East Contra Costa County Region
Proposition 84 Round 2 Grant Proposal

ATTACHMENT 7 –
TECHNICAL JUSTIFICATION OF PROJECTS

CONTENTS

PROPOSAL DESCRIPTION AND SUMMARY OF BENEFITS.....2

TECHNICAL JUSTIFICATION FOR PHYSICAL BENEFITS CLAIMED 5

Project 1: Beacon West Arsenic Well and Tank Replacement Project 5
Existing Data and Studies 5
Summary of Benefits 5
Background / Recent and Historical Conditions 6
Without Project Conditions 7
Relationship to Other Proposed Projects 7
Description of Benefits and Methods to Estimate Benefits 8
Facilities Required to Achieve Benefits 9
Uncertainty of Benefits 9
Project Adverse Effects 9
Annual Project Physical Benefits 9
Project 2: Rossmoor Well Replacement / Groundwater Monitoring Well System Expansion 10
Existing Data and Studies 10
Summary of Benefits 10
Background / Recent and Historical Conditions 11
Without Project Conditions 12
Relationship to Other Proposed Projects 12
Description of Benefits and Methods to Estimate Benefits 12
Facilities Required to Achieve Benefits 13
Uncertainty of Benefits 13
Project Adverse Effects 14
Annual Project Physical Benefits 14
Project 3: Integrated Regional Flood Protection and Water Quality Improvement Borrow Area Project 15
Existing Data and Studies 16
- Upper Sand Creek Basin Preliminary Soil Characterization Study, 2000 – Appendix 3-1.1 17
- Upper San Creek Detention Basin Design Report, August 2010 – Appendix 3-1.2 17
- CEQA analysis regarding hauling of fill from the Sand Creek Bain site by the Contra Costa County Flood Control & Water Conservation District, Approved by Contra Costa County Board of Supervisors on November 2010 – Appendix 3-1.3 17
- Upper Sand Creek Basin Geotechnical Report, 2012 – Appendix 3-1.4 17
- Upper Sand Creek Basin Project Plans and Specifications, 2012 – Appendix 3-1.5 17
- Contra Costa Flood Control District Proposition 1E Round 1 Funding Application Work Plan and Economic Analysis – Upper Sand Creek Basin – Appendix 3-1.6 17

Relationship to Other Proposed Projects 20
Summary of Benefits 20
Background / Recent and Historical Conditions 23
Description of Benefits and Methods to Estimate Benefits 24
Uncertainty of Benefits 52
Project Adverse Effects 52
Annual Project Physical Benefits 52
Project 4: Knightsen Wetland Restoration and Flood Protection 64
Existing Data and Studies 65
Summary of Benefits 65
Background / Recent and Historical Conditions 66
Without Project Conditions 67
Relationship to Other Proposed Projects 68
Description of Benefits and Methods to Estimate Benefits 68
Facilities Required to Achieve Benefits 75
Uncertainty of Benefits 75
Project Adverse Effects 75
Annual Project Physical Benefits 75
Project 5: Recycled Water Salinity Reduction and Distribution System Expansion Project 77
Existing Data and Studies 77
Summary of Benefits 77
Background / Recent and Historical Conditions 78
Without Project Conditions 79
Relationship to Other Proposed Projects 80
Description of Benefits and Methods to Estimate Benefits 80
Facilities Required to Achieve Benefits 82
Uncertainty of Benefits 83
Project Adverse Effects 83
Annual Project Physical Benefits 83

Proposal Description and Summary of Benefits

The East Contra Costa County Proposition 84 Round 2 implementation grant proposal includes a series of projects selected based on their ability to address the region's critical issues. The following five projects included in this Proposal provide a suite of benefits that will benefit not only the Region, but – due to the Region's location within and dependence upon the statutory Delta – significant benefits statewide.

- **Project 1:** Beacon West Arsenic Well and Tank Replacement Project
- **Project 2:** Rossmoor Well Replacement / Monitoring Well System Expansion
- **Project 3:** Integrated Regional Flood Protection and Water Quality Improvement Borrow Area Project
- **Project 4:** Knightsen Wetland Restoration and Flood Protection
- **Project 5:** Recycled Water Salinity Reduction and Distribution System Expansion Project

Table 7-1 summarizes the physical benefits that would be achieved through implementation of this Proposal.

Table 7-1: Summary of Proposal Physical Benefits for All Projects

Project	Benefit Summary
Water Supply	
Beacon West Arsenic Well and Tank Replacement	Nine (9) million gallons per year of groundwater supply meeting the arsenic maximum contaminant level (MCL)
Rossmoor Well Replacement / Monitoring Well System Expansion	500 acre-feet per year (AFY) of groundwater supply
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	19 AFY increase in emergency supply 359 AFY supply conserved due to reduced salinity-driven Central Valley Project / State Water Project (CVP/SWP) releases 120 AFY conserved from reduced CVP/SWP releases due to Old and Middle Rivers (OMR) restrictions
Recycled Water Salinity Reduction and Distribution System Expansion	75.6 AFY of Delta supply offset with recycled water
Water Quality	
Beacon West Arsenic Well and Tank Replacement	Reduction in arsenic concentration to less than the MCL of 10 microgram per liter (ug/L)
Rossmoor Well Replacement / Monitoring Well System Expansion	500 AFY supply remaining in Delta
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	Reduction in average bromate concentration from 5.6 to 4.99 ug/L 0.002 reduction in excess cancer cases per year due to bromate 12.6 acre reduction in agricultural runoff area 0.02% reduction in annual solids handling requirements
Knightsen Wetland Restoration and Flood Protection	Approximately 17 acre feet of stormwater treated per storm event
Flood Damage Reduction	
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	3 residential structures protected from flooding per year, on average 0.3-acre reduction in average annual acres inundated from flooding 14 thousand cubic feet per day (Mcf/d) reduction in average annual energy interruptions from flooding 1-acre reduction in average annual acres of Dutch Slough Property inundated from flooding 0.014-mile reduction in average annual road inundation from flooding 0.01-day per year reduction in average annual response time to address a 50-foot levee breach due to flooding 2 AFY reduction in average annual supply interruption due to flooding 5 year reduction in time to realize flood damage reduction benefits of the Upper Sand Creek Basin (USCB) flood control project, including 100-year protection to more than 3,000 parcels
Knightsen Wetland Restoration and Flood	Approximately 17 acre feet (AF) managed to reduce flooding per storm event

Protection	
Environmental Resources	
Rossmoor Well Replacement / Monitoring Well System Expansion	500 AFY supply remaining in Delta
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	5 year reduction in time to realize environmental benefits of Dutch Slough Tidal Marsh Restoration Project
Knightsen Wetland Restoration and Flood Protection	30-acre wetlands created
Recycled Water Salinity Reduction and Distribution System Expansion	471 acres of Dow Wetlands supported with one (1) AFY of recycled water
Energy	
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	10 megawatt hours per year (MWH/year) reduction in energy required for pumping 9,670 pounds (lbs) per year reduction in carbon dioxide (CO2) emissions per year due to reduced pumping 448,000-pound reduction in CO2 emissions in 2018 associated with reduced fill hauling distance
Recycled Water Salinity Reduction and Distribution System Expansion	336 million tons (MT) carbon dioxide (CO2) emissions avoided
Recreation / Public Access	
Integrated Regional Flood Protection and Water Quality Improvement Borrow Area	Five (5) year reduction in time to realize recreation benefits of Dutch Slough Tidal Marsh Restoration Project, including a 55-acre community park Five (5) year reduction in time to realize recreation benefits of USCB Flood Control Project, including 6.25-acre park in Antioch
Other Physical Benefits	
Recycled Water Salinity Reduction and Distribution System Expansion	Reduction in nutrient application requirements as follows: 359,100 lbs of nitrogen 756 lbs of phosphorus 64,260 lbs of potassium

Technical Justification for Physical Benefits Claimed

This section summarizes the extensive technical work that has been completed to quantify and substantiate the physical benefits summarized in Table 7-1.

Project 1: Beacon West Arsenic Well and Tank Replacement Project

This project will benefit the Beacon West, a community within census tract 3010 (and also the Census Designated Place, Bethel Island), which is considered a disadvantaged community (DAC) based on the definition contained in PRC §75005 (g). The project will replace a well that has high arsenic levels (in excess of Primary Drinking Water Standards) with a well in a shallower aquifer zone with water shown to have arsenic levels below Primary Drinking Water Standards in order to meet Compliance Order No. 002-09 issued by the Contra Costa County Health Department. The project will also replace two 1,500 gallon hydropneumatic pressure tanks that have corroded and jeopardize the community's water supply. The location of the new well has already been determined and DWD has received a Variance Permit from the Contra Costa Health Services Department given its location within the existing road right-of-way.

Past Well Construction in the Diablo Water District Service Area

Existing Data and Studies

The Project is supported by a series of studies documenting the potential project benefits, including:

- 1999 Investigation of Groundwater Resources – Appendix 1-1
- Diablo Water District (DWD) 2013 Feasibility Study - Beacon West Arsenic Well and Tank Replacement Project – Appendix 1-2
    - Well Drillers log for target aquifer – included in Feasibility Study (Appendix 1-2) as attachment 3
    - Geologic Cross Section of target aquifer – included in Feasibility Study (Appendix 1-2) as attachment 3
    - Lab results of water sample from target aquifer showing non-detect arsenic levels – included in Feasibility Study (Appendix 1-2) as attachment 4
    - Approved Variance request from Health Department for location of well – included in Feasibility Study (Appendix 1-2) as attachment 5
    - Construction cost quotes for the new well system and replacement of the two 1,500 gallon pressure tanks – included in Feasibility Study (Appendix 1-2) as Attachment 6
- DWD 2010 Urban Water Management Plan - Appendix 1-3
- Preliminary Design and Site Planning, 2013 - Appendix 1-4

Summary of Benefits

The projected project benefits include:

- **Water Supply:** The project will allow the Beacon West community to continue to use groundwater supplies to meet demands without implementing costly treatment or trucking in supplies.
- **Water Quality:** The project will reduce arsenic concentrations in the groundwater supply, bringing the community into compliance with the MCL for arsenic and reducing the excess cancer risk associated with arsenic in drinking water.

These benefits are summarized in the following table.

Table 7-2: Summary of Project Physical Benefits

Category	Benefit Summary
Water Supply	• Nine (9)million gallons per year of groundwater supply meeting arsenic MCL
Water Quality	• Reduction in arsenic concentration to below the arsenic MCL of 10 ug/L
Flood Damage Reduction	• No quantified physical benefits
Environmental Resources	• No quantified physical benefits
Recreation/Public Access	• No quantified physical benefits
Energy	• No quantified physical benefits
Other Physical Benefits	• No quantified physical benefits

Background / Recent and Historical Conditions

As discussed on pages 1 and 2 of the Feasibility Study provided as Appendix 1-2, the community known as Beacon West, at the end of Bethel Island Road, on Bethel Island, is supplied with drinking water from a well, operated and maintained by DWD that has arsenic levels ranging between 0.029 and 0.032 milligrams per liter (mg/l). On November 15, 2008, the California Department of Public Health (CDPH) revised the California Arsenic Standard MCL from 0.050 mg/l to 0.010 mg/l. On September 4, 2009, the Contra Costa Environmental Health Department (County Health) issued Compliance Order No. 002-09 to the Beacon West water system for noncompliance with the Arsenic MCL and ordered the system to meet the new Arsenic standards.

The residents of Beacon West reside in an area designated as a DAC block group based on 2010 data from Contra Costa County (also according to the U.S. Census and American Community Survey data compiled by DWR for the years of 2006 to 2010). The 21 residences pay $1,018 per year for water service and generate approximately $21,026 in revenue that is used to pay for the operation and maintenance (O&M) of the water system, which varies from $14,000 to $31,000 per year.

Crumbling Footings of Hydro-pneumatic Pressure Tank

The system therefore does not have the revenue base to support the installation and additional O&M costs of an arsenic treatment system. Additionally, the two 1,500 gallon hydro-pneumatic pressure

tanks that provide storage and pressure for the water system are in jeopardy of failing due to crumbling footings, corrosion and pin holes that have been repaired by welding.

In 1999, DWD participated in an Investigation of Ground-Water Resources in the East Contra Costa Area (see Appendix 1-1 for the report in full, or excerpt included in Attachment 3 of the Feasibility Study provided as Appendix 1-2). Cross section C - C' included in 1999 investigation shows the geologic relationship between the Beacon West Well 10E and Well 3N (also known as the Bob Butler well) located approximately 1,500 feet away. The Beacon West well 10E draws water from the aquifer located approximately 250 feet below ground surface (bgs). This is the aquifer zone that has the high arsenic levels exceeding Primary Drinking Water Standards.

As can be seen in cross section C - C', the aquifer at elevation 170 feet bgs for Well 3N is continuous with the same 170 feet bgs location at the Beacon West well 10E. The Well Drillers Reports for both of these wells are included in Attachment 3 of the Feasibility Study provided as Appendix 1-2. In May of 2011, DWD sampled Well 3N and the lab results came back as non-detect for arsenic in the two samples taken, as noted in Attachment 4 of the Feasibility Study. Given that the water in the non-arsenic bearing 170 feet bgs aquifer is continuous between the two well locations, the District believes that completing a new well 170 feet bgs in the vicinity of Beacon West into the same aquifer as the 3N well will yield water with Arsenic levels that are non-detect or, at a minimum, below the MCL.

The District prepared a plot plan for the location of the new well targeting the 170 feet bgs aquifer and after reviewing this information with County Health, they issued a Variance permit approving the installation of the new well, as noted in Attachment 5 of the Feasibility Study (see Appendix 1-2). DWD's contractor will still need to secure a well drilling permit, but that will occur just prior to construction.

Hydro-pneumatic Pressure Tank Corrosion and Crumbling Footings

Without Project Conditions

Without the project, the County Health Department may force the water system to install treatment or shut down the well which would leave the community without water. Requiring treatment would cause current water charges to quadruple, going from approximately $1,000 per year to $4,000 per year per household which would be cost-prohibitive for this community. Alternatively, the County Health Department could require that water be trucked in for the community on a daily basis, which would also be cost-prohibitive and impractical.

Additionally, the corrosion, pin holes, and crumbling footings observed on the two 1,500 gallon hydro-pneumatic pressure tanks that provide storage and pressure for the water system will not be corrected; as such, one or both tanks are likely to fail.

Relationship to Other Proposed Projects

As discussed in Attachment 3, the projects included in this proposal are all intrinsically linked through the objectives of the East County Integrated Regional Water Management Program. However, no other projects in this proposal must be implemented to achieve the benefits claimed in this attachment.

It is critical to the Region's commitment to assisting the Region in meeting critical water-related needs of DACs, one of the key objectives of this Proposal.

Description of Benefits and Methods to Estimate Benefits

The following sections summarize project benefits and methods used to estimate benefits in the following areas:

- Water Supply
- Water Quality
- Flood Damage Reduction
- Environmental Resources
- Recreation/Public Access
- Energy
- Other Physical Benefits

Water Supply Benefits

Project implementation will allow the Beacon West community to achieve compliance for arsenic levels in its potable water supply. As such, they will not be required to implement costly wellhead arsenic treatment or truck in water on a continual basis. The quantity of water meeting the MCL is equal to the current well production of nine million gallons per year (based on DWD's 2012 production records).

Water Quality Benefits

As shown on page 1 of the Feasibility Study provided as Appendix 1-2 to this Attachment, arsenic levels in the existing Beacon West well range from 29 to 32 ug/l. The project will reduce the arsenic levels in the drinking water to below the MCL of 10 ug/L. DWD has data from a well drawing water from the 170 feet bgs target aquifer zone indicating that the arsenic levels are below the detection limit of 2 ug/L. Because arsenic levels in the target aquifer were below the detection limit of 2 ug/L (refer to laboratory report, which is provided as Attachment 4 to the Feasibility Study provided in Appendix 1-2), the actual arsenic concentration is unknown but is expected to be below the MCL.

