43
42
41
40
39
38
37
36
35
-200
-150
-100
-50
0
50
Station (feet)
Proposed Conditions reach starts downstream of node CaC_1950
RAS xsect 2400
XP Existing

Attachment 2

XP-Storm Tabular Summaries

Capri Creek Terracing XP-Storm Results Summary - 10-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Capri Creek	LCaC_47.1	CaC_0047	cc_0040	77	77		28.76	28.75	
	LCaC_47.2	CaC_0047	cc_0040	70	70		28.76	28.75	
	LCaC_47.3	CaC_0047	cc_0040	102	102		28.76	28.75	
	UW_CaC0047	CaC_0047	CaC_TP30	0	0		28.49	28.49	
	LCaC_350	CaC_0350	CaC_0047	244	244		29.03	29.02	
	UW_cacL150	CaC_0350	CaC_L150	0	0		29.90	29.90	
	LCaC_584	CaC_0584	CaC_0350	245	244		29.75	29.75	
	LCaC_850.1	CaC_0850	CaC_0584	227	227		34.33	34.33	
	Link1258	CaC_0850	CaC_L10	0	0		34.33	34.33	
	Link1262	CaC_0850	CaC_R10	67	66		34.33	34.33	
	UWCaC0850	CaC_0850	CapriStor	48	48		29.00	29.00	
	LCaC_1050	CaC_1050	CaC_0850	294	294		34.50	34.36	-0.14
	LCaC_1250	CaC_1250	CaC_1050	295	295		34.94	34.63	-0.31
	LCaC_1450	CaC_1450	CaC_1250	295	295		35.66	35.37	-0.29
	LCaC_1750	CaC_1750	CaC_1450	295	295		37.42	36.91	-0.51
	LCaC_1950	CAC_1950	CaC_1750	295	295		38.63	38.36	-0.27
	LCaC_2150	CaC_2150	CAC_1950	295	295		39.54	39.50	-0.04
	LCaC_2241	CaC_2241	CaC_2150	295	296		40.51	40.51	
	2350weir	CaC_2350	CaC_2241	25	26		36.94	36.94	
	LCaC2350.1	CaC_2350	CaC_2241	271	271		42.44	42.44	
	LCaC_2850	CaC_2850	CaC_2350	277	277		44.84	44.84	
	LCaC_3250	CaC_3250	CaC_2850	278	278		48.34	48.34	
	LCaC_3650	CaC_3650	CaC_3250	278	278		51.43	51.43	
	lCaC_3898	CaC_3898	CaC_3650	278	278		52.80	52.80	
	LCaC_3900	CaC_3900	CaC_3898	279	278		53.69	53.69	
	LCaC4044.1	CaC_4044	CaC_3900	267	266		55.62	55.61	
	UWCac4044	CaC_4044	CaC_3900	17	16		49.35	49.35	
	lCaC_4446	CaC_4446	CaC_4044	251	250	-1	55.60	55.60	
	lCaC_4448	CaC_4448	CaC_4446	251	251		56.24	56.24	
	LCaC_4450	CaC_4450	CaC_4448	252	252		57.44	57.44	
	lCaC_4846	CaC_4846	CaC_4450	253	253		58.09	58.09	
	lCaC_4848	CaC_4848	CaC_4846	253	253		59.36	59.36	
	LCaC_4850	CaC_4850	CaC_4848	253	253		61.28	61.28	
	Link1346	CaC_5171	CaC5171L10	5	5		64.94	64.94	
	Link1354	CaC_5171	CaC_4850	253	253		64.94	64.94	
	LCaC_5181	CaC_5181	CaC_5171	256	256		65.40	65.40	
	LCaC_5548	CaC_5548	CaC_5181	258	258		67.57	67.57	
	LCaC_5902	CaC_5902	CaC_5548	275	275		75.27	75.27	
	LCaC_6105	CaC_6105	CaC_5902	276	276		78.75	78.75	
	lCaC_6200	CaC_6200	CaC_6105	276	276		84.22	84.22	
	Link1278	CaC_L02	CaC_L04	2	2		34.10	34.08	-0.02
	UW_cacL04	CaC_L04	CaC_L20	1	0		34.00	34.00	
	UW_cacL130	CaC_L04	CaC_L130	0	0		34.00	34.00	
	Link1259	CaC_L10	CaC_L20	0	0		34.67	34.67	
	UW_cacL110	CaC_L100	CaC_L110	0	0		33.33	33.33	
	Link1447	CaC_L110	CaC_L160	0	0		33.33	33.33	
	Link1451	CaC_L120	CaC_L140	0	0		33.90	33.90	
	Link1455	CaC_L120	CaC_L110	0	0		33.90	33.90	
	Link1452	CaC_L130	CaC_L150	0	0		34.02	34.01	
	Link1454	CaC_L130	CaC_L120	0	0		34.02	34.01	
	Link1449	CaC_L140	CaC_L170	0	0		30.44	30.44	
	Link1453	CaC_L150	CaC_L140	0	0		30.10	30.05	-0.05
	Link1448	CaC_L160	CaC_L140	0	0		29.63	29.62	
	Link1450	CaC_L170	CaC_0047	0	0		30.00	30.00	
	Link1260	CaC_L20	CaC_L30	0	0		34.03	34.02	
	UW_cacL50	CaC_L20	CaC_L50	0	0		33.65	33.65	

Capri Creek Terracing XP-Storm Results Summary - 10-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	Link1261	CaC_L30	CaC_L40	0	0		32.85	32.84	-0.01
	UW_cacL40	CaC_L40	CaC_L100	0	0		33.60	33.60	
	Link1440	CaC_L50	CaC_L60	0	0		33.65	33.65	
	Link1441	CaC_L50	CaC_L70	0	0		33.65	33.65	
	Link1444	CaC_L70	CaC_L100	0	0		33.60	33.60	
	Link1263	CaC_R10	CaC_R20	66	66		34.33	34.33	
	Link1417	CaC_R100	CaC_R110	1	1		33.61	33.60	-0.01
	Link1438	CaC_R100	CaC_TP40	13	11	-2	33.61	33.60	-0.01
	Link1418	CaC_R110	CaC_R190	0	0		33.10	33.09	
	Link1420	CaC_R110	CaC_R120	0	0		33.10	33.09	
	Link1421	CaC_R120	CaC_R150	0	0		30.12	30.11	
	Link1422	CaC_R150	CaC_R160	0	0		29.02	29.01	-0.01
	Link1423	CaC_R160	CaC_R180	0	0		27.90	27.89	
	Link1424	CaC_R180	CaC_R200	0	0		27.21	27.19	-0.02
	Link1428	CaC_R190	CaC_R180	0	0		32.98	32.98	
	Link1264	CaC_R20	CaC_R30	14	14		34.12	34.10	-0.02
	Link1267	CaC_R20	CaC_R60	38	35	-4	34.12	34.10	-0.02
	Link1269	CaC_R20	CaC_R80	12	12		34.12	34.10	-0.02
	Link1425	CaC_R200	CaC_R210	0	0		28.00	28.00	
	Link1265	CaC_R30	CaC_R40	2	1		34.12	34.10	-0.02
	Link1266	CaC_R40	CaC_R50	0	0		34.12	34.10	-0.02
	Link1415	CaC_R50	CaC_R52	0	0		34.05	34.04	-0.01
	Link1416	CaC_R52	CaC_R54	0	0		33.75	33.73	-0.02
	Link1268	CaC_R60	CaC_R70	34	31	-3	34.12	34.10	-0.02
	,	CaC_R70	CaC_TP10	6	4	-2	33.70	33.70	
	Link1271	CaC_R70	CaC_R72	23	20	-3	34.12	34.10	-0.02
	Link1277	CaC_R70	CaC_L02	3	3		34.12	34.10	-0.02
	UW_cacR70	CaC_R70	CaC_TP10	6	4	-2	33.70	33.70	
	Link1272	CaC_R72	CaC_R74	6	6		34.03	34.02	
	UW_cacR72	CaC_R72	CaC_R100	21	18	-2	33.40	33.40	
	Link1273	CaC_R74	CaC_R76	1	0		34.04	34.03	
	UW_cacR76	CaC_R76	CaC_R110	0	0		33.00	33.00	
	Link1270	CaC_R80	CaC_R90	2	1		34.12	34.10	-0.02
	Link1274	CaC_R90	CaC_R92	0	0		34.12	34.10	-0.02
	Link1279	CaC_TP10	CaC_TP15	4	3	-2	33.79	33.77	-0.02
	Link1286	CaC_TP15	CaC_TP20	2	1	-1	30.88	30.85	-0.03
	Link1287	CaC_TP15	CaC_TP40	2	1		30.88	30.85	-0.03
	Link1280	CaC_TP20	CaC_TP30	2	1		30.32	30.27	-0.04
	Link1295	CaC_TP30	CaC_TP50	2	1		28.60	28.56	-0.03
	Link1288	CaC_TP40	CaC_TP50	14	12	-2	30.12	30.12	
	Link1289	CaC_TP50	CaC_TP70	9	7	-3	28.56	28.51	-0.05
	Link1292	CaC_TP70	CaC_TP80	1	1		28.56	28.51	-0.05
	UW_cacTP70	CaC_TP70	CaC_R130	-753	-753		30.35	30.35	
	Link1293	CaC_TP80	CaC_TP90	1	1		28.53	28.49	-0.05
	Link1439	CaC_TP90	pr_0510	1	1		27.58	27.54	-0.04
	lpr_0020	pr_0020	pr_0010	8510	8504	-6	6.53	6.53	
	lpr_0030	pr_0030	pr_0020	8509	8503	-6	6.59	6.59	
	lpr_0040	pr_0040	pr_0030	8508	8502	-6	6.65	6.65	
	lpr_0050	pr_0050	pr_0040	7083	7077	-6	6.73	6.73	
	lpr_0060	pr_0060	pr_0050	7075	7069	-5	6.76	6.76	
	lpr_0070	pr_0070	pr_0060	7069	7064	-5	6.93	6.93	
	lpr_0080	pr_0080	pr_0070	7066	7062	-5	6.98	6.98	
	lpr_0090	pr_0090	pr_0080	7064	7059	-5	7.05	7.05	
	lpr_0100	pr_0094	pr_0090	6520	6515	-5	7.07	7.07	
	Link1230	pr_0096	pr_0094	6517	6512	-5	7.19	7.18	
	Link1229	pr_0098	pr_0096	6516	6511	-5	7.23	7.23	