Flood Damage Reduction Benefits

No quantifiable flood damage reduction benefits are claimed as a result of project implementation.

Environmental Benefits

No quantifiable environmental benefits are claimed as a result of project implementation.

Recreation/Public Access Benefits

No quantifiable recreation / public access benefits are being claimed as a result of project implementation.

Energy-Related Benefits

No quantifiable energy-related benefits are being claimed as a result of project implementation.

Other Physical Benefits

No quantifiable energy-related benefits are being claimed as a result of project implementation.

Facilities Required to Achieve Benefits

In order to achieve the benefits summarized above, all project components must be implemented, including:

- Construct 8-inch well
- Install 18 gallons per minute (gpm) test pump for sampling purposes
- Install concrete slab with raised well head
- Install 10 horsepower (HP), 165 gpm pump
- Install approximately 40 feet of 4-inch piping from new well pump to tanks
- Convert old well to monitoring well
- Remove and replace two 1,500 gallon pressure tanks and pedestals

Uncertainty of Benefits

Although the new well would be drawing water from the same 170 foot deep aquifer as the well with no arsenic, it cannot be guaranteed that the water will have non-detect levels of arsenic, despite the relatively short distance between the wells.

Project Adverse Effects

The project will have temporary, construction-related impacts. No long-term adverse effects are expected from this project, and any adverse project effects will be fully mitigated.

Annual Project Physical Benefits

The following tables summarize the expected annual benefits from this project.

Table 9 – Annual Project Physical Benefits Project Name: Beacon West Arsenic Well and Tank Replacement Project Type of Benefit Claimed: WS1: Groundwater Supply Meeting Arsenic MCL Measure of Benefit Claimed (Name of Units): Million Gallons per Year Additional Information About this Measure: Reflects average annual well production			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2015-2064	0	90	90

Project 2: Rossmoor Well Replacement / Groundwater Monitoring Well System Expansion

Pittsburg Groundwater Well

The City of Pittsburg's Rossmoor Well Replacement / Groundwater Monitoring Well System Expansion Project will allow the City to meet current and future water demands in DACs while reducing current and future reliance on Delta supplies by replacing the current 600 gpm Rossmoor Well with a 1,400 gpm well fitted with a variable frequency drive (VFD), installing 1,200 feet of larger supply line, and implementing a multiport monitoring well to expand the groundwater monitoring system.

The City currently relies mostly on purchased raw surface water from the Delta from CCWD, and meets remaining water demands with groundwater. Surface and groundwater supplies are treated at the City's water treatment plant prior to delivery to its residents. The City produces groundwater from two wells, one of which, the Rossmoor Well, has experienced biofouling, which has caused a noticeable decline in groundwater production. By replacing the existing well, the City will obtain a more reliable groundwater supply and will be able to meet customer demands now and in the future, while reducing dependence on the Delta.

Existing Data and Studies

The Project is supported by a series of studies documenting the potential project benefits, including the following. In addition, the City implemented a similar project, replacing the Bodega Well, in 2009. The experience of replacing the Bodega Well provides additional assurance that this project is technically feasible, will be implemented as effectively as possible, and will provide the benefits claimed.

- Reports on Groundwater Monitoring Program (September 2009, February 2012) – Appendix 2-1
- Pittsburg Plain Groundwater Basin (2-4) CASGEM Monitoring Plan (December 2011) – Appendix 2-2
- Pittsburg Plain Groundwater Basin (2-4) Groundwater Management Plan (October 2012) – Appendix 2-3
- City of Pittsburg 2010 Urban Water Management Plan Update – Appendix 2-4
- California Environmental Quality Act (CEQA) Notice of Exemption – Appendix 2-5
- Cost comparison – Bodega and Rossmoor Wells – Appendix 2-6

Summary of Benefits

The projected project benefits include:

- **Water Supply**: The proposed Project will replace the current 600 gpm Rossmoor Well with a 1,400 gpm well to allow continued use of groundwater to meet a portion of the City's demands. Without the project, the City would be forced to increase reliance on Delta supplies to meet existing and future demands.

- **Water Quality:** The project will provide statewide water quality improvements by avoiding the need to purchase up to an additional 500 AFY of Delta supplies per year, over the 22-year project life.

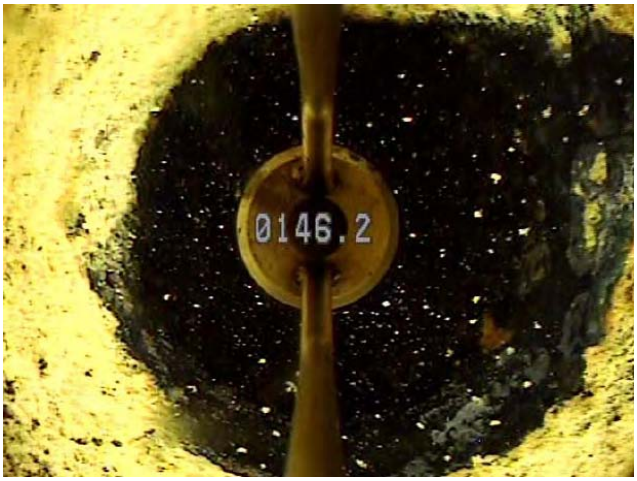
These benefits are summarized in the following table.

Table 7-3: Summary of Project Physical Benefits

Category	Benefit Summary
Water Supply	• 500 AFY of groundwater supply
Water Quality	• 500 AFY supply remaining in Delta
Flood Damage Reduction	• No quantified physical benefits
Environmental Resources	• 500 AFY supply remaining in Delta
Recreation/Public Access	• No quantified physical benefits
Energy	• No quantified physical benefits
Other Physical Benefits	• No quantified physical benefits

Background / Recent and Historical Conditions

Rocks Visible through Rossmoor Well Casing Hole
Rossmoor Video – November 19, 2012



Build-up of Biofouling Byproducts on Casing Wall
Rossmoor Video – November 19, 2012

As discussed on page 7 of the 2013 Report on the Groundwater Monitoring Program (Appendix 2-1), the Rossmoor Well was constructed in 1991 and has experienced severe biofouling problems since 2001. Rehabilitation work was performed in 2001, 2004, 2009, 2010, and 2011. The rehabilitations in 2009, 2010, and 2011 were preventative measures with the purpose of maximizing production from the well in the high demand summer months. Despite the severity of the biofouling on pump components, the well specific capacity appears unchanged from historic levels. In November 2012, performance testing was conducted on the Rossmoor well. The pump components were found to be clogged with biofouling agents consistent with past problems. A video log showed multiple holes in the well casing previously observed in 2011 (see Exhibit G of the Groundwater Management Plan (GWMP) included in Appendix 2-3, reproduced below).

The pump and column piping were serviced and cleaned by Kirby Pump and Mechanical and then reinstalled. Rehabilitation of the well structure was not recommended due to its deteriorated condition.

Options for Rossmoor are limited by an inability to implement structural modifications such as patches or inner liners. The former may be risky because of

the deteriorated condition of the casing evident in the 2011 and 2012 video logs. Considering the age, history, and construction features, the consultant preparing the report recommended replacement as the option that provides the most reliability in the future.

The table below, taken from page 6 of the 2012 Report on the Groundwater Monitoring Program (Appendix 2-1), shows the decline in production from the Rossmoor Well over time resulting from the biofouling. As shown in this table, pumping has declined by 535 AFY since 2008 as a result of well biofouling.

Table 7-4: Reduction in Pumping from Rossmoor Well due to Biofouling

	2008	2009	2010	2011	2012
Rossmoor Well Pumping (AFY)	992	899	483	532	457

Without Project Conditions

The City is expected to continue to depend on groundwater to meet a portion of demands. As shown in Tables 4-3 and 4-4 on page 20 of the City's 2010 Urban Water Management Plan Update (Appendix 2-4), the City's current and projected groundwater demand is 1,500 AFY. Without replacement of the Rossmoor Well to restore capacity, the remaining demand would need to be met with up to 500 AFY of additional Delta supplies. As such, the project provides water supply benefits by reducing the need to purchase up to an additional 500 AFY of Delta supplies and maintaining supply reliability for the DACs included in the City of Pittsburg water service area.

Relationship to Other Proposed Projects

As discussed in Attachment 3, the projects included in this proposal are all intrinsically linked through the objectives of the East County Integrated Regional Water Management Program. However, no other projects in this proposal must be implemented to achieve the benefits claimed for this project.

Description of Benefits and Methods to Estimate Benefits

The following sections summarize project benefits and methods used to estimate benefits in the following areas:

- Water Supply
- Water Quality
- Flood Damage Reduction
- Environmental Resources
- Recreation/Public Access
- Energy
- Other Physical Benefits

Water Supply Benefits

As previously described, the Rossmoor Well was constructed in 1991 and has experienced severe biofouling problems since 2001. Pumping from the Rossmoor Well has declined by 535 AFY since 2008 as a result of biofouling.

The City is expected to continue to depend on groundwater to meet a portion of demands. As shown in Tables 4-3 and 4-4 on page 20 of the City's 2010 Urban Water Management Plan Update (Appendix 2-4),

the City's current and projected groundwater demand is 1,500 AFY. Without replacement of the Rossmoor Well to restore capacity, the remaining demand would need to be met with up to 500 AFY of additional Delta supplies. As such, the project provides water supply benefits by reducing the need to purchase up to an additional 500 AFY of Delta supplies and maintaining supply reliability for the DACs within the City of Pittsburg water service area. Over the estimated 22-year project life (based on the life of the existing well), this amounts to an avoided 11,000 AF of Delta supply.

Water Quality Benefits

As discussed in the Water Supply Benefits section, if the Rossmoor Well replacement project is not implemented, the City of Pittsburg will need to increase reliance on Delta supplies, purchasing up to 500 AFY of additional supply to meet existing and future demands that would otherwise be met with groundwater supplies. By reducing demand for Delta supplies, this project could potentially leave up to an additional 500 AFY of supplies in the Delta, improving Delta water quality for the two-thirds of Californians who depend on the Delta for drinking water supplies.

Flood Damage Reduction Benefits

No quantifiable flood damage reduction benefits are claimed as a result of project implementation.

Environmental Benefits

As discussed in the Water Supply Benefits section, if the Rossmoor Well replacement project is not implemented, the City of Pittsburg will need to increase reliance on Delta supplies, purchasing up to 500 AFY of additional supply to meet existing and future demands that would otherwise be met with groundwater supplies. By reducing demand for Delta supplies, this project could potentially leave up to an additional 500 AFY of supplies in the Delta, improving in-stream flows and water quality for environmental resources.

Recreation/Public Access Benefits

No quantified recreation / public access benefits are being claimed as a result of project implementation.

Energy-Related Benefits

No quantified energy-related benefits are being claimed as a result of project implementation.

Other Physical Benefits

No other physical benefits are being claimed as a result of project implementation.

Facilities Required to Achieve Benefits

In order to achieve the benefits summarized above, all project components must be implemented, including:

- Installing a replacement well at the existing Rossmoor Well with a VFD and resulting in a capacity increase from 600 gpm to 1,400 gpm
- Installing 1,200 feet of a larger supply line
- Installing a multiport monitoring well to expand the groundwater monitoring system

Uncertainty of Benefits

Benefits associated with leaving water in the Delta are uncertain. Although the City of Pittsburg will not require an additional 500 AFY of Delta supply that would otherwise be required without the Project, the Delta supply that would be needed by the City of Pittsburg may instead be diverted by another supplier

for another use. If that supply was diverted by another user, it would not be available to provide water quality and environmental benefits to the Delta.

Project Adverse Effects

Based on page 1 of the Notice of Exemption filed by the City of Pittsburg for this project (Appendix 2-5), no trees would need to be removed for the new install, and the pump station would be enclosed within a concrete block building comparable to the existing equipment, to ensure that light, noise and visual effects of the new pump station would remain minimal for adjacent residents.

Annual Project Physical Benefits

The following tables summarize the expected annual benefits from this project.

Table 9 – Annual Project Physical Benefits

Project Name: Rossmoor Well Replacement / Groundwater Monitoring Well System Expansion

Type of Benefit Claimed: WS1: Groundwater Supply

Measure of Benefit Claimed (Name of Units): AFY

Additional Information About this Measure: Reflects restored annual groundwater use enabled by increased well capacity.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2015-2036	0	500	500

Table 9 – Annual Project Physical Benefits

Project Name: Rossmoor Well Replacement / Groundwater Monitoring Well System Expansion

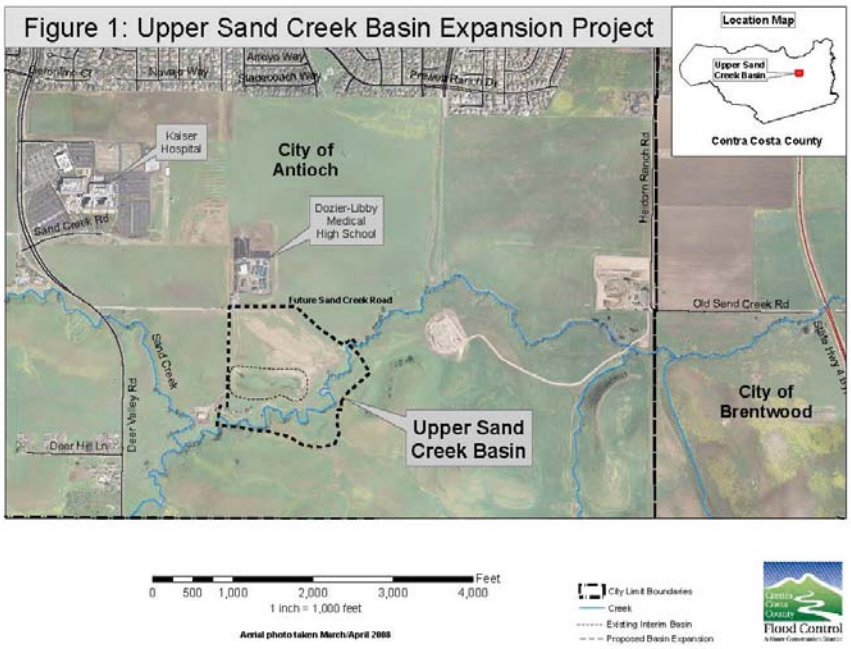
Type of Benefit Claimed: WQ1: Supply Left in Delta

Measure of Benefit Claimed (Name of Units): AFY

Additional Information About this Measure: Reflects supply remaining in Delta rather than being used to meet demands due to reduced groundwater capacity.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2015-2036	0	500	500

Project 3: Integrated Regional Flood Protection and Water Quality Improvement Borrow Area Project



The Contra Costa Water District (CCWD) and the Contra Costa County Flood Control & Water Conservation District (FCD) jointly propose the Integrated Regional Flood Protection and Water Quality Improvement Project (Project), in eastern Contra Costa County, for funding under the California Department of Water Resources' (DWR) IRWM Grant Program (executed Prop 1E contract provided in Appendix 3-3.11). The project will reuse surplus materials (fill) in a sustainable manner to improve water supply and quality by supporting the Canal Levee Elimination and Flood Protection Pipeline Construction and by expanding the Contra Costa County Upper Sand Creek Detention Basin Flood Control Project.