Capri Creek Terracing XP-Storm Results Summary - 10-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Petaluma River	Link1228	pr_0100	pr_0098	6515	6510	-4	7.27	7.27	
	lpr_0110	pr_0110	pr_0100	6482	6477	-5	7.33	7.33	
	lpr_0120	pr_0120	pr_0110	6480	6475	-5	7.33	7.33	
	lpr_0130	pr_0130	pr_0120	6478	6473	-5	7.38	7.38	
	lpr_0140	pr_0140	pr_0130	6478	6473	-5	7.43	7.42	
	lpr_0150	pr_0150	pr_0140	6480	6475	-5	7.50	7.50	
	lpr_0160	pr_0160	pr_0150	6268	6263	-5	7.61	7.61	
	lpr_0170	pr_0170	pr_0160	6263	6257	-6	7.67	7.67	
	lpr_0180	pr_0180	pr_0170	6241	6235	-6	7.71	7.71	
	lpr_0190	pr_0190	pr_0180	6241	6235	-6	7.76	7.75	
	lpr_0195	pr_0195	pr_0190	6204	6200	-4	7.87	7.87	
	lpr_0200	pr_0200	pr_0195	5691	5689	-2	7.94	7.94	
	Link1239	pr_0206	pr_0200	5660	5658	-2	7.96	7.96	
	lpr_0208	pr_0208	pr_0206	5658	5656	-2	8.04	8.03	
	lpr_0210	pr_0210	pr_0208	5656	5654	-2	8.03	8.02	
	lpr_0220	pr_0220	pr_0210	5639	5638	-2	8.07	8.07	
	lpr_0230	pr_0230	pr_0220	5636	5634	-2	8.08	8.07	
	lpr_0240	pr_0240	pr_0230	5631	5628	-3	8.08	8.08	
	lpr_0250	pr_0250	pr_0240	5628	5626	-2	8.08	8.08	
	lpr_0260	pr_0260	pr_0250	5626	5623	-3	8.09	8.08	
	lpr_0270	pr_0270	pr_0260	5624	5622	-3	8.09	8.09	
	lpr_0280	pr_0280	pr_0270	5623	5621	-2	8.11	8.10	
	lpr_0290	pr_0290	pr_0280	5622	5620	-2	7.99	7.99	
	lpr_0298	pr_0298	pr_0290	5505	5510	5	8.39	8.39	
	lpr_0300	pr_0300	pr_0298	5505	5510	5	8.53	8.52	
	lpr_0308	pr_0308	pr_0300	5505	5510	5	8.73	8.73	
	lpr_0310	pr_0310	pr_0308	5505	5510	5	8.86	8.86	
	lpr_0320	pr_0320	pr_0310	5505	5510	5	8.77	8.77	
	lpr_0322	pr_0322	pr_0320	5472	5472		19.42	19.42	
	lpr_0330	pr_0330	pr_0320	5505	5510	5	8.88	8.88	
	lpr_0338	pr_0338	pr_0330	5483	5488	5	9.18	9.18	
	lpr_0340	pr_0340	pr_0338	5483	5488	5	9.44	9.44	
	lpr_0350	pr_0350	pr_0340	5483	5488	5	9.78	9.78	
	lpr_0360	pr_0360	pr_0350	5483	5488	5	10.98	10.98	
	lpr_0370	pr_0370	pr_0360	5433	5438	5	11.68	11.69	
	lpr_0380	pr_0380	pr_0370	5433	5438	5	12.19	12.19	
	lpr_0390	pr_0390	pr_0380	4941	4945	4	13.05	13.06	
	lpr_0400	pr_0400	pr_0390	4404	4408	3	13.25	13.25	
	lpr_0410	pr_0410	pr_0400	60	60		21.97	21.97	
	lpr_0420	pr_0420	pr_0400	4404	4407	3	13.50	13.51	
	lpr_0430	pr_0430	pr_0420	4404	4407	3	13.69	13.69	
	lpr_0440	pr_0440	pr_0430	4404	4407	3	15.11	15.12	
	lpr_0445	pr_0445	pr_0440	4403	4406	3	16.07	16.08	
	lpr_0448	pr_0448	pr_0445	4403	4406	3	16.32	16.33	
	lpr_0450	pr_0450	pr_0448	4403	4406	3	16.54	16.55	
	lpr_0452	pr_0452	pr_0450	4403	4406	3	16.70	16.71	
	lpr_0458	pr_0458	pr_0452	4404	4407	3	16.98	16.99	
	lpr_0460	pr_0460	pr_0458	4404	4407	3	17.11	17.11	
	lpr_0465	pr_0465	pr_0460	4377	4380	3	17.34	17.34	
	lpr_0470	pr_0470	pr_0465	4378	4381	3	17.47	17.47	
	lpr_0480	pr_0480	pr_0470	4379	4382	3	17.72	17.73	
	lpr_0490	pr_0490	pr_0480	4380	4383	3	18.21	18.21	
	lpr_0496	pr_0496	pr_0490	4382	4385	3	18.43	18.43	
	lpr_0498	pr_0498	pr_0496	4383	4386	3	18.97	18.97	
	lpr_0500	pr_0500	pr_0498	4384	4387	3	19.04	19.04	
	lpr_0510	pr_0510	pr_0500	4385	4388	3	19.34	19.34	

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Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	lpr_0520	pr_0520	pr_0510	4358	4361	3	19.78	19.79	
	lpr_0530	pr_0530n	pr_0520	4361	4364	3	20.20	20.20	
	lpr_0540	pr_0540n	pr_0530n	4364	4367	3	21.01	21.01	
	lpr_0550	pr_0550	pr_0540n	3876	3878	2	21.55	21.55	
	lpr_0552	pr_0552	pr_0550	3878	3880	1	21.65	21.65	
	3876.1	pr_0554	pr_0552	3879	3880	1	21.62	21.62	
	3876.2	pr_0554	pr_0552	0	0		21.62	21.62	
	lpr_0560	pr_0560	pr_0554	3879	3881	1	22.11	22.12	
	lpr_0570	pr_0570	pr_0560	3891	3892	1	24.16	24.16	
	lpr_0580	pr_0580	pr_0570	3892	3893	1	25.13	25.13	
	lpr_0590	pr_0590n	pr_0580	3929	3929		26.85	26.85	
	lpr_0600	pr_0600n	pr_0590n	4078	4078		27.32	27.32	
	lpr_0606	pr_0606n	pr_0600n	4029	4030		28.03	28.03	
	2150.1	pr_0607n	pr_0606n	4033	4033		28.29	28.29	
	UWCorona	pr_0607n	pr_0606n	0	0		11.26	11.26	
	lpr_0608	pr_0608n	pr_0607n	4033	4033		28.32	28.32	
	lpr_0610	pr_0610n	pr_0608n	3591	3591		28.68	28.68	
	lpr_0612	pr_0612n	pr_0610n	3584	3585		28.84	28.84	
	lpr_0614	pr_0614n	pr_0612n	3578	3578		28.99	28.99	
	lpr_0616	pr_0616n	pr_0614n	3555	3556		29.08	29.08	
	lpr_0618	pr_0618n	pr_0616n	3546	3547		29.33	29.33	
	lpr_0620	pr_0620n	pr_0618n	3539	3540		30.04	30.04	
	lpr_0630	pr_0630n	pr_0620n	3537	3537		30.54	30.54	
	lpr_0640	pr_0640n	pr_0630n	3537	3537		31.44	31.44	
	lpr_0650	pr_0650	pr_0640n	3538	3538		31.52	31.52	
	lpr_0660	pr_0660	pr_0650	3548	3548		31.65	31.65	
	lpr_0670	pr_0670n	pr_0660	3562	3563		32.35	32.35	
	lpr_0680	pr_0680n	pr_0670n	3552	3553		32.40	32.40	
	2792.1	pr_0682	pr_0680n	3557	3557		32.51	32.51	
	682lob	pr_0682	pr_0680n	0	0		15.70	15.70	
	2791.1	pr_0684	pr_0682	3557	3558		32.63	32.63	
	684lob	pr_0684	pr_0682	0	0		15.89	15.89	
	lpr_0690	pr_0690n	pr_0684	3558	3559		32.58	32.58	
	lpr_0700	pr_0700	pr_0690n	3565	3565		32.75	32.76	
	lpr_0710	pr_0710	pr_0700	3567	3567		34.73	34.73	
	lpr_0720	pr_0720	pr_0710	3532	3533		35.69	35.69	
	lpr_0723	pr_0723	pr_0720	3533	3533		36.93	36.93	
	3663.1	pr_0725	pr_0723	1087	1088	1	37.39	37.39	
	3663.2	pr_0725	pr_0723	3032	3031		37.39	37.39	
	lpr_0730	pr_0730	pr_0725	3533	3533		37.65	37.65	
	lpr_0740	pr_0740	pr_0730	3587	3588		37.74	37.74	
	2526.1	pr_0745	pr_0740	3239	3239		38.06	38.06	
	2526.2	pr_0745	pr_0740	348	349		38.06	38.06	
	lpr_0750	pr_0750	pr_0745	3587	3587		38.19	38.19	
	lpr_0760	pr_0760	pr_0750	3587	3587		38.33	38.33	

Notes:

(1) Change due to project--negative values indicate a decrease, and positive values an increase. Differences in discharge less than 1 cfs and water surface elevation less than 0.01 feet are left blank.