The Upper Sand Creek Basin project (USCB) is currently being implemented, using funding from Proposition 1E (work plan provided in Appendix 3-1.6), to prevent flooding along the lower reach of Marsh Creek between Sand Creek and the Marsh Creek outfall into the Sacramento-San Joaquin River at Big Break in Oakley. The construction of USCB will expand an existing interim flood control basin from 41 acres in area to a final constructed area of approximately 62 acres, increasing the flood storage capacity of the basin from 123 acre feet to 900 AF with a 35-foot maximum depth. The expansion is being constructed by excavating the existing interim basin floor to create a deeper basin where water will be held and slowly released downstream during major storm events. Soil removed from the excavation is being used to construct an earthen dam on the northeast side of the basin to impound flood waters from major storm events. Remaining soil is being stockpiled for future use by interested parties. Currently, approximately 500,000 cubic yards (cy)of fill remains in the basin, reducing flood control capacity from 900 AF to 750 AF. FCD is actively pursuing alternatives to eliminate the 500,000 cubic yards of fill.

The proposed Project will consist of removing 75,000 cy of stockpiled, surplus earthen material from the USCB site, and reusing this material at the CCWD's Contra Costa Canal Levee Elimination and Flood Protection Project. The full, five-phased Contra Costa Canal Levee Elimination and Flood Protection Project will replace 21,000 feet of the unlined Contra Costa Canal (the Canal) with a pipeline and install a Canal flood isolation structure that will allow CCWD to remotely isolate the Canal following a major flood or earthquake. Completion of the Project will reduce regional flood risk and to improve water supply reliability and delivered water quality for CCWD's customers. Secondary benefits include increasing water supply and water supply reliability for the State Water Project and Central Valley Project and improving public safety by limiting access to the open Canal. Segment 1 of the Project,

encasement of the Canal from Pump Plant #1 to Marsh Creek, was completed in 2009. Construction of the flood isolation structure and Segment 2 pipeline is scheduled to begin in the fall of 2013.

In addition, by removing 75,000 cy of fill, capacity of the USCB will be increased by approximately 45 AF. By assisting in removing fill, it is estimated that this project will allow USCB to realize full flood control benefits approximately 5 years sooner than previously estimated (full benefits expected in 2018 rather than 2023). As such, the proposed project will accelerate the projected flood damage reduction benefits of the Proposition 1E-funded USCB project by approximately five years.

The Contra Costa Canal Levee Elimination and Flood Protection Project received $10 million in state funding from Round 1 of the Proposition 1E Stormwater Management and Flood Protection grant program to install approximately 4,000 linear feet of pipeline, replacing the Canal embankments along the portion of the unlined Canal in Oakley, reducing regional flood risk and improving water supply reliability and delivered water quality for CCWD's customers. As such, the portion of the Contra Costa Canal Flood Protection and Levee Elimination Project that was funded through Proposition 1E is expected to generate approximately 19% (4,000 feet out of 21,000 feet) of the benefits of the full, five-phased project. The ***Integrated Regional Flood Protection and Water Quality Improvement Project*** currently proposed would provide fill for the Contra Costa Canal Levee Elimination and Flood Protection Project, reducing the cost to procure fill and enabling CCWD to complete an additional 450 feet of pipeline installation for the existing Proposition 1E funded budget. Because the Project will allow an additional 450 feet of canal to be encased in a buried pipeline, the benefits of the portion of the full, five-phased project expected to be realized with the existing Proposition 1E funding would be expected to increase from 19% of the total project benefit to 21.1% of the total project benefits through implementation of this project.

Contra Costa Canal

Many of the benefits of the proposed project, as described below, are intrinsically linked to the construction of an additional 450 feet of pipeline for the Contra Costa Canal Flood Protection and Levee Elimination Project. An added 2.1% (450 feet out of 21,000 feet) of the total project benefits would be realized through implementation of the proposed ***Integrated Regional Flood Protection and Water Quality Improvement Project.***

Similarly, the USCB Flood Control Project is currently being implemented using $2 million in funding from Proposition 1E. Implementation of the proposed project would increase basin capacity by 45 AF. By moving the fill, the project will reduce the dependence of the USCB project on economic conditions and accelerate achievement of the full flood control benefits of the USCB Flood Control Project by approximately five years (with full benefits realized in 2018 instead of 2023).

Existing Data and Studies

CCWD and FCD have completed numerous studies and reports evaluating and quantifying the benefits of the Contra Costa Canal Levee Elimination and Flood Protection Project and USCB Flood Control

Project, both of which would be extended through implementation of the proposed project. As such, a wealth of information is available for both the with- and without project conditions to substantiate the physical benefits claimed. Phase 1 of the Contra Costa Canal Levee Elimination and Flood Protection Project has been constructed, and design of the remaining phases is nearing completion. The Upper Sand Creek Basin Flood Control Project is currently being implemented. Specific studies and actions completed to-date include the following.

Technical documents that support the feasibility of the Upper Sand Creek Basin portion of the project are included in Appendix 3-1 as follows:

- Upper Sand Creek Basin Preliminary Soil Characterization Study, 2000 – Appendix 3-1.1
- Upper San Creek Detention Basin Design Report, August 2010 – Appendix 3-1.2
- CEQA analysis regarding hauling of fill from the Sand Creek Bain site by the Contra Costa County Flood Control & Water Conservation District, Approved by Contra Costa County Board of Supervisors on November 2010 – Appendix 3-1.3
- Upper Sand Creek Basin Geotechnical Report, 2012 – Appendix 3-1.4
- Upper Sand Creek Basin Project Plans and Specifications, 2012 – Appendix 3-1.5
- Contra Costa Flood Control District Proposition 1E Round 1 Funding Application Work Plan and Economic Analysis – Upper Sand Creek Basin – Appendix 3-1.6

In addition, CCWD has completed numerous studies and reports evaluating and quantifying the benefits of the Contra Costa Canal Levee Elimination and Flood Protection Project, which would be extended through implementation of the proposed project. Phase 1 of the Project has been constructed, and design of the remaining phases is nearing completion. Specific studies and actions completed to-date supporting feasibility of the Contra Costa Canal Levee Elimination and Flood Protection Project include the following.

Environmental & Permitting Documentation – Appendix 3-2

- Environmental documentation has been completed in accordance with the California Environmental Quality Act (CEQA) and National Environmental Protection Act (NEPA). A Negative Declaration was approved on November 2006; it was determined that the Project will not have significant effects on the environment. Reclamation approved a NEPA Finding of No Significant Impact (FONSI) in July, 2007. CEQA Addendum and NEPA modifications will be conducted as required for new phases of construction. (Appendix 3-2.1)
- Mitigation Monitoring and Reporting Program for the Contra Costa Canal Replacement Project. State Clearinghouse # 2006042082. November 2006. (Appendix 3-2.2)
- Final Mitigated Negative Declaration for the Contra Costa Canal Replacement Project. November 2006. (Appendix 3-2.3)
- Final Environmental Assessment Contra Costa Canal Replacement Project, contra Costa County, California. June 2007. (Appendix 3-2.4)
- Several permits and agreements were secured in 2007, including: Central Valley Regional Water Quality Control Board 401 Permit, CA Department of Fish and Game 1600 and 2081 Permits, State Historic Preservation Officer MOU, US Army Corps of Engineers 404 Permit, National Marine Fisheries Service Letters of Concurrence, US Fish and Wildlife Coordination Act Letter, and Bureau of Reclamation/Western Area Power Administration (WAPA) NEPA EA/FONSI. These

permits may require modification to reflect current field conditions consistent with CEQA Addendum and NEPA updates. (Appendix 3-2.5)

- Conservation Easement Deed Holland Tract Preserve. Completed environmental mitigation included a total of 145 acres of mitigation land including 98 acres of upland habitat and 47 acres of wetland habitat in Holland Tract. (Appendix 3-2.6)

Engineering & Design Documentation – Appendix 3-3

- Geotechnical Engineering Investigation Contra Costa Water District Canal Replacement Project Oakley, CA. DCM Engineering/Carollo Engineers, November 2007. (Appendix 3-3.1)
- Recommended Pipeline Alignment. Technical Memorandum. Brown & Caldwell. June 2011. (Appendix 3-3.2)
- Canal Crossings. Technical Memorandum. Brown & Caldwell. June 2011. (Appendix 3-3.3)
- Canal Levee Elimination and Flood Mitigation Project Phase 2 – Pipeline. Access Structure Structural Calculations. Brown and Caldwell. June 2011. (Appendix 3-3.4)
- Cypress Grove Levee Protection. Technical Memorandum. Brown & Caldwell. June 2011 (Appendix 3-3.5)
- Pumping Plant 1 Test Report. Technical Memorandum. Brown & Caldwell, June 2011. (Appendix 3-3.6)
- Final Grade Elevations and Imported Backfill. Technical Memorandum. Brown & Caldwell, June 2011. (Appendix 3-3.7)
- 100% Design Drawings Segments 2 – 4 (Appendix 3-3.8)
- Volume-1-DIV-00-17-FULL (Appendix 3-3.9)
- Volume-2-Appendices (Appendix 3-3.10)
- Executed Prop 1E Agreement for Contra Costa Canal Levee Elimination and Flood Protection Project (Appendix 3-3.11)

Flood Benefits Documentation – Appendix 3-4

- Photos and narrative description of historical flood damage: RD 1237, Contra Costa Water District Operations and Maintenance Staff (Appendix 3-4.1)
- Flood frequency curves for Old River at Rock Slough and San Joaquin River at Antioch. Developed by Corps of Engineers, Sacramento California. February 1992. (Appendix 3-4.2)
- FEMA inundation maps. (Appendix 3-4.3)
- Water surface elevations measured at Rock Slough. http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=RSL (Appendix 3-4.4)
- Application for Individual Permit Supplemental Attachment. Dutch Slough Tidal Marsh Restoration (SPK-2004000043). Prepared for U.S. Army Corps of Engineers Sacramento District, Regulatory Division. Prepared by California Department of Water Resources. March 2012 (Appendix 3-4.5).
- Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report. SCH # 2006042009. State of California Department of Water Resources. March 2010. (Appendix 3-4.6)
- City of Oakley 2020 General Plan. Updated January 2010. http://www.ci.oakley.ca.us/UserFiles/file/GeneralPlan/General%20Plan%202020_Updated%20January%2026,%202010.pdf (Appendix 3-4.7)
- City of Oakley East Cypress Corridor Specific Plan Final Supplemental Environmental Impact Report. January 2009. http://www.ci.oakley.ca.us/UserFiles/file/planning/East%20Cypress/ECC%20SP%20Draft%20EIR.pdf (Appendix 3-4.8)

Water Supply Benefits Documentation – Appendix 3-5

- Spreadsheet of CCWD daily operations model output (Appendix 3-5.1)
- Contra Costa Water District Daily Operations Model (WRSEL based linear program). Los Vaqueros Expansion Model Documentation. Technical Memorandum. MBK Engineers. November 3, 2010. (Appendix 3-5.2)
- G-model used to estimate water savings to CVP/SWP associated with compliance with water quality standards. Accounting for Antecedent Conditions in Seawater Intrusion Modeling – Applications for the San Francisco Bay-Delta. Richard Denton, 1993. Hydraulic Engineering, Volume 1, ASCE, pp. 448-453. (Appendix 3-5.3)
- Calculation of water savings based on Rock Slough salinity requirements, Conra Costa Water District, 2013. (Appendix 3-5.4)

Water Quality Benefits Documentation – Appendix 3-6

- Water Quality at Contra Costa Water District's Contra Costa Canal Intake: A Review of Rock Slough Water Quality Analyses. Contra Costa Water District Interoffice Memorandum. August 14, 2001. (Appendix 3-6.1)
- Rock Slough Technical Memorandum Evaluating Veale Tract Discharge. FlowScience. December 19, 2003. (Appendix 3-6.2)
- Identification of Water Quality Degradation Sources in Rock Slough and Unlined Portion of Contra Costa Canal. Contra Costa Water District Interoffice Memorandum. October 23, 2003. (Appendix 3-6.3)
- Bay Area Water Quality & Supply Reliability Program. CALFED Bay Delta Program. May 2005. (Appendix 3-6.4)
- Amy, G.L., M. Siddiqui, K. Ozekin, H.W. Zhu, and C. Wang, (1998). Empirically Based Models for Predicting Chlorination and Ozonation By-Product: Haloacetic Acids, Chloral Hydrate, and Bromate. EPA Report CX 819579. USEPA Office of Groundwater and Drinking Water: Cincinnati, OH. 1998. (Appendix 3-6.5)
- Field data collected by Contra Costa Water District and the Department of Water Resources. (Appendix 3-6.6)
- Beneficial Use Impact Study, Final Report Ironhouse Sanitary District, Oakley, California. Prepared by HydroFocus. December 2003. (Appendix 3-6.7)

Environmental Benefits Documentation – Appendix 3-7

- Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report. SCH # 2006042009. State of California Department of Water Resources. March 2010. (Appendix 3-7.1)
- East Contra Costa County HCP/NCCP Mitigation Fee Audit. East Contra Costa County Habitat Conservancy, December 2012. (Appendix 3-7.2)
- East Contra Costa County Habitat Conservancy Governing Board Memorandum: Review and Adjustment of the HCP/NCCP Mitigation Fees, July 2011. (Appendix 3-7.3)

Energy Related Benefits Documentation - Appendix 3-8

- Spreadsheet of CCWD daily operations model output, Contra Costa Water District Daily Operations Model (WRSEL based linear program). Los Vaqueros Expansion Model Documentation. Technical Memorandum. MBK Engineers. November 3, 2010. Greenhouse gas (GHG) emissions for the Contra Costa Water District (CCWD) is based on the Climate Registry's (Registry) General Reporting Protocol v3.1 (Protocol) released in January 2009. (Appendix 3-8.1)

Because the Project has been fully evaluated and designed, the projected physical benefits are well-defined and justifiable. The following sections provide the technical justification to support these claimed benefits.

Relationship to Other Proposed Projects

As discussed in Attachment 3, the projects included in this proposal are all intrinsically linked through the objectives of the East County Integrated Regional Water Management Program. However, no other projects in this proposal must be implemented to achieve the benefits claimed in this attachment.

This project is intrinsically linked to the USCB project and the Contra Costa Canal Flood Protection and Levee Elimination projects as follows.

- USCB Project Linkage: The USCB Project is currently being implemented to prevent flooding along the lower reach of Marsh Creek between Sand Creek and the Marsh Creek outfall into the Sacramento-San Joaquin River at Big Break in Oakley. The construction of USCB is expanding an existing interim flood control basin by excavating the existing interim basin floor. The proposed project would involve using soil removed from the excavation for use by CCWD.
- Contra Costa Canal Flood Protection and Levee Elimination and Flood Protection Project Linkage: The soil would be used by CCWD as fill material for the Contra Costa Canal Flood Protection and Levee Elimination Project, which received funding for implementation under Round 1 of Proposition 1E and is currently under construction. Implementing the proposed project will eliminate the cost of fill material for the Contra Costa Canal Flood Protection and Levee Elimination Project, allowing an additional 450 feet of canal to be encased in a pipeline with the existing Proposition 1E funding, extending the benefits of the funded project from 19% of the total project benefit to 21.2% of the total project benefits, or a benefit equal to 2.1% of the total projected benefits of the Contra Costa Canal Flood Protection and Levee Improvement Project.

Summary of Benefits

The projected project benefits are related to the ability of the Project to 1) enable an additional 450 feet of pipeline to be constructed using the existing Contra Costa Canal Flood Protection and Levee Elimination Project contract and budget funded through the Proposition 1E program, and 2) accelerate the benefits of the USCB Flood Protection Project also funded through the Proposition 1E program. By increasing the length of pipeline able to be constructed and removing fill from the detention basin, an additional 2.1% of the total Contra Costa Canal Flood Protection and Levee Elimination Project benefits will be able to be achieved, and the USCB project benefits will be accelerated by approximately five years. Benefits include:

- **Water supply benefits:** Funding for fill along the Canal right-of-way allows CCWD to construct an additional 450 feet of pipeline with its existing Proposition 1E grant for the Contra Costa Canal Flood Protection and Levee Elimination Project. This translates to greater water quality improvements since more of the Canal is protected from shallow groundwater infiltration.
- **Water quality improvements:** Increased pipeline construction supports water quality improvements from avoidance of shallow ground infiltration along the unlined Canal. CCWD estimates that its Canal system could provide up to 50% of its total water demands. Based on 2012 water demands this is approximately 50,000 AFY.

- **Flood damage reduction benefits:** The project will allow a portion of the Canal to be encased in a buried pipeline, eliminating the risk of flooding due to overtopping. It will also remove fill from the Upper Sand Creek flood control basin, accelerating full flood control benefits.
- **Environmental benefits :** Additional pipeline construction supports environmental benefits in three primary ways:
  1. Enables habitat improvements by the DWR Dutch Slough Tidal Restoration Project.
  2. Allows the project area to become potential habitat for burrowing owls and other upland species.
  3. Minimizes ongoing maintenance costs and avoids the creation of wetlands over time.
- **Recreation/Public Access benefits:** The project will provide an approximate five- year reduction in the time required to realize recreation benefits of Dutch Slough Tidal Marsh Restoration Project, including a 55-acre community park. In addition, it will reduce the time required to complete the USCB flood control project and associated recreation benefits, including a 62.5-acre park in Antioch
- **Energy benefits:** The project will reduce annual energy requirements and associated greenhouse gas emissions due to decreased Delta demands and associated pumping. It will also allow CCWD to obtain fill from a location nearer to the project site, reducing greenhouse gas impacts associated with transporting fill over long distances.
- **Other benefits:** The project will eliminate the risk of drowning in the portion of the Canal able to be encased. In addition, maintenance, patrolling, and herbicide application requirements will be eliminated.

These benefits are summarized in the following table.

Table 7-5: Summary of Project Physical Benefits

Category	Benefit Summary
Water Supply	• 19 AFY increase in emergency supply • 359 AFY supply conserved due to reduced salinity-driven CVP/SWP releases • 120 AFY conserved from reduced CVP/SWP releases due to OMR restrictions
Water Quality	• Reduction in average bromate concentration from 5.6 to 4.99 ug/L • 0.002 reduction in excess cancer cases per year due to bromate • 12.6 acre reduction in agricultural runoff area • 0.02% reduction in annual solids handling requirements
Flood Damage Reduction	• 3 residential structures protected from flooding per year, on average • 0.3-acre reduction in average annual acres inundated from flooding • 14 Mcf/d reduction in average annual energy interruptions from flooding • 1-acre reduction in average annual acres of Dutch Slough Property inundated from flooding • 0.014-mile reduction in average annual road inundation from flooding • 0.01-day per year reduction in average annual response time to address a 50-foot levee breach due to flooding • 2 AFY reduction in average annual supply interruption due to flooding • 5 year reduction in time to realize flood damage reduction benefits of the USCB flood control project, including 100-year protection to more than 3,000 parcels
Environmental Resources	• 5 year reduction in time to realize environmental benefits of Dutch Slough Tidal Marsh Restoration Project
Recreation/Public Access	• 5 year reduction in time to realize recreation benefits of Dutch Slough Tidal Marsh Restoration Project, including a 55-acre community park • 5 year reduction in time to realize recreation benefits of USCB Flood Control Project, including 6.25-acre park in Antioch
Energy	• 10 MWH/year reduction in energy required for pumping • 9,670 pound per year reduction in CO2 emissions per year due to reduced pumping • 448,000-pound reduction in CO2 emissions in 2018 associated with reduced fill hauling distance
Other Physical Benefits	• No quantified physical benefits

Each of these benefits is discussed in further detail in the following sections.

Background / Recent and Historical Conditions

Contra Costa Canal

The Canal was developed as part of the Central Valley Project in the 1930s and is an integral part of the water delivery system for CCWD. The unlined portion of the Canal begins at Rock Slough and continues for four miles until it connects to the 44.6-mile concrete-lined Canal. The Canal levees in the unlined portion are in poor condition; they are not designed to provide flood protection and are not seismically sound. They are composed of unconsolidated dredging spoils from the original construction. At least seven square miles are currently at risk of flooding if the Canal levees failed, including housing developments, roads, small businesses, working farms and a tidal marsh restoration project.

In addition, groundwater along the Canal is high in salinity and impact supply reliability and water quality delivered to CCWD's customers. Because Canal water quality at Rock Slough is a salinity monitoring point for the State Water Project, elevated Canal salinity actually impact water supply reliability statewide. Encasing the Canal in a pipeline would eliminate water quality and supply reliability impact associated with saline groundwater intrusion into the Canal. Without the Contra Costa Canal Flood Protection and Levee Elimination Project, groundwater seepage into the Canal will continue to occur, impacting water supply reliability and water quality throughout the region and Statewide. Without this Project, only 4,000 feet of the full, five-phased project would be constructed through Proposition 1E funding (refer to contract, provided in Appendix 3-3.11). With this project, an additional 450 feet of pipeline would be constructed, corresponding to an additional 2.1% of the benefits of the full, five-phased Project.

Upper Sand Creek Basin

The area below the planned detention basin consists of Sand Creek (which provides little to no flood protection from relatively minor storms). Sand Creek enters into Marsh Creek, which has engineered banks intended to protect adjacent areas from flooding up to a 50-year event. The area at risk covers over 10,000 acres, and includes residential developments (nearly 2000 homes), as well as over 250 commercial, industrial and institutional buildings, agricultural lands, and numerous arterial roads (including Highway 4) and bridges. The USCB Flood Protection Project is constructing a 900 AF stormwater detention basin to provide regional flood protection to areas of Antioch, Brentwood and Oakley. The basin plan provides stormwater attenuation, stormwater infiltration, trash capture, and environmental enhancement of 3,500 linear feet of Sand Creek. The basin will also create seasonal wetlands and riparian habitat fed by urban runoff. The basin plan also allows future development as a regional sports park for the City of Antioch (refer to work plan, provided in Appendix 3-1.6).

The basin currently holds approximately 500,000 cy of fill, which reduces capacity from 900 AF to approximately 750 AF. The timing of fill removal is dependent on local economic conditions, but the FCD estimates it may take 10 years to find users for the remaining fill. By using 75,000 cy of fill, the proposed project will increase basin capacity by approximately 45 AF, and will accelerate complete removal of fill by approximately five years.

Existing Proposition 1E funding for the Contra Costa Canal Flood Protection and Levee Elimination project will provide for 4,000 feet of pipeline to be constructed. The proposed project would increase that by 450 feet to 4,450 feet, which means that an additional 2.1% of the benefits of the total, five-phased project benefits will be realized.

In addition, the existing Proposition 1E funding for the Upper San Creek Basin will provide for a 900 AF detention basin. Basin capacity is currently reduced by approximately 150 AF due to fill storage. Implementation of the proposed project would reduce dependence on economic conditions for fill removal, allowing the full flood protection benefits to be achieved five years sooner.

Description of Benefits and Methods to Estimate Benefits

The following section summarizes project benefits and methods used to estimate benefits in the following areas:

- Water Supply
- Water Quality
- Flood Damage Reduction
- Environmental Resources
- Recreation/Public Access
- Energy
- Other Physical Benefits

Uncertainty of the benefits, and factors that lead to uncertainty and quantified estimates of physical benefits described using PSP Table 7 are provided in later sections of this attachment.

Water Supply Benefits

CCWD is a wholesale water supplier to three water suppliers in the East County region (City of Pittsburg, City of Antioch, and DWD). The city of Brentwood has a Delta surface supply purchased from ECCID that is diverted by CCWD at its Delta intakes and also has well water. Also, CCWD serves a portion of Brentwood that lies within its service area boundaries using the unlined Canal system. CCWD also has emergency agreements with East Bay Municipal Utility District.

There are three main water supply benefits that will be achieved by the completion of the Contra Costa Canal Flood Protection and Levee Elimination Project: 1) CCWD will retain more water in Los Vaqueros Reservoir and thereby improve availability and reliability of emergency water supplies for CCWD customers and partner agencies; 2) water quality at Pumping Plant 1 will improve, allowing the CVP/SWP to release less water from upstream reservoirs to meet water quality standards at Rock Slough (compliance measured at Pumping Plant 1) promulgated by the State Water Resources Control Board Decision 1641; 3) because water quality at Pumping Plant 1 will improve, CCWD can shift pumping away from the Old and Middle River Intakes and CVP/SWP will gain operational flexibility and possibly increase maximum exports during times when export operations are normally constrained by Old and Middle River flow regulations. Greater details and explanations of these are provided below. Together these four sources of water supply benefits are expected to yield approximately 25,000 AFY.

This Project is expected to provide a portion of the following water supply benefits provided by the Contra Costa Canal Flood Protection and Levee Elimination Project:

WS1: Increase in emergency water supply available for CCWD customers and partners
WS2: CVP/SWP water savings from upstream reservoirs that would otherwise be released to meet state water quality regulations as measured at the downstream end of the Canal
WS3: CVP/SWP operational flexibility and possibly increase in water exports during times when regulations set limits on Old and Middle River flows
Estimated benefits and methods for developing these estimates are provided below.

WS1: Increase in Emergency Water Supplies Benefits & Methods

CCWD owns and operates four intakes in the Delta, as well as the Los Vaqueros Reservoir and two raw water treatment plants. CCWD operations are designed to deliver supplies with chloride concentrations of 65 mg/L or less. Poor water quality in the Canal and Pumping Plant 1 can cause CCWD to reduce or eliminate diversions at Pumping Plant 1, increase diversions at other intakes, or increase releases from

Los Vaqueros Reservoir. Implementation of the Project will improve water quality at Pumping Plant 1 which will, in turn, enable CCWD to use Pumping Plant 1 more often to meet a greater portion of customer demand that was previously met by using other intakes and releases from the Los Vaqueros Reservoir. This will have the net effect of decreasing the amount the reservoir is used to meet 'normal' demand, thereby increasing the minimum amount of water in the reservoir at any time available for an emergency.

Replacing the unlined Canal with a pipeline will lead to improved water quality at the Rock Slough intake, which will decrease the amount of water released from Los Vaqueros Reservoir in order to meet CCWD's customer water quality delivery goals. The proposed Project effectively adds 340 AFY on average to water available in storage but increases available storage up to 860 AFY during dry times, assumed to occur 2 out of every 5 years for an average emergency water supply savings of 340 AFY. In addition, reduced evaporation losses from the open Canal amount to an estimated 60 AFY saved per year. Combined, there is a savings of 400 AFY for CCWD. CCWD operations model output is provided in Appendix 3-5.1, and documentation is provided in Appendix 3-5.2.

Table 7-6: Expected Annual Water Supply Benefit Resulting from Increased Emergency Supplies

	Minimum Storage in Los Vaqueros Reservoir [AF]
Without Project	148,570
With Project	147,710
Emergency Supply Benefit of Contra Costa Canal Flood Protection and Levee Elimination Project	**860**
Benefits Attributable to Implementation of the Proposed Integrated Regional Flood Protection and Water Quality Improvement(2.1 percent)	**19**

WS2: Statewide Water Savings to Meet Water Quality Regulations – 17,000 AFY

Water quality in the Contra Costa Canal affects both CCWD operations and statewide CVP/SWP operations. The federal water and state water projects are required to meet state water quality objectives defined by the State Water Resource Control Board Decision 1641; compliance with two state water quality objectives are measured at Pumping Plant 1. One of the D-1641 objectives specifies that salinity in the Contra Costa Canal as measured at Pumping Plant 1 (PP1) must be below 150 mg/L chlorides for a minimum of 155 days per year and up to 240 days per year depending on water year type. The second objective specifies that water quality at Pumping Plant 1 must be below 250 mg/L chlorides to comply with the secondary MCL. Although compliance with these standards does not often dictate statewide water operations, there are times when CVP/SWP reservoirs must make releases specifically to meet these water quality objectives. Estimated savings calculations are provided in Appendix 3-5.4.

There are three sources of salinity and contamination in the Canal: 1) seawater intrusion from the ocean into the Delta, 2) groundwater intrusion from an elevated water table adjacent to the Canal, and agricultural return flow from adjacent farms and ranches. Salinity in the Canal from seawater is naturally variable due to the variation in hydrologic conditions and tidal forcing. When freshwater outflow from the Delta dominates, water in the Canal is relatively fresh because the river flow is sufficient to keep seawater downstream of the Delta. Conversely, when there is low freshwater outflow from the Delta, water in the Canal is relatively salty because seawater is able to mix upstream in the Delta. Salinity from

the other two sources, groundwater and agricultural return flow, are largely due to human activities and will be eliminated by implementing the Project. Eliminating the two "human-derived" sources of salt will improve water quality in the Canal and will in turn, improve SWP/CVP operations to provide a water supply benefit. Specifically, implementing the Project would improve water quality, or decrease salinity, by approximately 15% on average. The methodology for determining this reduction is described below.

Because compliance with the regulatory standards is measured at PP1 (at the downstream end of the unlined Canal), degradation incurred along the unlined portion of the Canal from groundwater intrusion and agricultural runoff can result in increased releases from CVP/SWP reservoirs. Historical land use practices adjacent to the unlined Canal, such as land disposal of sewage, agricultural drainage, and cattle grazing, have resulted in significant water quality degradation in the unlined Canal. Implementing the Project will eliminate salinity intrusion from groundwater and direct agricultural runoff thereby decreasing the salinity at Pumping Plant 1 and decreasing the amount of water CVP/SWP need to release from upstream reservoirs to meet the water quality standards.

To calculate the water savings associated with improving water quality at the compliance point, CCWD ran the 'G'-model[1] using the same water quality time series as was input into the daily operations model for the other water supply calculations. Implementing the Project would improve water quality, or decrease salinity, by approximately 15%. The G-model output indicated the amount of outflow that would be saved by the improvements to meet the 150 and 250 chloride standards. Daily chloride concentrations from 1999 through 2007 measured by CCWD at Rock Slough were examined to determine the number of days the water quality savings could have been realized. This period was chosen because it captures the data available before the implementation of Segment 1 of the Project which began in 2007. According to the historical record during this period, implementing the Project could have improved the water quality on average 16 days per year to meet the 150 mg/L chloride standard at Rock Slough for an average savings of 14,000 AFY. On average, water quality at Rock Slough would have improved 11 days per year to meet the 250 mg/L chloride standard for an average water savings of 2,593 AFY. Combined, based on historical conditions, implementing the Project would save between 2,000 AFY and 24,000 AFY depending on the water year type. Over the eight-year period of analysis, the average potential water savings was 17,000 AFY. Calculations of water savings based on Rock Slough salinity are provided in Appendix 3-5.4.

[1] Gmodel - *Accounting for Antecedent Conditions in Seawater Intrusion Modeling – Applications for the San Francisco Bay-Delta.* Richard Denton, 1993. Hydraulic Engineering, Volume 1, ASCE, pp. 448-453.