Capri Creek Terracing XP-Storm Results Summary - 25-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Capri Creek	LCaC_47.1	CaC_0047	cc_0040	87	84	-3	29.08	28.98	-0.11
	LCaC_47.2	CaC_0047	cc_0040	79	76	-3	29.08	28.98	-0.11
	LCaC_47.3	CaC_0047	cc_0040	112	107	-5	29.08	28.98	-0.11
	UW_CaC0047	CaC_0047	CaC_TP30	-19	-17	-2	28.49	28.49	
	LCaC_350	CaC_0350	CaC_0047	267	258	-9	29.32	29.22	-0.10
	UW_cacL150	CaC_0350	CaC_L150	0	0		29.90	29.90	
	LCaC_584	CaC_0584	CaC_0350	268	259	-9	29.98	29.90	-0.08
	LCaC_850.1	CaC_0850	CaC_0584	236	236		34.49	34.49	
	Link1258	CaC_0850	CaC_L10	0	0		34.49	34.49	
	Link1262	CaC_0850	CaC_R10	145	144		34.49	34.49	
	UWCaC0850	CaC_0850	CapriStor	48	48		29.00	29.00	
	LCaC_1050	CaC_1050	CaC_0850	382	381		34.75	34.53	-0.22
	LCaC_1250	CaC_1250	CaC_1050	382	382		35.29	34.85	-0.44
	LCaC_1450	CaC_1450	CaC_1250	382	382		36.06	35.58	-0.48
	LCaC_1750	CaC_1750	CaC_1450	382	382		37.81	37.12	-0.69
	LCaC_1950	CAC_1950	CaC_1750	383	383		39.02	38.63	-0.40
	LCaC_2150	CaC_2150	CAC_1950	383	383		39.95	39.89	-0.06
	LCaC_2241	CaC_2241	CaC_2150	383	383		40.88	40.88	
	2350weir	CaC_2350	CaC_2241	123	122		36.94	36.94	
	LCaC2350.1	CaC_2350	CaC_2241	274	274		42.72	42.72	
	LCaC_2850	CaC_2850	CaC_2350	359	359		45.15	45.15	
	LCaC_3250	CaC_3250	CaC_2850	359	360		48.69	48.69	
	LCaC_3650	CaC_3650	CaC_3250	360	360		51.76	51.76	
	lCaC_3898	CaC_3898	CaC_3650	360	360		53.17	53.17	
	LCaC_3900	CaC_3900	CaC_3898	360	360		54.08	54.08	
	LCaC4044.1	CaC_4044	CaC_3900	271	271		55.92	55.92	
	UWCac4044	CaC_4044	CaC_3900	108	108		49.35	49.35	
	lCaC_4446	CaC_4446	CaC_4044	325	325		55.90	55.90	
	lCaC_4448	CaC_4448	CaC_4446	326	326		56.64	56.64	
	LCaC_4450	CaC_4450	CaC_4448	327	327		57.91	57.92	
	lCaC_4846	CaC_4846	CaC_4450	327	327		58.46	58.46	
	lCaC_4848	CaC_4848	CaC_4846	327	327		59.74	59.74	
	LCaC_4850	CaC_4850	CaC_4848	327	327		61.68	61.68	
	Link1346	CaC_5171	CaC5171L10	8	8		65.45	65.45	
	Link1354	CaC_5171	CaC_4850	327	327		65.45	65.45	
	LCaC_5181	CaC_5181	CaC_5171	331	331		65.91	65.91	
	LCaC_5548	CaC_5548	CaC_5181	335	335		67.91	67.91	
	LCaC_5902	CaC_5902	CaC_5548	353	353		75.33	75.33	
	LCaC_6105	CaC_6105	CaC_5902	354	354		78.83	78.83	
	lCaC_6200	CaC_6200	CaC_6105	354	354		84.41	84.41	
	Link1278	CaC_L02	CaC_L04	9	9		34.33	34.33	
	UW_cacL04	CaC_L04	CaC_L20	5	5		34.00	34.00	
	UW_cacL130	CaC_L04	CaC_L130	4	4		34.00	34.00	
	Link1259	CaC_L10	CaC_L20	0	0		34.67	34.67	
	UW_cacL110	CaC_L100	CaC_L110	0	0		33.33	33.33	
	Link1447	CaC_L110	CaC_L160	0	0		33.34	33.34	
	Link1451	CaC_L120	CaC_L140	0	0		33.94	33.94	
	Link1455	CaC_L120	CaC_L110	0	0		33.94	33.94	
	Link1452	CaC_L130	CaC_L150	3	3		34.09	34.08	
	Link1454	CaC_L130	CaC_L120	0	0		34.09	34.08	
	Link1449	CaC_L140	CaC_L170	1	1		30.54	30.54	
	Link1453	CaC_L150	CaC_L140	2	2		30.55	30.54	
	Link1448	CaC_L160	CaC_L140	-1	-1		30.25	30.23	-0.02
	Link1450	CaC_L170	CaC_0047	0	0		30.14	30.13	
	Link1260	CaC_L20	CaC_L30	0	0		34.14	34.14	
	UW_cacL50	CaC_L20	CaC_L50	1	1		33.65	33.65	

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Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	Link1261	CaC_L30	CaC_L40	0	0		33.05	33.04	
	UW_cacL40	CaC_L40	CaC_L100	0	0		33.60	33.60	
	Link1440	CaC_L50	CaC_L60	0	0		34.02	34.01	
	Link1441	CaC_L50	CaC_L70	0	0		34.02	34.01	
	Link1444	CaC_L70	CaC_L100	0	0		33.60	33.60	
	Link1263	CaC_R10	CaC_R20	145	144		34.49	34.49	
	Link1417	CaC_R100	CaC_R110	3	3		33.74	33.74	
	Link1438	CaC_R100	CaC_TP40	52	51		33.74	33.74	
	Link1418	CaC_R110	CaC_R190	1	1		33.24	33.24	
	Link1420	CaC_R110	CaC_R120	4	4		33.24	33.24	
	Link1421	CaC_R120	CaC_R150	4	4		30.26	30.26	
	Link1422	CaC_R150	CaC_R160	3	3		29.28	29.27	
	Link1423	CaC_R160	CaC_R180	3	3		27.99	27.99	
	Link1424	CaC_R180	CaC_R200	0	0		27.71	27.69	-0.02
	Link1428	CaC_R190	CaC_R180	1	1		33.04	33.04	
	Link1264	CaC_R20	CaC_R30	24	25	2	34.42	34.42	
	Link1267	CaC_R20	CaC_R60	129	127	-2	34.42	34.42	
	Link1269	CaC_R20	CaC_R80	17	18	1	34.42	34.42	
	Link1425	CaC_R200	CaC_R210	0	0		28.00	28.00	
	Link1265	CaC_R30	CaC_R40	6	6		34.43	34.42	
	Link1266	CaC_R40	CaC_R50	4	4		34.43	34.42	
	Link1415	CaC_R50	CaC_R52	4	4		34.30	34.29	-0.01
	Link1416	CaC_R52	CaC_R54	0	0		34.30	34.29	-0.01
	Link1268	CaC_R60	CaC_R70	128	126	-2	34.42	34.42	
	,	CaC_R70	CaC_TP10	54	53	-1	33.70	33.70	
	Link1271	CaC_R70	CaC_R72	63	63		34.39	34.39	
	Link1277	CaC_R70	CaC_L02	10	9		34.39	34.39	
	UW_cacR70	CaC_R70	CaC_TP10	54	53	-1	33.70	33.70	
	Link1272	CaC_R72	CaC_R74	8	8		34.15	34.15	
	UW_cacR72	CaC_R72	CaC_R100	57	57		33.40	33.40	
	Link1273	CaC_R74	CaC_R76	3	3		34.15	34.14	
	UW_cacR76	CaC_R76	CaC_R110	3	3		33.00	33.00	
	Link1270	CaC_R80	CaC_R90	4	4		34.42	34.42	
	Link1274	CaC_R90	CaC_R92	0	0		34.43	34.42	
	Link1279	CaC_TP10	CaC_TP15	53	52	-1	33.99	33.99	
	Link1286	CaC_TP15	CaC_TP20	34	33		31.16	31.15	
	Link1287	CaC_TP15	CaC_TP40	20	19		31.16	31.15	
	Link1280	CaC_TP20	CaC_TP30	35	35		30.63	30.64	
	Link1295	CaC_TP30	CaC_TP50	35	34		29.81	29.79	-0.02
	Link1288	CaC_TP40	CaC_TP50	70	68	-2	30.24	30.24	
	Link1289	CaC_TP50	CaC_TP70	47	47		29.81	29.79	-0.02
	Link1292	CaC_TP70	CaC_TP80	18	17		29.81	29.79	-0.02
	UW_cacTP70	CaC_TP70	CaC_R130	-753	-753		30.35	30.35	
	Link1293	CaC_TP80	CaC_TP90	18	17		29.72	29.70	-0.02
	Link1439	CaC_TP90	pr_0510	17	17		28.44	28.42	-0.02
	lpr_0020	pr_0020	pr_0010	10071	10067	-4	6.53	6.53	
	lpr_0030	pr_0030	pr_0020	10071	10067	-4	6.62	6.62	
	lpr_0040	pr_0040	pr_0030	10070	10067	-4	6.70	6.70	
	lpr_0050	pr_0050	pr_0040	8401	8399	-2	6.81	6.81	
	lpr_0060	pr_0060	pr_0050	8401	8398	-3	6.85	6.85	
	lpr_0070	pr_0070	pr_0060	8401	8397	-4	7.07	7.07	
	lpr_0080	pr_0080	pr_0070	8400	8396	-4	7.14	7.14	
	lpr_0090	pr_0090	pr_0080	8399	8395	-4	7.20	7.20	
	lpr_0100	pr_0094	pr_0090	7778	7779	1	7.23	7.23	
	Link1230	pr_0096	pr_0094	7778	7779	1	7.37	7.37	
	Link1229	pr_0098	pr_0096	7778	7779	1	7.43	7.43	