Table 7-7: Expected Annual Water Supply Benefit to SWP / CVP Operations

	150 standard			250 standard			
Water Year	Amount of Water Saved to Meet Standard by Implementing Project [AF/d]	Max. # of Days / Year that Water Quality Savings Could be Realized	Amount of Water Could be Saved [AFY]	Amount of Water Saved to Meet Standard by Implementing Project [AF/d]	Max. # of Days Per Year Where Water Quality Savings Could be Realized	Amount of Water Could be Saved [AFY]	Maximum Total Water Saved [AFY]
1999	936	20	18,720	244	16	3,904	22,624
2000	936	14	13,104	244	13	3,172	16,276
2001	936	20	18,720	244	23	5,612	24,332
2002	936	13	12,168	244	33	8,052	20,220
2003	936	28	26,208	244	0	0	26,208
2004	936	20	18,720	244	0	0	18,720
2005	936	7	6,552	244	0	0	6,552
2006	936	2	1,872	244	0	0	1,872
Average (full Canal Project)		**16**	**14,508**		**11**	**2,593**	**17,101**
Portion Attributable to proposed Project (2.1 percent)			**305**			**54**	**359**

WS3: Statewide Water Supply Benefits during 'OMR' Regulations

Conflicts between the need to divert water from the Delta and the legal requirements to protect endangered species can result in pumping restrictions that severely limit the quantity of Delta water allowed to be withdrawn in a given year. The CVP/SWP are subject to flow restrictions from January through June each year to protect endangered species such as Delta smelt. One of these restrictions limits the amount of exporting by regulating flow in Old and Middle Rivers (a.k.a. OMR). CCWD maintains four intakes in the Delta; Mallard Slough Intake, Rock Slough Intake (Pumping Plant 1), Old River Intake and Middle River Intake. Implementation of the Project will improve water quality at Pumping Plant 1 which in turn will enable CCWD to use Pumping Plant 1 more often to meet a greater portion of customer demand that was previously met by using other intakes and releases from the Los Vaqueros Reservoir. CCWD would be able to shift diversions from our Old and Middle River Intakes to Pumping Plant 1, thereby providing CVP/SWP more operational flexibility during that critical regulatory window and possibly increasing the amount of water available for export while complying with OMR regulations.

To calculate the potential water supply benefit to the CVP/SWP during the OMR regulatory period, the CCWD daily operations model[2] was run simulating conditions with the Project implemented and without

[2] Contra Costa Water District Daily Operations Model (WRSEL based linear program). Los Vaqueros Expansion Model Documentation. Technical Memorandum. MBK Engineers. November 3, 2010.

the Project. The model was run using hydrologic input from January 1999 through November 2007. This end date was chosen because construction of Segment 1 of the Project started in November 2007. The total diversions at CCWD's OMR intakes from January through June were tabulated with and without project. As is shown in Table 7-5 below, implementing the Project would shift approximately 5,700 AFY on average away from CCWD's OMR intakes from January through June each year. There are many factors that influence CVP/SWP operations so the federal and state water projects may not be able to increase diversions by the same amount that CCWD is able to reduce Old and Middle River diversions every year but implementing the Project would at least reduce constraints on CVP/SWP operations every year.

Table 7-8: Expected Annual Water Supply Benefit to SWP / CVP Resulting from OMR Compliance

	CCWD Old River Pumping Jan – Jun [AFY]	**CCWD Middle River Pumping Jan – Jun [AFY]**	**Total CCWD Pumping Jan – Jun [AFY]**
Without Project	17,578	7,605	25,183
With Project	14,044	5,431	19,475
CVP/SWP Supply Benefit During OMR Restrictions (Full Canal Project)	**3,534**	**2,174**	**5,708**
Benefit Attributable to Proposed Project (2.1 percent)	**74**	**46**	**120**

Water Quality Benefits

Water quality is an ongoing challenge facing East County water suppliers. Delta water quality is highly variable depending upon the season, the water year, and the intake location. During dry years and seasons Delta supplies contain high concentrations of TDS, chloride and bromide. Total organic carbon (TOC) concentrations in Delta supplies are also highly variable, with increases generally corresponding to periods of increased runoff. The Los Vaqueros Reservoir, which is owned and operated by CCWD, is used to improve the water quality delivered to CCWD's customers. Currently, water is pumped into Los Vaqueros during spring and early summer months when Delta water quality is good. During the late summer and fall, when Delta water quality is poor, Delta supplies are blended with the high quality water stored in Los Vaqueros Reservoir to improve the water quality delivered to CCWD's untreated and treated water customers. Water quality data for CCWD's intake at Rock Slough is provided in Appendix 3-6.1, 3-6.2, and 3-6.3.

The quality of Delta water is also dependent on maintenance of the Delta levee system as well as land and water management activities throughout the Delta and its larger watershed. Failure of the Delta levee system due to flooding or seismic events could dramatically increase levels of chloride, bromide, and TOC, and potentially render the water supply unusable for municipal or agricultural purposes. Similarly, changes in Delta land-use and water management practices, including many identified by CALFED, could increase levels of undesirable constituents at East County intake locations.

The proposed Project will allow an increased portion of the Canal to be encased, improving drinking water quality for residents of Contra Costa County by decreasing the amount of saline groundwater intrusion or stormwater into the Canal. This will reduce the concentrations of TDS, chloride, bromide and other constituents in CCWD's source water. This Project is expected to yield the following water quality benefits:

WQ1: Reduced Levels of DBPs in Drinking Water
WQ2: Decreased Agricultural Runoff from Adjacent Fields
Decreased turbidity, salinity and nutrients associated with runoff
WQ3: Decreased Risk in Fecal Borne Pathogens Transported into the Canal
WQ4: Decreased Turbidity and Associated Solids Handling Requirements

Estimated benefits and methods for developing these estimates are provided below.

WQ1: Reduced Levels of DBPs in Drinking Water

The primary water quality benefit expected from the Contra Costa Canal Flood Protection and Levee Elimination Project is a reduction in disinfection byproduct formation, and associated public health protection. Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project will reduce bromide concentrations at PP1 by 15% on average. Figure 7-1 below shows the increase in bromide concentration that occurs as water travels down the unlined canal; this increase in bromide concentration is due to groundwater intrusion. Groundwater beneath the Ironhouse Sanitary District (ISD) properties immediately adjacent to Segment 1 of the Canal has bromide concentrations regularly exceeding 5 mg/L[3]which is more than ten times greater than the concentration measured in surface water. Similarly, the bromide concentration on the Dutch Slough Properties adjacent to Segments 2 through 4 of the Canal can exceed 3 mg/L[4]. The lower panel of Figure 7-1 shows that by implementing the Project, bromide concentrations could be reduced between 0% and 60%, with an annual average reduction of 15%.

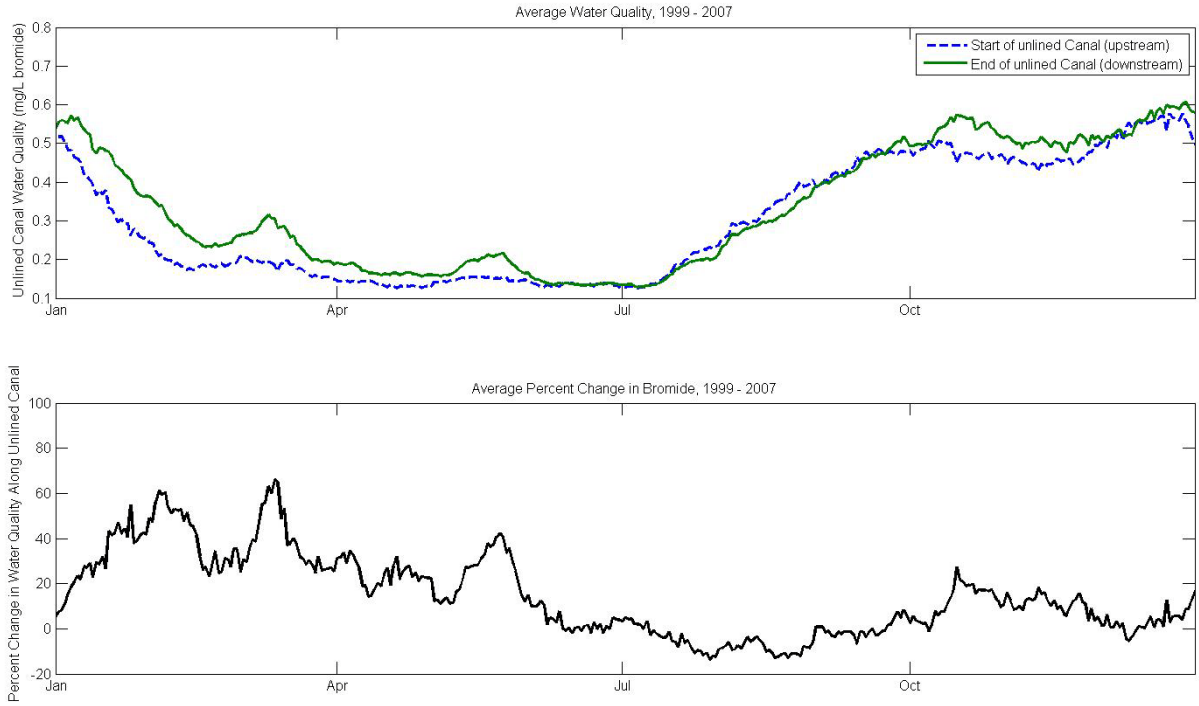
Bromide in the source water is transformed into bromate during ozonation at CCWD's Randall Bold Treatment Plant. Bromate is suspected of contributing to kidney and thyroid cancer in humans. The state and federal MCL for bromate is 10 ug/L. Bromate concentration in CCWD service area has exceeded 10 ug/L in the past, with a maximum of 12 ug/L recorded in 2005. Since 2008, Segment 1 of the Contra Costa Canal Flood Protection and Levee Elimination Project was implemented limiting the groundwater flux of bromide from ISD's property and the treatment process at Randall Bold Water Treatment Plant was modified to limit bromate concentrations in the service area to less than 5 ug/L.

As bromate is presumed to have a linear no-threshold dose-response relationship, the only risk-free level of exposure to bromate is zero. Thus, any Project that reduces the potential level of bromate in drinking water provides a positive reduction in risk of cancer to those who drink that water.[5]

[3] Beneficial Use Impact Study, Final Report Ironhouse Sanitary District, Oakley, California. Prepared by HydroFocus. December 2003; provided as Appendix 3-6.7
[4] Dutch Slough Restoration Area First and Second Quarters 2012. Semi Annual Groundwater Monitoring Report. Prepared by HydroFocus October 2012; provided as Appendix 3-6.6
[5] US EPA Toxicological Review of Bromate(CAS No. 15541-45-4), In Support of Summary Information on the Integrated Risk Information System (IRIS), March 2001, Section 6. http://www.epa.gov/iris/toxreviews/1002tr.pdf#page=40

The bromate model of Ozekin and Amy determines bromate formation based on ozone dose, bromide, DOC, and pH as follows:[6]

Figure 7-1: Influence of Groundwater Intrusion on Canal Bromide Concentration



$$BrO^3 = 1.63 \times 10\text{-}6 * TOC^{-1.26} * pH^{5.82} * (O_3 \text{ dose})^{1.57} * Br^{0.73} * time^{0.28}$$

with BrO3 in ug/L, TOC in mg/L, O_3 in mg/L, Br in ug/L, and contact time in minutes. The 2005 CALFED Bay Area Water Quality and Supply Reliability Program (BAWQ&SRP) assessed bromate formation at CCWD's water treatment plants.[7] Page C-29 of the BAWQ&SRP report presents long-term average water quality concentrations for CCWD source water at Rock Slough. Long-term average TOC and bromide concentrations presented in this report are approximately 3.0 mg/L and 0.35 mg/L, respectively. Based on conversations with CCWD staff, long-term average pH in water treatment plant influent is approximately 7.2. The BAWQ&SRP also estimated water treatment conditions at Randall Bold water treatment plant. Based on this report (page D-13), ozone dose is approximately 1 mg/L and contact time is approximately 11 min. Bromate production would therefore be calculated as 5.6 ug/L as follows:

$$BrO^3 = 1.63 \times 10\text{-}6 * (3.0 \text{ mg/L TOC})^{-1.26} * (\text{pH of } 7.2)^{5.82} * (O_3 \text{ dose of } 1 \text{ mg/L})^{1.57} * (\text{Br of } 350 \text{ ug/L})^{0.73} * (11 \text{ min})^{0.28}$$

Reducing bromide by 15% would reduce bromate formation to 4.99 ug/L (11.2%), as follows:

[6] Amy, G.L., M. Siddiqui, K. Ozekin, H.W. Zhu, and C. Wang, (1998). Empirically Based Models for Predicting Chlorination and Ozonation By-Product: Haloacetic Acids, Chloral Hydrate, and Bromate. EPA Report CX 819579. USEPA Office of Groundwater and Drinking Water: Cincinnati, OH, 1998; provided as Appendix 3-6.5

[7] Bay Area Water Quality & Supply Reliability Program. CALFED Bay Delta Program. May 2005; provided as Appendix 3-6.4

$$BrO^3 = 1.63 \times 10\text{-}6 * (3.0 \text{ mg/L TOC})^{-1.26} * (\text{pH of } 7.2)^{5.82} * (O_3 \text{ dose of } 1 \text{ mg/L})^{1.57} * (\text{Br of } 350 * 0.85 \text{ ug/L})^{0.73} * (11 \text{ min})^{0.28}$$

The drinking water unit cancer risk for bromate is equal to $2 * 10^{-5}$ per ug/L; for water at the MCL concentration of 10 ug/L, this corresponds to 2 in 10,000, or 2 x 10-4 per ug/L (US EPA, 2011). The relationship between bromate risk and concentration is linear, so risk at 5.6 ug/L (as calculated above) equals 56% of the risk at the MCL, or 1.1×10^{-4} per ug/L. Multiplying this risk level by the number of households served (178,571) and the average number of people per household in the area (3.1) provides the estimate of the excess lifetime cancer cases expected under baseline: 61. The Contra Costa Canal Flood Protection and Levee Elimination Project will reduce bromate levels by approximately 11.2% on average to 4.99 ug/L. This corresponds to an excess lifetime cancer cases expected under the with-Project condition of 54 ($0.98 * 10^{-4} * 178{,}571 * 3.1$). This translates to a reduction in excess lifetime cancer cases of 7 fewer cancer cases per 70-year lifetime compared to baseline, or an average of 0.1 cases avoided each year.

The proposed Project will enable an additional 450 feet of pipeline to be constructed, and therefore will result in 2.1 percent of the benefits of the full Contra Costa Canal Flood Protection and Levee Elimination Project. This translates to a reduction in excess lifetime cancer cases attributable to the proposed Project of 0.15 fewer cancer cases per 70-year lifetime compared to baseline, or an average of 0.002 cases avoided each year.

WQ2: Decreased Agricultural Runoff

A previous study[8] of the Canal found that a single point source of agricultural discharge contributes up to 17 mg/L of total dissolved solids to the Canal. The study also found that non-point source runoff from adjacent farms also causes a spike in Canal salinity and other constituents during the early stages of a storm event. There is an initial flushing of the fields as water carries salts, suspended sediment and cattle manure that have accumulated during the dry season that corresponds to the observed spike in salinity. After the initial flushing period, runoff from the farms is generally better quality. There are approximately 600 acres that are irrigated for cattle grazing adjacent to the Canal. Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project would eliminate non-point sources of agricultural return flow and improve water quality in the Canal.

The proposed Project will enable an additional 450 feet of pipeline to be constructed, and therefore will result in 2.1 percent of the benefits of the full Contra Costa Canal Flood Protection and Levee Elimination Project. This translates to a reduction in agricultural runoff from approximately 12.6 acres of agricultural land (600 * 0.021).

WQ3: Decreased Risk in Fecal Borne Pathogens Transported into the Canal

Cattle access to streams has been shown to lead to a four-fold increase in total Kjehldahl nitrogen, a five-fold increase in total phosphorous, an eleven-fold increase in total suspended solids and turbidity, and a 36-fold increase in E. coli bacteria in water supplies[9]. As noted above, approximately 600 acres adjacent to the Canal are currently used for cattle grazing. Figure 7-2 below shows cattle in the Rock

[8] Rock Slough Technical Memorandum Evaluating Veale Tract Discharge. FlowScience. December 19, 2003; provided as Appendix 3-6.2.