Capri Creek Terracing XP-Storm Results Summary - 25-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Petaluma River	Link1228	pr_0100	pr_0098	7778	7779	1	7.48	7.48	
	lpr_0110	pr_0110	pr_0100	7761	7762	1	7.55	7.55	
	lpr_0120	pr_0120	pr_0110	7760	7761	1	7.55	7.55	
	lpr_0130	pr_0130	pr_0120	7760	7761	1	7.61	7.61	
	lpr_0140	pr_0140	pr_0130	7759	7760	1	7.68	7.67	
	lpr_0150	pr_0150	pr_0140	7758	7759	1	7.78	7.77	
	lpr_0160	pr_0160	pr_0150	7636	7637	1	7.91	7.91	
	lpr_0170	pr_0170	pr_0160	7636	7637	1	7.99	7.99	
	lpr_0180	pr_0180	pr_0170	7624	7625	1	8.05	8.05	
	lpr_0190	pr_0190	pr_0180	7624	7625	1	8.11	8.11	
	lpr_0195	pr_0195	pr_0190	7623	7624	1	8.26	8.26	
	lpr_0200	pr_0200	pr_0195	7350	7352	1	8.37	8.37	
	Link1239	pr_0206	pr_0200	7333	7334	1	8.40	8.40	
	lpr_0208	pr_0208	pr_0206	7333	7334	1	8.53	8.53	
	lpr_0210	pr_0210	pr_0208	7333	7334	1	8.52	8.53	
	lpr_0220	pr_0220	pr_0210	7324	7325	1	8.60	8.60	
	lpr_0230	pr_0230	pr_0220	7324	7325	1	8.61	8.62	
	lpr_0240	pr_0240	pr_0230	7324	7326	2	8.62	8.62	
	lpr_0250	pr_0250	pr_0240	7325	7326	1	8.62	8.62	
	lpr_0260	pr_0260	pr_0250	7325	7327	1	8.63	8.63	
	lpr_0270	pr_0270	pr_0260	7326	7327	1	8.64	8.64	
	lpr_0280	pr_0280	pr_0270	7326	7327	1	8.66	8.66	
	lpr_0290	pr_0290	pr_0280	7326	7328	1	8.49	8.49	
	lpr_0298	pr_0298	pr_0290	7221	7223	1	9.08	9.08	
	lpr_0300	pr_0300	pr_0298	7222	7223	1	9.27	9.27	
	lpr_0308	pr_0308	pr_0300	7222	7223	1	9.58	9.58	
	lpr_0310	pr_0310	pr_0308	7223	7224	1	9.74	9.74	
	lpr_0320	pr_0320	pr_0310	7223	7224	1	9.62	9.62	
	lpr_0322	pr_0322	pr_0320	5472	5472		19.42	19.42	
	lpr_0330	pr_0330	pr_0320	7223	7224	1	9.79	9.79	
	lpr_0338	pr_0338	pr_0330	7197	7198	1	10.23	10.23	
	lpr_0340	pr_0340	pr_0338	7197	7198	1	10.56	10.56	
	lpr_0350	pr_0350	pr_0340	7197	7199	1	10.96	10.96	
	lpr_0360	pr_0360	pr_0350	7198	7199	1	12.31	12.31	
	lpr_0370	pr_0370	pr_0360	7138	7139	1	13.08	13.08	
	lpr_0380	pr_0380	pr_0370	7138	7140	1	13.64	13.64	
	lpr_0390	pr_0390	pr_0380	6330	6333	3	14.53	14.53	
	lpr_0400	pr_0400	pr_0390	5670	5673	3	14.73	14.73	
	lpr_0410	pr_0410	pr_0400	60	60		21.97	21.97	
	lpr_0420	pr_0420	pr_0400	5669	5672	3	14.99	14.99	
	lpr_0430	pr_0430	pr_0420	5669	5672	3	15.18	15.19	
	lpr_0440	pr_0440	pr_0430	5668	5670	3	17.22	17.23	
	lpr_0445	pr_0445	pr_0440	5666	5668	2	17.68	17.68	
	lpr_0448	pr_0448	pr_0445	5664	5666	2	17.83	17.83	
	lpr_0450	pr_0450	pr_0448	5663	5665	2	17.97	17.98	
	lpr_0452	pr_0452	pr_0450	5661	5664	2	18.09	18.09	
	lpr_0458	pr_0458	pr_0452	5660	5662	2	18.30	18.30	
	lpr_0460	pr_0460	pr_0458	5659	5662	2	18.40	18.40	
	lpr_0465	pr_0465	pr_0460	5624	5626	2	18.60	18.60	
	lpr_0470	pr_0470	pr_0465	5623	5626	2	18.69	18.70	
	lpr_0480	pr_0480	pr_0470	5623	5625	2	18.95	18.95	
	lpr_0490	pr_0490	pr_0480	5622	5624	2	19.44	19.44	
	lpr_0496	pr_0496	pr_0490	5622	5624	2	19.59	19.59	
	lpr_0498	pr_0498	pr_0496	5622	5624	2	20.24	20.24	
	lpr_0500	pr_0500	pr_0498	5622	5624	2	20.31	20.32	
	lpr_0510	pr_0510	pr_0500	5622	5624	2	20.59	20.60	

Capri Creek Terracing XP-Storm Results Summary - 25-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	lpr_0520	pr_0520	pr_0510	5579	5581	2	21.19	21.20	
	lpr_0530	pr_0530n	pr_0520	5581	5583	3	21.87	21.87	
	lpr_0540	pr_0540n	pr_0530n	5583	5585	3	22.49	22.49	
	lpr_0550	pr_0550	pr_0540n	5038	5040	1	23.31	23.31	
	lpr_0552	pr_0552	pr_0550	5596	5626	30	23.39	23.39	
	3876.1	pr_0554	pr_0552	5481	5425	-56	23.36	23.36	
	3876.2	pr_0554	pr_0552	0	0		23.36	23.36	
	lpr_0560	pr_0560	pr_0554	6094	5997	-97	23.52	23.52	
	lpr_0570	pr_0570	pr_0560	5052	5053	1	24.49	24.49	
	lpr_0580	pr_0580	pr_0570	5052	5053	1	25.55	25.55	
	lpr_0590	pr_0590n	pr_0580	4993	4993		27.41	27.41	
	lpr_0600	pr_0600n	pr_0590n	5184	5184		27.81	27.81	
	lpr_0606	pr_0606n	pr_0600n	5115	5115		28.50	28.50	
	2150.1	pr_0607n	pr_0606n	5116	5116		28.87	28.87	
	UWCorona	pr_0607n	pr_0606n	0	0		11.26	11.26	
	lpr_0608	pr_0608n	pr_0607n	5116	5116		28.91	28.91	
	lpr_0610	pr_0610n	pr_0608n	4302	4302		29.32	29.32	
	lpr_0612	pr_0612n	pr_0610n	4291	4290		29.45	29.45	
	lpr_0614	pr_0614n	pr_0612n	4280	4279		29.63	29.63	
	lpr_0616	pr_0616n	pr_0614n	4248	4248		29.72	29.72	
	lpr_0618	pr_0618n	pr_0616n	4231	4231		29.92	29.92	
	lpr_0620	pr_0620n	pr_0618n	4217	4217		30.51	30.51	
	lpr_0630	pr_0630n	pr_0620n	4214	4213		31.21	31.21	
	lpr_0640	pr_0640n	pr_0630n	4213	4213		32.73	32.73	
	lpr_0650	pr_0650	pr_0640n	4216	4216		32.77	32.77	
	lpr_0660	pr_0660	pr_0650	4226	4226		32.82	32.82	
	lpr_0670	pr_0670n	pr_0660	4245	4245		33.32	33.32	
	lpr_0680	pr_0680n	pr_0670n	4248	4248		33.36	33.36	
	2792.1	pr_0682	pr_0680n	4247	4247		33.61	33.61	
	682lob	pr_0682	pr_0680n	43	43		15.70	15.70	
	2791.1	pr_0684	pr_0682	4202	4202		33.88	33.88	
	684lob	pr_0684	pr_0682	155	155		15.89	15.89	
	lpr_0690	pr_0690n	pr_0684	4273	4273		33.81	33.81	
	lpr_0700	pr_0700	pr_0690n	4296	4296		33.88	33.88	
	lpr_0710	pr_0710	pr_0700	4310	4310		35.26	35.26	
	lpr_0720	pr_0720	pr_0710	4275	4274		36.07	36.07	
	lpr_0723	pr_0723	pr_0720	4276	4276		37.25	37.25	
	3663.1	pr_0725	pr_0723	2312	2312		37.55	37.55	
	3663.2	pr_0725	pr_0723	3030	3030		37.55	37.55	
	lpr_0730	pr_0730	pr_0725	4276	4276		37.70	37.70	
	lpr_0740	pr_0740	pr_0730	4320	4320		37.86	37.86	
	2526.1	pr_0745	pr_0740	3500	3500		38.29	38.29	
	2526.2	pr_0745	pr_0740	820	820		38.29	38.29	
	lpr_0750	pr_0750	pr_0745	4320	4320		38.56	38.56	
	lpr_0760	pr_0760	pr_0750	4320	4320		38.73	38.73	

Notes:

(1) Change due to project--negative values indicate a decrease, and positive values an increase. Differences in discharge less than 1 cfs and water surface elevation less than 0.01 feet are left blank.

Capri Creek Terracing XP-Storm Results Summary - 50-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Capri Creek	LCaC_47.1	CaC_0047	cc_0040	98	98		29.51	29.48	-0.03
	LCaC_47.2	CaC_0047	cc_0040	90	89		29.51	29.48	-0.03
	LCaC_47.3	CaC_0047	cc_0040	119	118		29.51	29.48	-0.03
	UW_CaC0047	CaC_0047	CaC_TP30	-64	-62	-2	28.49	28.49	
	LCaC_350	CaC_0350	CaC_0047	290	282	-8	29.74	29.71	-0.03
	UW_cacL150	CaC_0350	CaC_L150	0	0		29.90	29.90	
	LCaC_584	CaC_0584	CaC_0350	294	287	-7	30.28	30.20	-0.08
	LCaC_850.1	CaC_0850	CaC_0584	239	239		34.57	34.57	
	Link1258	CaC_0850	CaC_L10	0	0		34.57	34.57	
	Link1262	CaC_0850	CaC_R10	193	192		34.57	34.57	
	UWCaC0850	CaC_0850	CapriStor	48	48		29.00	29.00	
	LCaC_1050	CaC_1050	CaC_0850	432	431		34.88	34.62	-0.26
	LCaC_1250	CaC_1250	CaC_1050	432	431		35.47	34.96	-0.51
	LCaC_1450	CaC_1450	CaC_1250	432	432		36.26	35.69	-0.57
	LCaC_1750	CaC_1750	CaC_1450	432	432		38.01	37.23	-0.77
	LCaC_1950	CAC_1950	CaC_1750	432	432		39.22	38.76	-0.46
	LCaC_2150	CaC_2150	CAC_1950	432	432		40.15	40.08	-0.08
	LCaC_2241	CaC_2241	CaC_2150	433	432		41.08	41.08	
	2350weir	CaC_2350	CaC_2241	178	178		36.94	36.94	
	LCaC2350.1	CaC_2350	CaC_2241	274	274		42.82	42.82	
	LCaC_2850	CaC_2850	CaC_2350	398	397		45.29	45.29	
	LCaC_3250	CaC_3250	CaC_2850	399	398		49.35	49.35	
	LCaC_3650	CaC_3650	CaC_3250	418	418		51.97	51.97	
	lCaC_3898	CaC_3898	CaC_3650	418	418		53.43	53.43	
	LCaC_3900	CaC_3900	CaC_3898	419	419		54.32	54.32	
	LCaC4044.1	CaC_4044	CaC_3900	274	273		56.01	56.01	
	UWCac4044	CaC_4044	CaC_3900	182	182		49.35	49.35	
	lCaC_4446	CaC_4446	CaC_4044	380	380		55.98	55.98	
	lCaC_4448	CaC_4448	CaC_4446	380	380		56.85	56.85	
	LCaC_4450	CaC_4450	CaC_4448	380	380		58.20	58.20	
	lCaC_4846	CaC_4846	CaC_4450	380	380		58.69	58.69	
	lCaC_4848	CaC_4848	CaC_4846	380	380		59.98	59.98	
	LCaC_4850	CaC_4850	CaC_4848	380	380		61.94	61.94	
	Link1346	CaC_5171	CaC5171L10	12	12		65.77	65.77	
	Link1354	CaC_5171	CaC_4850	380	380		65.77	65.77	
	LCaC_5181	CaC_5181	CaC_5171	385	385		66.24	66.24	
	LCaC_5548	CaC_5548	CaC_5181	390	390		68.13	68.13	
	LCaC_5902	CaC_5902	CaC_5548	408	408		75.36	75.36	
	LCaC_6105	CaC_6105	CaC_5902	409	409		78.89	78.89	
	lCaC_6200	CaC_6200	CaC_6105	410	409		84.52	84.52	
	Link1278	CaC_L02	CaC_L04	14	14		34.40	34.40	
	UW_cacL04	CaC_L04	CaC_L20	6	7		34.00	34.00	
	UW_cacL130	CaC_L04	CaC_L130	7	7		34.00	34.00	
	Link1259	CaC_L10	CaC_L20	0	0		34.67	34.67	
	UW_cacL110	CaC_L100	CaC_L110	0	0		33.33	33.33	
	Link1447	CaC_L110	CaC_L160	0	0		33.34	33.34	
	Link1451	CaC_L120	CaC_L140	0	0		33.95	33.95	
	Link1455	CaC_L120	CaC_L110	0	0		33.95	33.95	
	Link1452	CaC_L130	CaC_L150	6	6		34.12	34.12	
	Link1454	CaC_L130	CaC_L120	0	0		34.12	34.12	
	Link1449	CaC_L140	CaC_L170	2	2		30.61	30.61	
	Link1453	CaC_L150	CaC_L140	6	6		30.64	30.64	
	Link1448	CaC_L160	CaC_L140	-4	-4		30.55	30.55	
	Link1450	CaC_L170	CaC_0047	2	2		30.20	30.20	
	Link1260	CaC_L20	CaC_L30	1	1		34.17	34.17	
	UW_cacL50	CaC_L20	CaC_L50	3	3		33.65	33.65	

Capri Creek Terracing XP-Storm Results Summary - 50-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	Link1261	CaC_L30	CaC_L40	0	0		33.15	33.14	
	UW_cacL40	CaC_L40	CaC_L100	0	0		33.60	33.60	
	Link1440	CaC_L50	CaC_L60	0	0		34.13	34.12	
	Link1441	CaC_L50	CaC_L70	0	0		34.13	34.12	
	Link1444	CaC_L70	CaC_L100	0	0		33.60	33.60	
	Link1263	CaC_R10	CaC_R20	193	192		34.57	34.57	
	Link1417	CaC_R100	CaC_R110	4	4		33.77	33.77	
	Link1438	CaC_R100	CaC_TP40	70	70		33.77	33.77	
	Link1418	CaC_R110	CaC_R190	1	1		33.30	33.29	
	Link1420	CaC_R110	CaC_R120	7	6		33.30	33.29	
	Link1421	CaC_R120	CaC_R150	6	6		30.34	30.34	
	Link1422	CaC_R150	CaC_R160	6	6		29.36	29.36	
	Link1423	CaC_R160	CaC_R180	6	6		28.04	28.04	
	Link1424	CaC_R180	CaC_R200	0	0		28.03	28.02	
	Link1428	CaC_R190	CaC_R180	1	1		33.06	33.06	
	Link1264	CaC_R20	CaC_R30	24	27	2	34.54	34.54	
	Link1267	CaC_R20	CaC_R60	180	180		34.54	34.54	
	Link1269	CaC_R20	CaC_R80	19	21	2	34.54	34.54	
	Link1425	CaC_R200	CaC_R210	0	0		28.03	28.02	
	Link1265	CaC_R30	CaC_R40	10	9		34.54	34.54	
	Link1266	CaC_R40	CaC_R50	9	9		34.54	34.54	
	Link1415	CaC_R50	CaC_R52	8	8		34.53	34.53	
	Link1416	CaC_R52	CaC_R54	0	0		34.54	34.53	
	Link1268	CaC_R60	CaC_R70	180	179		34.54	34.54	
	,	CaC_R70	CaC_TP10	84	83		33.70	33.70	
	Link1271	CaC_R70	CaC_R72	81	81		34.49	34.49	
	Link1277	CaC_R70	CaC_L02	14	14		34.49	34.49	
	UW_cacR70	CaC_R70	CaC_TP10	84	83		33.70	33.70	
	Link1272	CaC_R72	CaC_R74	8	8		34.20	34.20	
	UW_cacR72	CaC_R72	CaC_R100	74	74		33.40	33.40	
	Link1273	CaC_R74	CaC_R76	5	5		34.19	34.19	
	UW_cacR76	CaC_R76	CaC_R110	5	5		33.00	33.00	
	Link1270	CaC_R80	CaC_R90	4	4		34.54	34.54	
	Link1274	CaC_R90	CaC_R92	0	0		34.54	34.54	
	Link1279	CaC_TP10	CaC_TP15	83	83		34.07	34.07	
	Link1286	CaC_TP15	CaC_TP20	52	52		31.24	31.24	
	Link1287	CaC_TP15	CaC_TP40	32	31		31.24	31.24	
	Link1280	CaC_TP20	CaC_TP30	52	52		30.68	30.68	
	Link1295	CaC_TP30	CaC_TP50	47	48	1	30.12	30.11	-0.01
	Link1288	CaC_TP40	CaC_TP50	101	100		30.30	30.30	
	Link1289	CaC_TP50	CaC_TP70	55	58	3	30.12	30.11	-0.01
	Link1292	CaC_TP70	CaC_TP80	33	32		30.12	30.11	-0.01
	UW_cacTP70	CaC_TP70	CaC_R130	-753	-753		30.35	30.35	
	Link1293	CaC_TP80	CaC_TP90	32	31		30.02	30.01	-0.01
	Link1439	CaC_TP90	pr_0510	30	30		28.72	28.72	
	lpr_0020	pr_0020	pr_0010	11039	11034	-5	6.53	6.53	
	lpr_0030	pr_0030	pr_0020	11038	11033	-5	6.64	6.64	
	lpr_0040	pr_0040	pr_0030	11038	11033	-5	6.73	6.73	
	lpr_0050	pr_0050	pr_0040	9475	9480	4	6.89	6.89	
	lpr_0060	pr_0060	pr_0050	9474	9478	4	6.94	6.94	
	lpr_0070	pr_0070	pr_0060	9473	9477	4	7.20	7.20	
	lpr_0080	pr_0080	pr_0070	9472	9476	4	7.28	7.28	
	lpr_0090	pr_0090	pr_0080	9471	9475	4	7.37	7.37	
	lpr_0100	pr_0094	pr_0090	9143	9148	4	7.40	7.40	
	Link1230	pr_0096	pr_0094	9143	9148	4	7.59	7.59	
	Link1229	pr_0098	pr_0096	9143	9148	4	7.68	7.68	