[9] Unrestricted cattle access to streams and water quality in till landscape of the Midwest. Philippe Vidon, Marie Campbell, Mark Gray. Agricultural Water Management. V 94, Is3, pp 322-330. March 2008.

Slough Extension adjacent to the mouth of the unlined Canal. Continuous cattle grazing adjacent to the Canal can increase the fecal contamination and turbidity of the Canal. Pathogens associated with fecal contamination can be transported into the Canal via surface water runoff and groundwater seepage. Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project will reduce nutrients, turbidity and fecal contamination (E. coli, Cryptosporidium, and total coliform) in the Canal. The local reduction in nutrients may help reduce algae growth throughout CCWD's raw water system, improving treatability and reducing treatment costs. The reduction in turbidity would also help reduce treatment costs by reducing the amount of coagulant added, decreasing the frequency that the filtration bed materials need to be replaced, and decreasing the amount of solid waste generated.

Figure 7-2: Photo Illustrating Cattle in Rock Slough Extension Adjacent to Canal

WQ4: Decreased Turbidity and Associated Solids Handling Requirements

Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project would result in an approximately four-fold reduction in turbidity during the beginning of rain events and the beginning of irrigation return flow, approximately 14 days per year total. CCWD has found that turbidity accounts for roughly 25% of the solid waste that must disposed and that alum added as a coagulant accounts for the remaining 75%. Table 7-9 below shows the solids composition at Randall-Bold treatment plant in 2008 and 2009. Assuming that turbidity during those 14 days accounts for approximately 4%of the total solids

attributable to turbidity (14 out of 365), turbidity during those 14 days would account for approximately one percent of CCWD's total solids handling (0.04*0.25). A four-fold reduction in turbidity during those 14 days would therefore result in an overall 0.8 percent reduction in total solids handling requirements for CCWD (0.01*0.8) for the full Contra Costa Canal Flood Protection and Levee Elimination Project.

The portion of the 0.8%reduction attributable to implementation of the proposed project is approximately 0.02% (0.8*0.021).

Table 7-9 Solids Concentration and Removal Rate at Randall Bold Treatment Plant

Month (FY09)	Total Million Gallons Treated	Average RB Influent Turbidity (NTU)	Total Alum Dose (lbs)	Settled Turbidity (NTU)	Average Sedimentation Basin Solids Removed (lbs/month)	lbs/month from Alum	lbs/month from Turbidity	% from alum	% from turbidity
Jul-08	808	14.7	210,322	1.1	211,700	92,542	119,158	44%	56%
Aug-08	825	6.7	181,804	1.0	130,900	79,994	50,906	61%	39%
Sep-08	887	4.4	297,456	0.7	166,900	130,880	36,020	78%	22%
Oct-08	816	3.8	270,518	0.6	147,300	119,028	28,272	81%	19%
Nov-08	488	2.9	166,619	0.4	86,600	73,312	13,288	85%	15%
Dec-08	317	2.9	114,326	0.5	58,500	50,303	8,197	86%	14%
Jan-09	413	3.1	175,471	0.6	88,400	77,207	11,193	87%	13%
Feb-09	257	5.7	110,646	0.8	62,200	48,684	13,516	78%	22%
Mar-09	427	10	190,208	1.1	124,800	83,692	41,108	67%	33%
Apr-09	571	6.4	193,288	0.9	119,300	85,047	34,253	71%	29%
May-09	697	7.6	248,016	1.0	159,000	109,127	49,873	69%	31%
Jun-09	787	6	394,525	0.9	217,300	173,591	43,709	80%	20%
Average	608	6	212767	1	131075	93617	37458	74%	26%

Flood Damage Reduction Benefits

The following sections summarize avoided flood damages. Quantified avoided flood damages include the following.

FD1: Residential and Commercial Structure and Content Damage
FD2: Loss of Agricultural Land Production
FD3: Loss of Gas Production
FD4: Damage to Dutch Slough Property
FD5: Road Inundation
FD6: Emergency Response Requirements
FD7: Supply Replacement Needs

FD1: Residential and Commercial Structure and Content Damage

The Canal was developed as part of the Central Valley Project in the 1930s and is an integral part of the water delivery system for CCWD. The unlined portion of the Canal begins at Rock Slough and continues

for four miles until it connects to the 44.6-mile concrete-lined Canal. The Canal levees in the unlined portion are in poor condition; they are not designed to provide flood protection and are not seismically sound. They are composed of unconsolidated dredging spoils from the original construction. At least seven square miles are currently at risk of flooding if the Canal levees failed, including housing developments, roads, small businesses, working farms and a tidal marsh restoration project.

The historically agricultural lands adjacent to the Canal are being converted to urban development. The Project is imperative to ensure compatibility with adjacent land uses, and manage and minimize potential risks to CCWD customers and surrounding neighborhoods. There is currently a population of 10,000 in the immediate area that would be affected by failure of the facility. By 2030, ongoing rapid residential development could result in 30,000 residents endangered by this facility including three primary/secondary schools. Failure of this facility would also compromise the water supply for CCWD's customers.

The proposed Project will enable 450 feet of the Contra Costa Canal Flood Protection and Levee Elimination Project to be implemented, which will eliminate the potential for flooding associated with a Canal failure along the portion of Canal encased in a pipeline. By encasing the Canal in a buried pipeline, virtually all concerns with regard to system security and public safety are alleviated as well. Fences and maintenance roads will be maintained along the 300-foot right of way boundary, and security personnel will patrol the area.

A portion of the region at risk of flooding surrounding the unlined portion of the Canal is known as the East Cypress Corridor. The East Cypress Corridor Specific Plan includes development of mixed-uses for the 2,546-acre site. The project has planned up to 5,609 residential units, 92.6 acres of commercial use, 52.6 acres of public schools, 152.3 acres of man-made lake, 190 acres of open space/easements, 20.5 acres of existing and proposed gas well sites, 122.1 acres of wetlands/dunes, 46,100 feet of flood-control levees, 101.7 acres of parks (neighborhood and community), 5.7 acres of light industrial use, 37.3 acres of commercial recreation and a 6-acre beach club. Some of the planned development has been constructed, but some of the proposed development has been delayed due to the poor economy. Twenty-three acres of parks have been developed, and the beach club house has been developed. Development is projected to resume in 2016.

The Canal has experienced overtopping events in the past due to hydrologic conditions (refer to Appendix 3-4.1). Figure 7-3 shows the areas that have suffered failures in the past. In 1996 and 1997, the Canal experienced multiple major levee slumping and overtopping events at the western end of the Canal near Pump Plant #1. At the time, Los Vaqueros Reservoir was not completed, and water continued to be conveyed through the Canal. Due to the complete dependence on the Canal at that time, full repairs were not possible until the summer of 1998 (see attached photos). The repairs took approximately two weeks. Adjacent properties experienced limited flood damage due to emergency response to stabilize the levee. Emergency response and levee repairs cost just over $1M. The engineering report prepared at the time noted that investment was needed to prevent a complete failure of the reach. The greatest risk associated with the 1996-1997 levee damage was sewage from the Ironhouse Sanitary District flowing into the Canal from an adjacent property where sewage was land-applied. This section of the Canal (from Pump Plant #1 to Marsh Creek) was encased in 2009; encasing that portion of the Canal cost $13M (construction cost, not including permits and mitigation).

In February of 1998, the Canal failed at the intersection of Cypress Rd. The road was partially flooded and emergency repairs were made. Emergency repairs (sandbags) cost more than $13,000; rip-rap

repairs to this section occurred the same month for an additional cost of $25,000. These cost estimates do not include time spent by Contra Costa County to provide emergency assistance or any repairs to adjacent properties.

In January of 2006, Emerson Slough overtopped its banks and flooded the southern portion of the Emerson parcel, Sellers Ave, and portions of E. Cypress Rd. The roads were partially flooded and the historic landmark house on the Emerson parcel was flooded. Flood waters needed to be pumped out of the house and the house remained habitable.

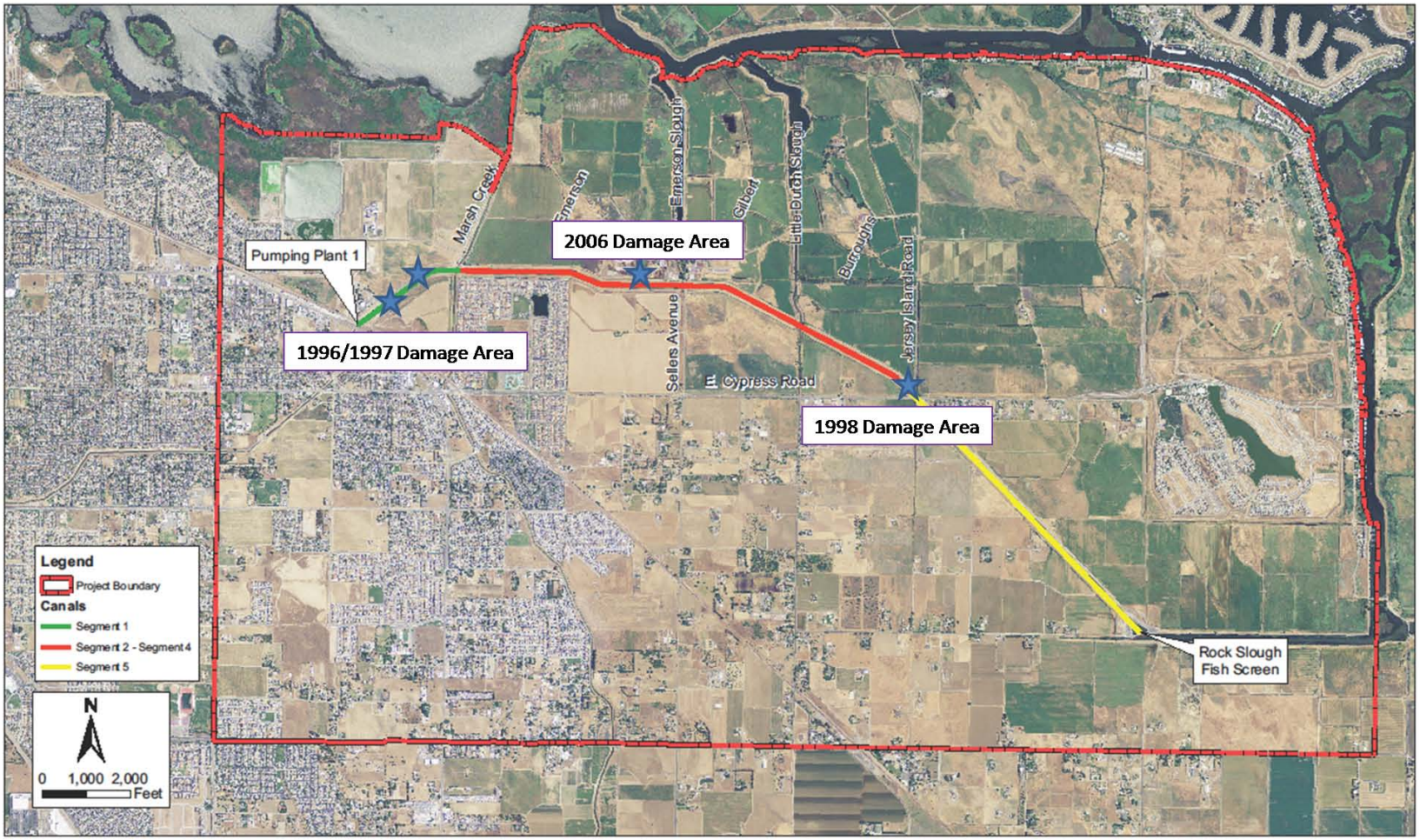
Without the Contra Costa Canal Flood Protection and Levee Elimination Project, the risk of Canal levee failure will continue into the future. Future flood probability is assumed to be similar to historical flooding. However, the damage associated with future floods will be greater because it is an area that is being converted from agricultural land to urban land.

Flood frequency curves developed by the U.S. Army Corps of Engineers (USACE) at nearby gage stations were examined to determine the return interval of water surface levels during events when there was historical damage (Appendix 3-4.2). Table 7-10 summaries the USACE water levels of various return intervals for the two nearby gages.

Table 7-10: Flood Frequency Summary for Two Local Gages in Project Region from USACE

	Water Surface Elevation [ft NGVD]			
	25 year	50 year	100 year	500 year
Old River @ Rock Slough	6.7	6.8	7.3	7.8
San Joaquin River @ Antioch	6.2	6.4	6.6	6.8

Figure 7-3: Map of Past Flood Damage



During the 1996 Canal failure, water surface elevation was not high during the time of Canal failure, but there had been significant rainfall for the preceding week. Appendix 3-4.4 provides water surface elevation data measured at Rock Slough. Daily rain gage data for a nearby station in Brentwood from 1985 through 2012 was ranked to estimate the return interval of the rain levels during the historical damage. The most conservative return interval of 50 years, or 2% annual chance, was chosen to represent the existing level of risk of major damage without the Project. Table 7-11 summarizes water surface elevations and precipitation conditions during historical Canal flooding events.

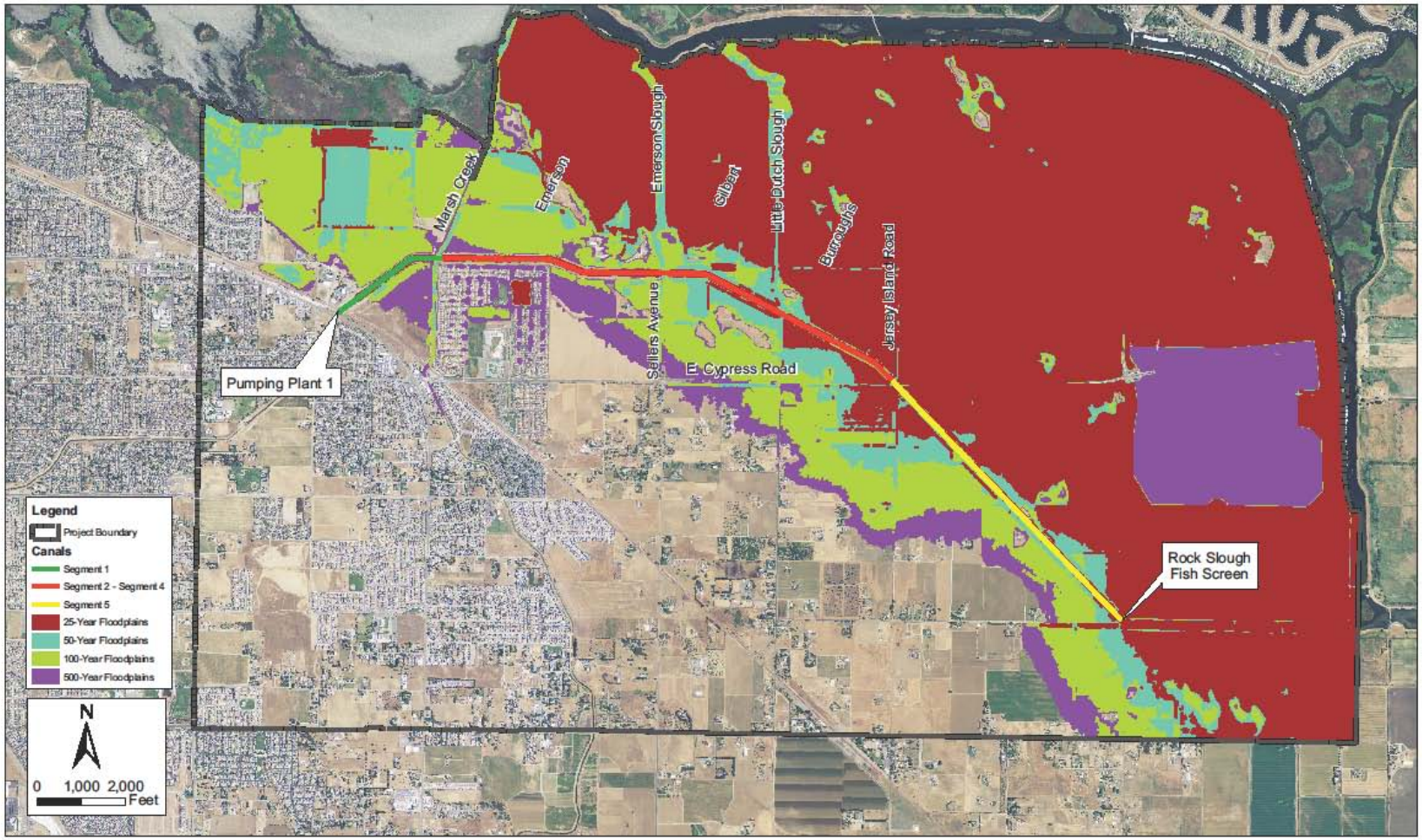
Table 7-11: Flood Frequency Summary for Two Local Gages in Project Region from USACE

Year of Flood Damage along the Canal	Description of Damage	Maximum Water Surface Elevation at Antioch [ft NGVD]	Estimated Return Interval of Water Surface Elevation	7 Day Rain Total in Brentwood [in][10]	Estimated Return Interval of Precipitation [yrs]	Estimated Probability of Occurrence in a Year
Dec - 1996	Canal embankment failure/sloughing due to recent rains and saturated embankments.	4.54	1 yr	2.17	40 years	3% Based on precipitation
Dec 1997 through Jan 1998	Canal embankment failure near PP1.	6.36	33 years	1.89	30 years	3% Based on Water surface Elevation
Jan - 2006	Emerson Slough overtopped embankments, flooded roads and houses.	6.39	50 years	2.91	80 years	2% Based on water surface elevation

Figure 7-4 below shows the potential inundation areas for the various levels of flooding estimated without the Project.