Capri Creek Terracing XP-Storm Results Summary - 50-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Petaluma River	Link1228	pr_0100	pr_0098	9143	9148	4	7.74	7.74	
	lpr_0110	pr_0110	pr_0100	9125	9129	4	7.84	7.84	
	lpr_0120	pr_0120	pr_0110	9125	9129	4	7.84	7.84	
	lpr_0130	pr_0130	pr_0120	9125	9129	4	7.92	7.93	
	lpr_0140	pr_0140	pr_0130	9125	9129	4	8.01	8.01	
	lpr_0150	pr_0150	pr_0140	9125	9129	4	8.14	8.14	
	lpr_0160	pr_0160	pr_0150	8994	8999	5	8.32	8.32	
	lpr_0170	pr_0170	pr_0160	8995	9000	5	8.41	8.41	
	lpr_0180	pr_0180	pr_0170	8982	8987	5	8.49	8.49	
	lpr_0190	pr_0190	pr_0180	8983	8987	5	8.56	8.56	
	lpr_0195	pr_0195	pr_0190	8983	8988	5	8.76	8.76	
	lpr_0200	pr_0200	pr_0195	8681	8686	5	8.90	8.90	
	Link1239	pr_0206	pr_0200	8662	8667	5	8.93	8.93	
	lpr_0208	pr_0208	pr_0206	8662	8667	5	9.11	9.11	
	lpr_0210	pr_0210	pr_0208	8663	8668	5	9.11	9.12	
	lpr_0220	pr_0220	pr_0210	8653	8658	5	9.23	9.23	
	lpr_0230	pr_0230	pr_0220	8654	8659	5	9.25	9.25	
	lpr_0240	pr_0240	pr_0230	8656	8660	5	9.25	9.26	
	lpr_0250	pr_0250	pr_0240	8657	8662	5	9.26	9.26	
	lpr_0260	pr_0260	pr_0250	8658	8663	5	9.27	9.27	
	lpr_0270	pr_0270	pr_0260	8658	8663	5	9.28	9.28	
	lpr_0280	pr_0280	pr_0270	8659	8664	5	9.30	9.30	
	lpr_0290	pr_0290	pr_0280	8660	8664	5	9.11	9.11	
	lpr_0298	pr_0298	pr_0290	8542	8547	5	9.78	9.78	
	lpr_0300	pr_0300	pr_0298	8543	8548	5	10.00	10.00	
	lpr_0308	pr_0308	pr_0300	8543	8549	5	10.36	10.36	
	lpr_0310	pr_0310	pr_0308	8544	8549	5	10.54	10.54	
	lpr_0320	pr_0320	pr_0310	8545	8550	5	10.40	10.41	
	lpr_0322	pr_0322	pr_0320	5472	5472		19.42	19.42	
	lpr_0330	pr_0330	pr_0320	8545	8550	5	10.59	10.59	
	lpr_0338	pr_0338	pr_0330	8517	8522	5	11.12	11.13	
	lpr_0340	pr_0340	pr_0338	8517	8522	5	11.48	11.48	
	lpr_0350	pr_0350	pr_0340	8518	8523	5	11.87	11.88	
	lpr_0360	pr_0360	pr_0350	8518	8523	5	13.26	13.27	
	lpr_0370	pr_0370	pr_0360	8451	8456	5	14.07	14.07	
	lpr_0380	pr_0380	pr_0370	8452	8457	5	14.67	14.67	
	lpr_0390	pr_0390	pr_0380	7485	7491	6	15.60	15.60	
	lpr_0400	pr_0400	pr_0390	6631	6638	6	15.81	15.82	
	lpr_0410	pr_0410	pr_0400	60	60		21.97	21.97	
	lpr_0420	pr_0420	pr_0400	6629	6635	6	16.10	16.10	
	lpr_0430	pr_0430	pr_0420	6628	6634	6	16.31	16.32	
	lpr_0440	pr_0440	pr_0430	6623	6629	6	18.31	18.32	
	lpr_0445	pr_0445	pr_0440	6621	6627	6	18.67	18.68	
	lpr_0448	pr_0448	pr_0445	6619	6625	6	18.80	18.80	
	lpr_0450	pr_0450	pr_0448	6617	6624	6	18.93	18.93	
	lpr_0452	pr_0452	pr_0450	6616	6622	6	19.03	19.03	
	lpr_0458	pr_0458	pr_0452	6615	6622	6	19.21	19.22	
	lpr_0460	pr_0460	pr_0458	6615	6622	6	19.30	19.30	
	lpr_0465	pr_0465	pr_0460	6577	6584	7	19.47	19.48	
	lpr_0470	pr_0470	pr_0465	6578	6584	7	19.56	19.56	
	lpr_0480	pr_0480	pr_0470	6579	6586	7	19.82	19.82	
	lpr_0490	pr_0490	pr_0480	6581	6588	7	20.25	20.25	
	lpr_0496	pr_0496	pr_0490	6584	6591	7	20.37	20.37	
	lpr_0498	pr_0498	pr_0496	6586	6593	7	21.11	21.11	
	lpr_0500	pr_0500	pr_0498	6587	6594	7	21.19	21.19	
	lpr_0510	pr_0510	pr_0500	6589	6596	7	21.44	21.45	

Capri Creek Terracing XP-Storm Results Summary - 50-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	lpr_0520	pr_0520	pr_0510	6550	6557	7	22.06	22.06	
	lpr_0530	pr_0530n	pr_0520	6565	6572	8	22.76	22.77	
	lpr_0540	pr_0540n	pr_0530n	6575	6583	8	23.33	23.34	
	lpr_0550	pr_0550	pr_0540n	5965	5970	5	24.09	24.09	
	lpr_0552	pr_0552	pr_0550	5976	5982	5	24.19	24.20	
	3876.1	pr_0554	pr_0552	6384	6395	11	24.15	24.16	
	3876.2	pr_0554	pr_0552	-416	-422	6	24.15	24.16	
	lpr_0560	pr_0560	pr_0554	5994	5999	5	24.67	24.68	
	lpr_0570	pr_0570	pr_0560	5950	5952	2	25.17	25.18	
	lpr_0580	pr_0580	pr_0570	5998	6000	2	25.94	25.94	
	lpr_0590	pr_0590n	pr_0580	5705	5704		27.71	27.71	
	lpr_0600	pr_0600n	pr_0590n	5901	5900	-1	28.10	28.10	
	lpr_0606	pr_0606n	pr_0600n	5822	5821	-1	28.77	28.77	
	2150.1	pr_0607n	pr_0606n	5822	5821	-1	29.26	29.26	
	UWCorona	pr_0607n	pr_0606n	0	0		11.26	11.26	
	lpr_0608	pr_0608n	pr_0607n	5823	5821	-1	29.30	29.30	
	lpr_0610	pr_0610n	pr_0608n	4807	4806		29.71	29.71	
	lpr_0612	pr_0612n	pr_0610n	4802	4801		29.83	29.83	
	lpr_0614	pr_0614n	pr_0612n	4797	4796		30.04	30.03	
	lpr_0616	pr_0616n	pr_0614n	4770	4769	-1	30.14	30.14	
	lpr_0618	pr_0618n	pr_0616n	4767	4766	-1	30.30	30.30	
	lpr_0620	pr_0620n	pr_0618n	4765	4764		30.83	30.83	
	lpr_0630	pr_0630n	pr_0620n	4766	4765		31.62	31.62	
	lpr_0640	pr_0640n	pr_0630n	4767	4766		33.21	33.21	
	lpr_0650	pr_0650	pr_0640n	4770	4769		33.24	33.24	
	lpr_0660	pr_0660	pr_0650	4783	4783		33.29	33.29	
	lpr_0670	pr_0670n	pr_0660	4818	4811	-7	33.72	33.72	
	lpr_0680	pr_0680n	pr_0670n	4895	4859	-36	33.77	33.77	
	2792.1	pr_0682	pr_0680n	4629	4628	-1	34.01	34.01	
	682lob	pr_0682	pr_0680n	695	693	-1	15.70	15.70	
	2791.1	pr_0684	pr_0682	4422	4421	-1	34.22	34.22	
	684lob	pr_0684	pr_0682	1214	1206	-8	15.89	15.89	
	lpr_0690	pr_0690n	pr_0684	4847	4844	-3	34.16	34.16	
	lpr_0700	pr_0700	pr_0690n	4866	4866		34.23	34.23	
	lpr_0710	pr_0710	pr_0700	4887	4885	-2	35.42	35.42	
	lpr_0720	pr_0720	pr_0710	4817	4816		36.32	36.32	
	lpr_0723	pr_0723	pr_0720	4802	4801		37.34	37.34	
	3663.1	pr_0725	pr_0723	3008	3007	-1	37.59	37.59	
	3663.2	pr_0725	pr_0723	3026	3027		37.59	37.59	
	lpr_0730	pr_0730	pr_0725	4801	4801		37.74	37.74	
	lpr_0740	pr_0740	pr_0730	4825	4824		37.94	37.94	
	2526.1	pr_0745	pr_0740	3626	3626		38.45	38.45	
	2526.2	pr_0745	pr_0740	1199	1198		38.45	38.45	
	lpr_0750	pr_0750	pr_0745	4825	4824		38.84	38.84	
	lpr_0760	pr_0760	pr_0750	4825	4825		39.02	39.02	

Notes:

(1) Change due to project--negative values indicate a decrease, and positive values an increase. Differences in discharge less than 1 cfs and water surface elevation less than 0.01 feet are left blank.

Capri Creek Terracing XP-Storm Results Summary - 100-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Capri Creek	LCaC_47.1	CaC_0047	cc_0040	115	115		30.10	30.08	-0.02
	LCaC_47.2	CaC_0047	cc_0040	106	105		30.10	30.08	-0.02
	LCaC_47.3	CaC_0047	cc_0040	127	127		30.10	30.08	-0.02
	UW_CaC0047	CaC_0047	CaC_TP30	-109	-107	-1	28.49	28.49	
	LCaC_350	CaC_0350	CaC_0047	309	306	-2	30.21	30.19	-0.02
	UW_cacL150	CaC_0350	CaC_L150	0	0		29.90	29.90	
	LCaC_584	CaC_0584	CaC_0350	310	308	-2	30.49	30.48	-0.01
	LCaC_850.1	CaC_0850	CaC_0584	241	241		34.66	34.64	-0.01
	Link1258	CaC_0850	CaC_L10	0	0		34.66	34.64	-0.01
	Link1262	CaC_0850	CaC_R10	249	240	-9	34.66	34.64	-0.01
	UWCaC0850	CaC_0850	CapriStor	48	48		29.00	29.00	
	LCaC_1050	CaC_1050	CaC_0850	493	481	-11	35.03	34.70	-0.33
	LCaC_1250	CaC_1250	CaC_1050	493	482	-11	35.68	35.06	-0.61
	LCaC_1450	CaC_1450	CaC_1250	494	482	-12	36.49	35.79	-0.69
	LCaC_1750	CaC_1750	CaC_1450	495	483	-13	38.24	37.34	-0.89
	LCaC_1950	CAC_1950	CaC_1750	496	483	-13	39.47	38.90	-0.57
	LCaC_2150	CaC_2150	CAC_1950	497	483	-14	40.40	40.26	-0.14
	LCaC_2241	CaC_2241	CaC_2150	502	484	-18	41.44	41.43	-0.01
	2350weir	CaC_2350	CaC_2241	269	267	-1	36.94	36.94	
	LCaC2350.1	CaC_2350	CaC_2241	276	276		42.89	42.89	
	LCaC_2850	CaC_2850	CaC_2350	470	470		45.53	45.52	
	LCaC_3250	CaC_3250	CaC_2850	472	472		49.62	49.62	
	LCaC_3650	CaC_3650	CaC_3250	472	472		52.15	52.15	
	lCaC_3898	CaC_3898	CaC_3650	472	472		53.70	53.70	
	LCaC_3900	CaC_3900	CaC_3898	473	473		54.53	54.53	
	LCaC4044.1	CaC_4044	CaC_3900	276	276		56.07	56.07	
	UWCac4044	CaC_4044	CaC_3900	249	249		49.35	49.35	
	lCaC_4446	CaC_4446	CaC_4044	431	431		56.03	56.03	
	lCaC_4448	CaC_4448	CaC_4446	431	431		57.03	57.03	
	LCaC_4450	CaC_4450	CaC_4448	431	431		58.46	58.46	
	lCaC_4846	CaC_4846	CaC_4450	432	432		58.90	58.90	
	lCaC_4848	CaC_4848	CaC_4846	432	432		60.19	60.19	
	LCaC_4850	CaC_4850	CaC_4848	432	432		62.16	62.16	
	Link1346	CaC_5171	CaC5171L10	14	14		66.05	66.05	
	Link1354	CaC_5171	CaC_4850	432	432		66.05	66.05	
	LCaC_5181	CaC_5181	CaC_5171	437	437		66.53	66.53	
	LCaC_5548	CaC_5548	CaC_5181	443	443		68.32	68.32	
	LCaC_5902	CaC_5902	CaC_5548	462	462		75.39	75.39	
	LCaC_6105	CaC_6105	CaC_5902	463	463		78.93	78.93	
	lCaC_6200	CaC_6200	CaC_6105	463	463		84.62	84.62	
	Link1278	CaC_L02	CaC_L04	19	18		34.46	34.45	
	UW_cacL04	CaC_L04	CaC_L20	8	8		34.00	34.00	
	UW_cacL130	CaC_L04	CaC_L130	9	9		34.00	34.00	
	Link1259	CaC_L10	CaC_L20	0	0		34.67	34.67	
	UW_cacL110	CaC_L100	CaC_L110	0	0		33.33	33.33	
	Link1447	CaC_L110	CaC_L160	0	0		33.35	33.35	
	Link1451	CaC_L120	CaC_L140	0	0		33.96	33.96	
	Link1455	CaC_L120	CaC_L110	0	0		33.96	33.96	
	Link1452	CaC_L130	CaC_L150	9	9		34.14	34.14	
	Link1454	CaC_L130	CaC_L120	0	0		34.14	34.14	
	Link1449	CaC_L140	CaC_L170	5	5		30.68	30.68	
	Link1453	CaC_L150	CaC_L140	8	8		30.70	30.70	
	Link1448	CaC_L160	CaC_L140	-6	-6		30.69	30.68	
	Link1450	CaC_L170	CaC_0047	5	5		30.35	30.34	
	Link1260	CaC_L20	CaC_L30	1	1		34.20	34.20	
	UW_cacL50	CaC_L20	CaC_L50	5	5		33.65	33.65	

Capri Creek Terracing XP-Storm Results Summary - 100-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	Link1261	CaC_L30	CaC_L40	0	0		33.28	33.28	
	UW_cacL40	CaC_L40	CaC_L100	0	0		33.60	33.60	
	Link1440	CaC_L50	CaC_L60	0	0		34.18	34.18	
	Link1441	CaC_L50	CaC_L70	0	0		34.18	34.18	
	Link1444	CaC_L70	CaC_L100	0	0		33.60	33.60	
	Link1263	CaC_R10	CaC_R20	249	240	-9	34.65	34.64	-0.01
	Link1417	CaC_R100	CaC_R110	5	5		33.78	33.78	
	Link1438	CaC_R100	CaC_TP40	80	80		33.78	33.78	
	Link1418	CaC_R110	CaC_R190	2	2		33.32	33.32	
	Link1420	CaC_R110	CaC_R120	8	8		33.32	33.32	
	Link1421	CaC_R120	CaC_R150	8	8		30.37	30.37	
	Link1422	CaC_R150	CaC_R160	8	8		29.40	29.40	
	Link1423	CaC_R160	CaC_R180	8	7		28.24	28.23	
	Link1424	CaC_R180	CaC_R200	1	1		28.24	28.23	
	Link1428	CaC_R190	CaC_R180	2	2		33.08	33.08	
	Link1264	CaC_R20	CaC_R30	28	30	2	34.62	34.62	
	Link1267	CaC_R20	CaC_R60	228	224	-4	34.62	34.62	
	Link1269	CaC_R20	CaC_R80	20	21	1	34.62	34.62	
	Link1425	CaC_R200	CaC_R210	0	0		28.24	28.23	
	Link1265	CaC_R30	CaC_R40	15	14		34.63	34.62	
	Link1266	CaC_R40	CaC_R50	12	12		34.63	34.63	
	Link1415	CaC_R50	CaC_R52	9	10		34.64	34.64	
	Link1416	CaC_R52	CaC_R54	0	0		34.65	34.65	
	Link1268	CaC_R60	CaC_R70	227	224	-3	34.62	34.62	
	,	CaC_R70	CaC_TP10	113	112	-2	33.70	33.70	
	Link1271	CaC_R70	CaC_R72	94	93		34.55	34.55	
	Link1277	CaC_R70	CaC_L02	19	19		34.55	34.55	
	UW_cacR70	CaC_R70	CaC_TP10	113	112	-2	33.70	33.70	
	Link1272	CaC_R72	CaC_R74	8	9		34.21	34.21	
	UW_cacR72	CaC_R72	CaC_R100	100	100		33.40	33.40	
	Link1273	CaC_R74	CaC_R76	6	6		34.20	34.20	
	UW_cacR76	CaC_R76	CaC_R110	6	6		33.00	33.00	
	Link1270	CaC_R80	CaC_R90	5	5		34.63	34.62	
	Link1274	CaC_R90	CaC_R92	0	0		34.63	34.62	
	Link1279	CaC_TP10	CaC_TP15	112	111	-1	34.12	34.12	
	Link1286	CaC_TP15	CaC_TP20	70	70		31.31	31.31	
	Link1287	CaC_TP15	CaC_TP40	42	42		31.31	31.31	
	Link1280	CaC_TP20	CaC_TP30	70	69		30.75	30.74	
	Link1295	CaC_TP30	CaC_TP50	-63	-62	-1	30.31	30.31	
	Link1288	CaC_TP40	CaC_TP50	121	121		30.33	30.33	
	Link1289	CaC_TP50	CaC_TP70	51	55	4	30.32	30.31	
	Link1292	CaC_TP70	CaC_TP80	42	42		30.32	30.31	
	UW_cacTP70	CaC_TP70	CaC_R130	-753	-753		30.35	30.35	
	Link1293	CaC_TP80	CaC_TP90	41	41		30.22	30.21	
	Link1439	CaC_TP90	pr_0510	40	39		28.90	28.89	
	lpr_0020	pr_0020	pr_0010	11912	11907	-5	6.53	6.53	
	lpr_0030	pr_0030	pr_0020	11912	11907	-5	6.66	6.66	
	lpr_0040	pr_0040	pr_0030	11912	11907	-5	6.77	6.77	
	lpr_0050	pr_0050	pr_0040	10865	10865		6.98	6.98	
	lpr_0060	pr_0060	pr_0050	10858	10858		7.07	7.07	
	lpr_0070	pr_0070	pr_0060	10857	10857		7.38	7.38	
	lpr_0080	pr_0080	pr_0070	10856	10856		7.48	7.48	
	lpr_0090	pr_0090	pr_0080	10855	10855		7.81	7.81	
	lpr_0100	pr_0094	pr_0090	10491	10491		7.85	7.85	
	Link1230	pr_0096	pr_0094	10492	10492		8.10	8.10	
	Link1229	pr_0098	pr_0096	10492	10492		8.19	8.19	