[10] http://www.cimis.water.ca.gov/

Figure 7-4: Potential Inundation Areas for Various Levels of Flooding – Without Contra Costa Canal Flood Protection and Levee Elimination Project



Aerial Source: NAIP 2012
FEMA Source: http://www.fema.gov/index.shtm
FEMA3.mxd

To calculate the avoided flood structural damages, existing and future planned land use inventories from the City of Oakley were overlaid with potential inundation maps to calculate the level of damage for Canal failures of various magnitudes. The return intervals of the stream gages developed by the USACE listed in Table 7-11 were used to develop the potential inundation maps.

The potential inundation maps were compared to FEMA maps of the areas and were generally in good agreement (refer to Appendix 3-4.3 for FEMA inundation maps). The potential inundation maps do not include the water levels that could occur after the flood isolation structure is installed. Once the flood isolation structure is built, it will enable the Canal to be closed off from the Delta. However, the extent to which the structure is able to minimize flooding in the region depends on the response time after a Canal failure has occurred. Because the response time following an emergency is unknown and variable, the inundation maps show the maximum flood damage possible. As noted above, while the flood isolation structure may limit damage, it will not reduce the probability of the Canal failing if the complete Project is not implemented. Based on historical damage, it is estimated that there is at least a 2% chance of a major Canal failure every year (or a failure once every 50 years). Once the Contra Costa Canal Flood Protection and Levee Elimination Project is implemented and the related Dutch Slough Tidal Marsh Restoration Project & East Cypress Corridor Project move forward, the level of protection for the area will exceed the 200 year urban levee design criteria.

Table 7-12 summarizes the regional infrastructure and structures that could be potentially inundated if the Canal were to fail and the region flooded.[11] With the Contra Costa Canal Flood Protection and Levee Elimination Project, these damages would be avoided. Because the proposed project would enable approximately 450 feet of Canal to be encased in a buried pipeline, approximately 2.1%of the damages cited below could be avoided through project implementation.

Table 7-12: Potential Flood Damage under Varying Hydrologic Events – without Contra Costa Canal Flood Protection and Levee Elimination Project

	25 year Event	50 year Event	100 year Event	500 year Event
Total Acreage	3,215	3,562	4,482	5,512
Number of Homes	6,169	6,189	6,259	7,971
Miles of Road	23	28	37	43
Number of Schools	3	3	3	5
Number of Gas Wells	6	8	8	8
Acres of Farmland	257	561	872	1,030
Acres of Commercial & Industrial Property	319	322	333	383
Acres of Easement for Overhead Power lines	123	123	123	123
Acres of Dutch Slough Tidal Marsh Restoration Project	1200	1200	1200	1200

[11] Includes East Cypress planned development to be implemented beginning in 2016, two years prior to the completion of the proposed Project. Refer to Appendix 3-4.8 for the City of Oakley Cypress Corridor Specific plan.

Similarly, implementation of the Upper San Creek Basin Flood Control Project would provide flood protection benefits, preventing property damage in the 100-year event. The area below the planned detention basin consists of Sand Creek (which provides little to no flood protection from relatively minor storms). Sand Creek enters into Marsh Creek, which has engineered banks intended to protect adjacent areas from flooding up to a 50-year event.

According to page 3 of the Economic Analysis – Flood Damage Reduction section of the successful Proposition 1E Round 1 application (Appendix 3-1.6), the area at risk covers over 10,000 acres, and includes residential developments (nearly 2000 homes), as well as over 250 commercial, industrial and institutional buildings. Figure 7-5 presents the 100-year floodplain for the USCB flood control project.

The following damages would be prevented by the USCB project:

- A 10-year event would conservatively be associated with a 2% probability of flooding in this area, with an associated damage loss of at least 2% of the property values at risk.
- A 50-year event would be associated with a 100% probability of flooding in this area, with an associated damage loss of at least 5% of the property values at risk.
- A 100-year flood event would conservatively be associated with a 100% probability of flooding in this area, with an associated damage loss of at least 10% of the property values at risk.

These damages would be avoided by implementation of the USCB project. The proposed project will accelerate the flood protection benefits of the full USCB project by approximately five years.

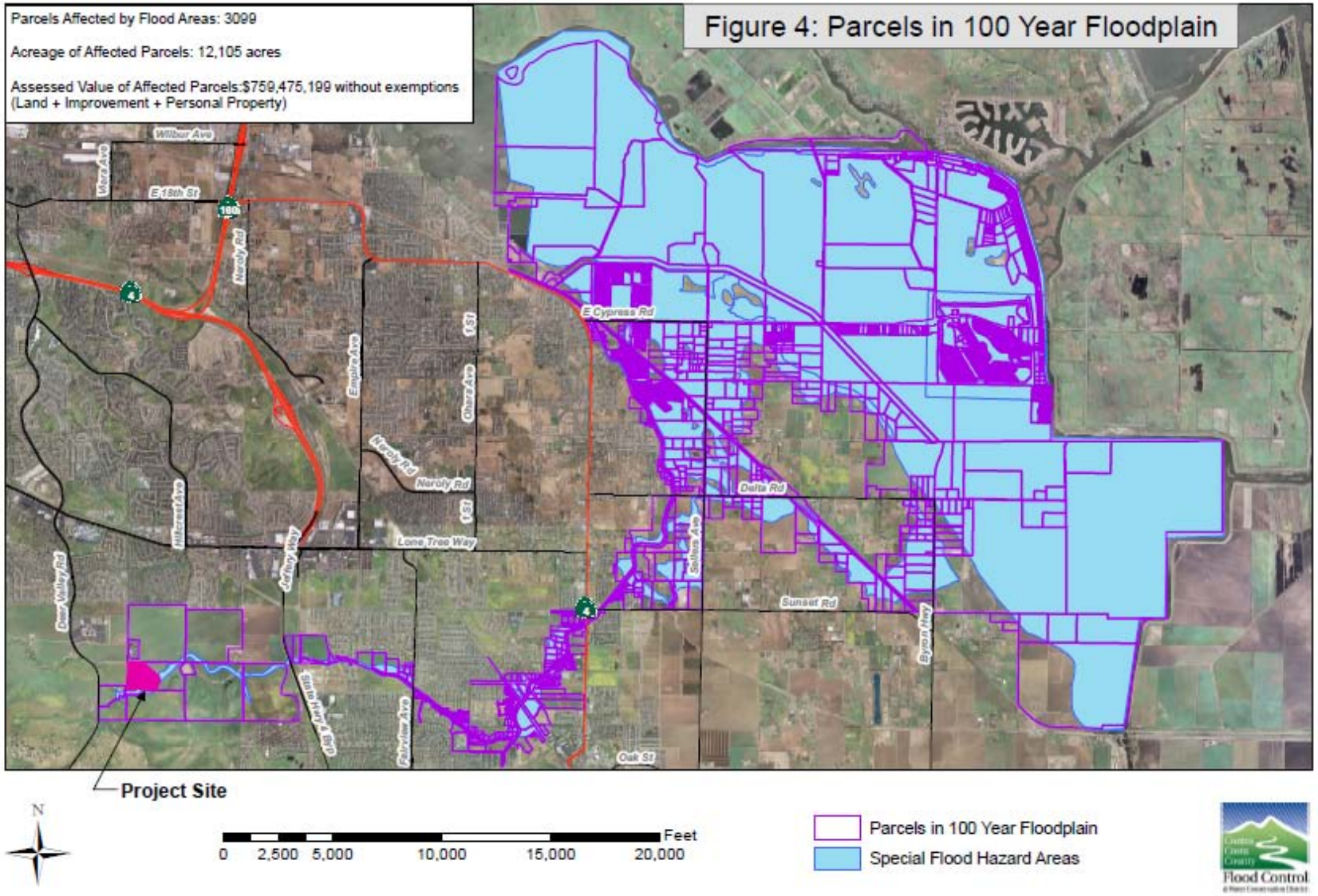
FD2: Loss of Agricultural Land Production

Adjacent to the Canal is 1,030 acres of prime farmland, the annual revenue of which is estimated to be up to $600 per acre per year. Due to the low-lying nature of the agricultural lands in this area, it was assumed that flooding would result in a 90% loss of agricultural revenue for the inundated areas.

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those losses. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those losses.

Unlined Contra Costa Canal – Aerial View

Figure 7-5: Parcels in 100-Year Floodplain Protected by USCB Project



FD3: Loss of Gas Production

Adjacent to the Canal is a gas well field, which would be inundated in a 25-, 50-, 100- or 500-year flood event (6 wells inundated in the 25-year event and 8 wells inundated in all other events). Venoco owns the mineral rights on the Dutch Slough properties.[12] Per Venoco, the field produces natural gas from the Hamilton, Anderson, Martinez and McCormick formations at depths ranging from 6,500 to 8,300 feet. Average net production from the field was 1,344 per thousand cubic feet per day (Mcf/d) in December 2005. As of December 31, 2005, there were five producing wells in the field. Two new wells were drilled in the first quarter of 2006.

Assuming that current average well production is equal to one fifth of the 2005 average production for five wells, production is estimated at 269 Mcf/d per well. Assuming inundation would cause a loss of inundated wells for at least a two-week period (14 days). This equates to a reduced gas production of 22,596 Mcf/d in the 25-year event (14 * 269 * 6) and 30,128 Mcf/d in the 50-year, 100-year, and 500-year event (14 * 269 * 8).[13]

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those losses. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those losses.

FD4: Damage to Dutch Slough Property

DWR's Dutch Slough Tidal Marsh Restoration Project will restore a tidal wetland just to the north of the Project. This Project is a critical early action to improve the ecosystem health of the Sacramento-San Joaquin Delta, a point highlighted by Governor Schwarzenegger in a July 2007 statement and its inclusion in the Interim Delta Plan. The Dutch Slough property, purchased for approximately $23 M in 2003 ($2003), is located entirely within the inundation area. This translates to a 2012 value of $27.6 M. It is assumed that inundation in the 25-year or greater flood would result in an approximate loss of 50% of land value.

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those losses. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1 percent of those losses.

FD5: Road Inundation

Road inundation was estimated by comparing aerial imagery of roads within the project area with the inundation maps for each flood event. The following table summarizes the length of each road type expected to be inundated in the 25-, 50-, 100- and 500-year flood events. As shown in Table 7-10, major roads, including E. Cypress Road, Sellers Ave, Bethel Island Rd and Sandmound Rd, would experience significant inundation in all flood events analyzed.

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those losses. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those losses.

---

[12] Summary provided at:http://www.wikinvest.com/stock/Venoco_(VQ)/Sacramento%20Basin>

[13] Gas prices estimated based on information accessed on January 28, 2013 from: http://www.eia.gov/dnav/ng/hist/n9190us3m.htm.

Table 7-13: Miles of Roads Inundated Without the Contra Costa Canal Flood Protection and Levee Elimination Project

Road	Category	Miles Inundated			
		25-Year Event	50-Year Event	100-Year Event	500-Year Event
BETHEL ISLAND RD	Major	2.3	2.8	3.71	4.31
BROADWAY	Unsealed	0.31	0.37	0.50	0.57
DUTCH SLOUGH RD	Minor	0.61	0.75	1.00	1.15
CYPRESS AND EAST CYPRESS RD	Major	4.61	5.61	7.41	8.62
JERSEY ISLAND RD	Major	4.61	5.61	7.41	8.62
KNIGHTSEN AVE	Minor	0.31	0.37	0.50	0.57
TULE LN	Minor	0.05	0.06	0.07	0.09
COW POKE LN	Unsealed	0.46	0.56	0.74	0.86
FRANKLIN RD	Unsealed	0.15	0.19	0.25	0.29
WELLS RD	Minor	2.00	2.43	3.22	3.74
CACTUS LN	Minor	0.05	0.06	0.07	0.09
DELTA RD	Minor	0.46	0.56	0.74	0.86
MARINER RD	Minor	0.15	0.19	0.25	0.29
SANDMOUND BLVD	Major	6.15	7.49	9.90	11.50
SELLERS AVE	Minor	0.77	0.94	1.24	1.44
TOTAL		23	28	37	43

In addition, the USCB will provide protection from road inundation in the 100-year event. As discussed on page 3 of the Economic Analysis – Flood Damage Reduction section of the successful Proposition 1E Round 1 funding application (Appendix 3-1.6), while the 10- and 50-year events would not cause road inundation, the 100-year event would result in extensive road inundation. Road inundation was calculated utilizing GIS mapping of 100-year flood zone and measurement of the roads flooded. Based on this analysis, the following road distances would be inundated in a 100 year event: 17.3 miles of arterial roads, 3.0 miles of major roads, 36.0 miles of minor roads, and 11.4 miles of unsealed roads, for a total of 67.7 miles. The proposed project would accelerate protection of those roads by five years.

Table 7-14: Miles of Roads Inundated Without the Upper San Creek Basin Flood Control Project

Road Category	Miles Inundated		
	25-Year Event	50-Year Event	100-Year Event
Arterial	0.0	0.0	17.3
Major	0.0	0.0	3.0
Minor	0.0	0.0	36.0
Unsealed	0.0	0.0	11.4
Total	0.0	0.0	67.7

FD6: Emergency Response Requirements

As discussed previously, the Canal has experienced overtopping events in the past due to hydrologic conditions (refer to Appendix 3-4.1).

- In 1996 and 1997, the Canal experienced multiple major levee slumping and overtopping events at the western end of the Canal near Pump Plant #1. At the time, Los Vaqueros Reservoir was not completed, and water continued to be conveyed through the Canal. Due to the complete dependence on the Canal at that time, full repairs were not possible until the summer of 1998 (see attached photos). The repairs took approximately two weeks. Adjacent properties experienced limited flood damage due to emergency response to stabilize the levee. The engineering report prepared at the time noted that investment was needed to prevent a complete failure of the reach.
- In February of 1998, the Canal failed at the intersection of Cypress Rd. The road was partially flooded and emergency repairs were made. Emergency repairs included sandbags and rip-rap repairs, as well as emergency assistance and repairs to adjacent properties.
- In January of 2006, Emerson Slough overtopped its banks and flooded the southern portion of the Emerson parcel, Sellers Ave, and portions of E. Cypress Rd. The roads were partially flooded and the historic landmark house on the Emerson parcel was flooded. Flood waters needed to be pumped out of the house and the house remained habitable. Waters flooding the roads eventually receded without pumping.