Capri Creek Terracing XP-Storm Results Summary - 100-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
Petaluma River	Link1228	pr_0100	pr_0098	10492	10493		8.27	8.27	
	lpr_0110	pr_0110	pr_0100	10473	10473		8.38	8.38	
	lpr_0120	pr_0120	pr_0110	10474	10474		8.38	8.38	
	lpr_0130	pr_0130	pr_0120	10475	10475		8.47	8.47	
	lpr_0140	pr_0140	pr_0130	10476	10476		8.56	8.56	
	lpr_0150	pr_0150	pr_0140	10477	10477		8.71	8.71	
	lpr_0160	pr_0160	pr_0150	10338	10338		8.92	8.92	
	lpr_0170	pr_0170	pr_0160	10340	10341		9.02	9.02	
	lpr_0180	pr_0180	pr_0170	10326	10327		9.11	9.11	
	lpr_0190	pr_0190	pr_0180	10328	10328		9.19	9.19	
	lpr_0195	pr_0195	pr_0190	10329	10329		9.44	9.44	
	lpr_0200	pr_0200	pr_0195	9998	9998		9.60	9.60	
	Link1239	pr_0206	pr_0200	9978	9978		9.63	9.63	
	lpr_0208	pr_0208	pr_0206	9978	9978		9.86	9.86	
	lpr_0210	pr_0210	pr_0208	9979	9980		9.89	9.89	
	lpr_0220	pr_0220	pr_0210	9969	9970		10.06	10.06	
	lpr_0230	pr_0230	pr_0220	9971	9972		10.09	10.09	
	lpr_0240	pr_0240	pr_0230	9974	9976	1	10.09	10.09	
	lpr_0250	pr_0250	pr_0240	9976	9977		10.09	10.09	
	lpr_0260	pr_0260	pr_0250	9978	9979	1	10.10	10.10	
	lpr_0270	pr_0270	pr_0260	9979	9979		10.12	10.12	
	lpr_0280	pr_0280	pr_0270	9980	9980		10.14	10.14	
	lpr_0290	pr_0290	pr_0280	9981	9981		9.93	9.93	
	lpr_0298	pr_0298	pr_0290	9852	9852		10.64	10.64	
	lpr_0300	pr_0300	pr_0298	9852	9853		10.87	10.87	
	lpr_0308	pr_0308	pr_0300	9854	9855		11.27	11.27	
	lpr_0310	pr_0310	pr_0308	9856	9856		11.45	11.45	
	lpr_0320	pr_0320	pr_0310	9856	9857		11.30	11.30	
	lpr_0322	pr_0322	pr_0320	5472	5472		19.42	19.42	
	lpr_0330	pr_0330	pr_0320	9857	9857		11.49	11.49	
	lpr_0338	pr_0338	pr_0330	9826	9826		12.04	12.04	
	lpr_0340	pr_0340	pr_0338	9826	9827		12.41	12.41	
	lpr_0350	pr_0350	pr_0340	9827	9827		12.80	12.80	
	lpr_0360	pr_0360	pr_0350	9828	9829		14.19	14.19	
	lpr_0370	pr_0370	pr_0360	9754	9755		15.02	15.02	
	lpr_0380	pr_0380	pr_0370	9755	9755		15.64	15.64	
	lpr_0390	pr_0390	pr_0380	8668	8669	1	16.52	16.52	
	lpr_0400	pr_0400	pr_0390	7768	7770	2	16.76	16.76	
	lpr_0410	pr_0410	pr_0400	60	60		21.97	21.97	
	lpr_0420	pr_0420	pr_0400	7766	7768	2	17.08	17.08	
	lpr_0430	pr_0430	pr_0420	7765	7767	2	17.32	17.32	
	lpr_0440	pr_0440	pr_0430	7761	7763	2	19.02	19.02	
	lpr_0445	pr_0445	pr_0440	7758	7760	2	19.40	19.40	
	lpr_0448	pr_0448	pr_0445	7756	7758	2	19.53	19.53	
	lpr_0450	pr_0450	pr_0448	7755	7757	2	19.64	19.64	
	lpr_0452	pr_0452	pr_0450	7755	7757	2	19.73	19.73	
	lpr_0458	pr_0458	pr_0452	7757	7759	2	19.93	19.94	
	lpr_0460	pr_0460	pr_0458	7759	7761	2	20.02	20.02	
	lpr_0465	pr_0465	pr_0460	7719	7721	2	20.20	20.20	
	lpr_0470	pr_0470	pr_0465	7721	7724	2	20.28	20.28	
	lpr_0480	pr_0480	pr_0470	7725	7727	2	20.55	20.55	
	lpr_0490	pr_0490	pr_0480	7730	7732	2	20.93	20.93	
	lpr_0496	pr_0496	pr_0490	7735	7737	2	21.05	21.05	
	lpr_0498	pr_0498	pr_0496	7737	7740	2	21.92	21.92	
	lpr_0500	pr_0500	pr_0498	7738	7740	2	22.00	22.01	
	lpr_0510	pr_0510	pr_0500	7742	7744	2	22.25	22.25	

Capri Creek Terracing XP-Storm Results Summary - 100-year Event

Flooding Source	Link ID	U/S Node	D/S Node	Peak Discharge (cfs)			U/S Node Water Surface Elevation		
				Existing Conditions	With Project	Change[1]	Existing Conditions	With Project	Change[1]
	lpr_0520	pr_0520	pr_0510	7700	7702	2	22.74	22.74	
	lpr_0530	pr_0530n	pr_0520	7715	7718	2	23.44	23.44	
	lpr_0540	pr_0540n	pr_0530n	7724	7727	2	24.02	24.02	
	lpr_0550	pr_0550	pr_0540n	7062	7063	1	25.13	25.13	
	lpr_0552	pr_0552	pr_0550	7078	7079	1	25.25	25.25	
	3876.1	pr_0554	pr_0552	7179	7178		25.27	25.27	
	3876.2	pr_0554	pr_0552	1151	1157	6	25.27	25.27	
	lpr_0560	pr_0560	pr_0554	7109	7111	2	25.60	25.60	
	lpr_0570	pr_0570	pr_0560	6826	6826		25.92	25.92	
	lpr_0580	pr_0580	pr_0570	6871	6871		26.44	26.44	
	lpr_0590	pr_0590n	pr_0580	6461	6460		28.04	28.04	
	lpr_0600	pr_0600n	pr_0590n	6503	6502		28.38	28.38	
	lpr_0606	pr_0606n	pr_0600n	6406	6406		29.01	29.01	
	2150.1	pr_0607n	pr_0606n	6403	6403		29.62	29.62	
	UWCorona	pr_0607n	pr_0606n	0	0		11.26	11.26	
	lpr_0608	pr_0608n	pr_0607n	6403	6403		29.67	29.67	
	lpr_0610	pr_0610n	pr_0608n	5325	5324		30.04	30.04	
	lpr_0612	pr_0612n	pr_0610n	5319	5319		30.15	30.15	
	lpr_0614	pr_0614n	pr_0612n	5314	5314		30.38	30.38	
	lpr_0616	pr_0616n	pr_0614n	5284	5284		30.48	30.48	
	lpr_0618	pr_0618n	pr_0616n	5281	5280		30.62	30.62	
	lpr_0620	pr_0620n	pr_0618n	5279	5279		31.11	31.11	
	lpr_0630	pr_0630n	pr_0620n	5280	5280		31.89	31.89	
	lpr_0640	pr_0640n	pr_0630n	5271	5271		33.57	33.57	
	lpr_0650	pr_0650	pr_0640n	5274	5273		33.60	33.60	
	lpr_0660	pr_0660	pr_0650	5285	5285		33.64	33.64	
	lpr_0670	pr_0670n	pr_0660	5303	5302		34.05	34.05	
	lpr_0680	pr_0680n	pr_0670n	5304	5303		34.10	34.10	
	2792.1	pr_0682	pr_0680n	4788	4790	2	34.31	34.31	
	682lob	pr_0682	pr_0680n	1447	1447		15.70	15.70	
	2791.1	pr_0684	pr_0682	4528	4528		34.49	34.49	
	684lob	pr_0684	pr_0682	1973	1972		15.89	15.89	
	lpr_0690	pr_0690n	pr_0684	5371	5371		34.43	34.43	
	lpr_0700	pr_0700	pr_0690n	5386	5385		34.50	34.50	
	lpr_0710	pr_0710	pr_0700	5401	5401		35.48	35.48	
	lpr_0720	pr_0720	pr_0710	5369	5368		36.46	36.46	
	lpr_0723	pr_0723	pr_0720	5374	5374		37.42	37.42	
	3663.1	pr_0725	pr_0723	3767	3767		37.62	37.62	
	3663.2	pr_0725	pr_0723	3026	3026		37.62	37.62	
	lpr_0730	pr_0730	pr_0725	5374	5374		37.78	37.78	
	lpr_0740	pr_0740	pr_0730	5359	5359		38.01	38.01	
	2526.1	pr_0745	pr_0740	3759	3759		38.62	38.62	
	2526.2	pr_0745	pr_0740	1599	1599		38.62	38.62	
	lpr_0750	pr_0750	pr_0745	5359	5358		39.09	39.09	
	lpr_0760	pr_0760	pr_0750	5360	5359	-1	39.28	39.28	

Notes:

(1) Change due to project--negative values indicate a decrease, and positive values an increase. Differences in discharge less than 1 cfs and water surface elevation less than 0.01 feet are left blank.