In the event of a canal failure, the following emergency response actions are anticipated to be needed by CCWD. In total, 20 days is estimated to be required to repair a 50-foot breach.

Table 7-15: Emergency Response Actions in Event of a Canal Failure

Initial Response and Condition Assessment	
	Mobilize; Perform emergency response and assessment of canal; Verify canal berm repair criteria. Duration: 3 days.
Canal Isolation (Cofferdam)	
	Material procurement; Installation of cofferdam. Duration: 5 days.
	Assumptions: - Hydrosack/sandbag cofferdam system
Canal Berm Repair	
	Material hauling from borrow source; stockpile at site; material handling and placement for canal repair. Duration: 7 days.
	Assumptions: - Typical Canal Berm Section (above adjacent ground): 600 square feet - Volume 50' Breech Section: 1,110 cubic yards (say 1,200 cubic yards)
Return to Service	
	Site restoration; Removal of Cofferdam. Duration: 5 days.
Miscellaneous	
	Contract Administration; Permits; Field Testing Services.

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those losses. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those losses.

FD7: Supply Replacement Needs

Water supply reliability can be defined in terms of water supply shortages resulting from failures of a system's physical components[14]. If the Canal was to fail and water could not be conveyed through the Canal, CCWD's customers, including the city of Brentwood, could experience a short-term water supply disruption. The city of Brentwood relies on the unlined Canal to meet over 78% of their 25,000 AFY annual demand. While other CCWD customers rely on the Canal, CCWD typically has greater flexibility to provide water to those customers from other sources. In total, CCWD relies on the unlined Canal to meet approximately 45% of its remaining 145,000 AFY annual demand (excluding Brentwood).

Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project would increase the system reliability from 98% in a given year (meaning there is a 2% chance of the Canal failing or a shortage due to Canal failure in any given year) to 100% in a given year by eliminating the potential for Canal levee failure. Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project would result in a 2% increase in supply reliability, and would subsequently eliminate any supply interruption or loss of supply that would occur without the Contra Costa Canal Flood Protection and Levee Elimination Project.

If the Canal failed in a similar fashion to the historical failures in the late 1990s, CCWD estimates that it would take approximately 20 days to repair the Canal and return the Canal to service. 20 days is roughly 5% of the year and that percent of CCWD's demand would need to be met by other water sources.

Table 7-16: Supply Replacement Needs in the Event of Canal Failure

	Amount of Demand Met by PP1 Diversions [AF/yr]	Percent of Annual Service Would be Interrupted by 20 day outage	Amount of Water that would need to be replaced in a 20-day outage [AF/yr]
Brentwood [15]	19,500	5.5%	1,069
Complete CCWD Service Area	65,250	5.5%	3,589
Total (Full Project)			4,658
Attributable to Proposed Project (2.1 percent)			**98**

The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those losses.

Environmental Benefits

Ecosystem restoration and habitat protection are linked to protecting the water quality and water supply reliability in East County. Protecting Delta water quality protects source water for the region and improves ecosystem habitat for the Delta's aquatic species while also protecting them from the harmful

[14] Shamir, U. & Howard, D. Water Supply Reliability Theory. Journal of American Water Works Association. V (73), No. 7. July 1981.
[15] http://www.brentwoodca.gov/pdf/newsletters/2010UWMP.pdf

impacts of degraded water quality. Promoting the recovery of the Delta's endangered fish species improves water supply reliability by reducing regulatory conflicts between the legal requirements to protect endangered species and project operations to divert water from the Delta and. Tidal wetland and riparian restoration projects can sometimes create habitat for endangered species while at the same time reducing the amount of polluted runoff flowing into the Delta – a win for water quality, endangered species, and water supply reliability.

The Contra Costa Canal Flood Protection and Levee Elimination Project will protect natural resources of the Delta and promote habitat restoration for sensitive species. Although construction of the full Project is not complete, the mitigation for the full Contra Costa Canal Flood Protection and Levee Elimination Project is complete. CCWD purchased 47 acres of wetland and 98 acres of upland habitat as mitigation for the full Project. These lands provide habitat for species of concern such as Delta smelt, longfin smelt and the giant garter snake. Completion of the full Project will also promote the completion of the DWR's Dutch Slough Tidal Marsh Restoration Project. DWR's Dutch Slough Tidal Marsh Restoration Project will restore a tidal wetland just to the north of the Project. The Project is a critical early action to improve the ecosystem health of the Sacramento-San Joaquin Delta. Completion of DWR's Dutch Slough Tidal Marsh Restoration Project is legislatively mandated (SBX7-1 Section 85085) and dependent on the construction of 11,000 ft of the pipeline adjacent to the Dutch Slough project site. This Project is expected to yield a portion of the following environmental benefits of the full Contra Costa Canal Flood Protection and Levee Elimination Project:

ENV1: Enabled Completion of Dutch Slough Tidal Marsh Restoration Project
ENV2: Reduction in Herbicide Treatment of Unlined Canal

Estimated benefits and methods for developing these estimates are provided below.

ENV1: Enabled Completion of Dutch Slough Tidal Marsh Restoration Project
Encasing the unlined Canal is a critical step for the completion of DWR's Dutch Slough Tidal Marsh Restoration Project, a tidal wetland restoration site just north of the Canal. DWR's Dutch Slough Tidal Marsh Restoration Project cannot move forward as planned until the Canal is replaced by a pipeline through this area. As specified in Mitigation term 3.1.1-5 of the Dutch Slough EIR Mitigation Monitoring and Reporting Program, "To avoid potential negative impacts to water quality within the Canal from groundwater intrusion, breaching of the Dutch Slough project site will not commence until encasement of the Canal south of the site is complete."

DWR's Dutch Slough Tidal Marsh Restoration Project, in the City of Oakley, is situated at a location and elevation which offer the only opportunity for an immediate and major tidal marsh restoration and research program in the western Delta. The 1,200 acre site is currently is the process of restoring over six miles of shoreline and a mosaic of tidal, riparian, and upland habitats. The resulting restored habitats will provide enhanced western Delta habitat for fish and wildlife. The unique site topography which is relatively unsubsided provides for immediate restoration of intertidal dendritic channels favored by native fish including threatened spring run Chinook salmon, endangered winter run Chinook salmon, and Sacramento splittail. The habitat restoration in the upland sites will allow for the development of riparian forest and shaded riverine habitats.

DWR's Dutch Slough Tidal Marsh Restoration Project is expected to provide important benefits to the larger Delta ecosystem. Numerous planning processes, including the Delta Vision Strategic Plan, the

CALFED Ecosystem Restoration Plan, and the Bay Delta Conservation Plan, have identified restoring tidal marsh as integral to restoring the health of the Bay-Delta Ecosystem.

Encasing the unlined Canal is a critical step for the completion of DWR's Dutch Slough Tidal Marsh Restoration Project, a tidal wetland restoration site just north of the Canal. DWR's Dutch Slough Tidal Marsh Restoration Project cannot move forward as planned until the Canal is replaced by a pipeline through this area. As specified in Mitigation term 3.1.1-5 of the Dutch Slough EIR Mitigation Monitoring and Reporting Program, "To avoid potential negative impacts to water quality within the Canal from groundwater intrusion, breaching of the Dutch Slough project site will not commence until encasement of the Canal south of the site is complete."

It has been assumed that the full value of the Dutch Slough Project will be realized approximately five years following completion of the pipeline, or in 2023. Without available funding to support replacement of the unlined Canal, the Dutch Slough Project would face substantial delays. It is assumed that, without expeditious completion of the Contra Costa Canal Flood Protection and Levee Elimination Project, the Dutch Slough project would not be implemented until 2033[16], which represents a ten-year delay. As such, implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent a ten-year delay of environmental benefits posed by the Dutch Slough Tidal Marsh Restoration Project.

The proposed Project would enable 450 feet of the 10,000 feet of Canal adjacent to the Dutch Slough Tidal Marsh Restoration Project to be encased in a buried Canal. This means that approximately 4.5% (450 out of 10,000) of the benefits associated with preventing the delayed implementation of the Dutch Slough Tidal Marsh Restoration Project could be attributed to the proposed Project.

Approximately 4.5 percent of the benefits associated with preventing delays to implementation of the Dutch Slough Tidal Marsh Restoration Project could be attributed to the proposed Project, which would enable 450 of the 10,000 feet adjacent to the Dutch Slough Tidal Marsh Restoration Project to be encased in a buried pipeline.

ENV2: Reduction in Herbicide Treatment of Unlined Canal

Figure 7-2 shows the excessive amount of submerged aquatic vegetation that grows along the Canal. The vegetation can become so dense that it becomes difficult to operate the rakes on the Rock Slough Fish screen and restricts water flow through the Canal such that the pumps at PP1 cannot maintain a sufficient head and shut down to avoid cavitation. CCWD currently has a permit to treat submerged aquatic vegetation in the Canal using Sonar. The U.S. Fish and Wildlife Service (USFWS) has approved CCWD to apply the herbicide Sonar annually at 20 ug/L in the Canal. Encasement of the unlined canal would eliminate photosynthetic plant growth, and thereby eliminate the need for this herbicide application.

[16] CCWD assumes that the Canal must be replaced before DWR implements the Tidal Restoration Project. Proposition 1E Round 2 is the last known grant funding opportunity that CCWD is aware of that is of sufficient size to allow the District to fully pipe the area adjacent to the Dutch Slough Tidal Restoration Project. It is assumed that if CCWD does not obtain Proposition 1E Round 2 grant funding to support work adjacent to the Dutch Slough Tidal Restoration Project, the Dutch Slough Tidal Marsh Restoration would be delayed from 2018 to 2028 (ten years) and the new Dutch Slough wetlands would not be successfully completed until 2033.

Implementation of the Contra Costa Canal Flood Protection and Levee Elimination Project would prevent those costs. The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would prevent approximately 2.1% of those costs.

Recreation Benefits

This Project is expected to yield a portion of the following recreation-related benefits generated from the Contra Costa Canal Flood Protection and Levee Elimination Project:

REC1: Accelerated Dutch Slough Recreation Benefits
REC2: Accelerated Implementation of Park in the City of Antioch

REC1: Accelerated Dutch Slough Recreation Benefits
As discussed previously, DWR's Dutch Slough Tidal Marsh Restoration Project cannot proceed without implementation of the proposed Project. A key goal of DWR's Dutch Slough Tidal Marsh Restoration is to:

> *Provide shoreline access, educational and recreational opportunities*

Proposed recreational elements described in the Adaptive Management Plan include:

- Open trail around Emerson levee
- Create a 55-acre community park
- Provide public access to the Delta shoreline
- Create signage to educate public about restoration project
- Build wildlife viewing platforms
- Involve schools and community groups
- Build non-motorized boat launch
- Create swimming opportunities for the public
- Create opportunities to canoe and kayak

By enabling DWR's Dutch Slough Tidal Marsh Restoration Project to proceed on an accelerated schedule, the proposed Project enables these recreation benefits to be realized five years sooner than without the Project.

REC2: Accelerated Implementation of 62.5 Acre Park in the City of Antioch
As discussed previously, the proposed project will allow the USCB Flood Control Project to be completed, and benefits realized, approximately five years sooner than without the Project. The project was designed to provide recreation benefits by creating a 62.5 acre open space park. The City of Antioch has plans to construct a regional sports park in this area and the site has been laid out to accommodate a number of sports fields that can be used for soccer, football, and baseball/softball. Implementation of the proposed project will allow these benefits to be realized approximately five years sooner than without the Project.

Energy Benefits

The vast majority of CCWD's GHG emissions are from indirect electricity purchases. These emissions account for approximately 90% of all CCWD GHG emissions. Mobile combustion accounts for approximately 8% of remaining emissions district wide, with the remainder of emissions (<2%) from stationary combustion of natural gas in district buildings. CCWD purchases power from Pacific Gas & Electric (PG&E) and Modesto Irrigation District (MID). The energy portfolio of each of these companies varies. Emissions factors associated with each of these power sources were obtained from California Climate Registry and are listed in Table 7-17.

Table 7-17: Emissions By Energy Supplier (lbs / MWh)[17]

	Energy Supplier	
Pollutant	**MID**	**PG&E**
SO2	0.0392	0.0032
NOx	0.1276	0.0788
CO2	942.88	444.64
CH4	0.01824	0.00053
N2O	0.00194	0.00005

This Project is expected to yield a portion of the following energy-related benefits generated from the Contra Costa Canal Flood Protection and Levee Elimination Project:

ERG1: Energy Reduction
ERG2: Greenhouse Gas Emission Reduction

ERG1: Energy Reduction
As mentioned above, CCWD operates four Delta intakes as well as the Los Vaqueros Reservoir. Each intake and the reservoir utilize a different combination of power suppliers depending on a variety of factors including water rights, location, power scheduling, time of day of use, etc. Implementing the Contra Costa Canal Flood Protection and Levee Elimination Project will alter CCWD's operations by shifting more pumping to Pumping Plant 1 away from Old and Middle River Intakes, and requiring fewer releases from Los Vaqueros Reservoir. These changes in operations will reduce CCWD's overall energy requirements and consequently reduce greenhouse gas emissions associated with raw water operations.

To calculate the energy reduction that would be achieved by implementing the Contra Costa Canal Flood Protection and Levee Elimination Project, the daily operations model was run from 1999 through 2007 as described above in the water supply section[18]. Modeling results are attached. CCWD estimates that the energy savings derived from pipeline-related improvements to water quality will amount to 490 MWH per year.

[17] http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/
[18] Contra Costa Water District Daily Operations Model (WRSEL based linear program). Los Vaqueros Expansion Model Documentation. Technical Memorandum. MBK Engineers. November 3, 2010. Provided as Appendix 3-8.1.

The proposed project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would provide approximately 2.1 percent of those savings (10 MWH per year).

ERG2: Greenhouse Gas Emission Reduction

The energy savings described above will generate a 460,000 pound-per-year reduction in CO_2 emissions through implementation of the full Contra Costa Canal Flood Protection and Levee Elimination Project, 9,670 of which can be attributed to the proposed project. Table 7-18 below shows the reduction in emissions of CO_2 as well as other GHGs.

Table 7-18: GHG Emissions With- and Without-Project

	Average Power Use CVP All Intakes MWh/yr	Average Power Use MID All Intakes MWh/yr	Average Power Use PG&E All Intake MWh/yr	Total CO2 Emissions [lbs/yr]	Total SO2 Emissions [lbs/yr]	Total NOx Emissions [lbs/yr]	Total CH4 Emissions [lbs/yr]	Total N2O Emissions [lbs/yr]
Without Encasement	19,325	10,093	8,377	13,241,573	422	1,948	189	20
With Encasement	19,324	9,605	8,376	12,781,105	403	1,886	180	19
Reduction in Energy & Greenhouse Gas Emissions (Full project)	**1**	**488**	**1**	**460,468**	**19**	**62**	**9**	**1**
Benefit Attributable to Proposed Project (2.1%)		**10**		**9,670**				

In addition, this project will enable CCWD to secure fill material from the USCB site. Without the project, CCWD would secure fill from an alternate location in Tracy. Assuming the standard capacity of 15 cy per truck, 5,000 truckloads (75,000 cy / 15 cy / truck) would be required to haul the fill. This equates to a 32 mile reduction, round-trip (distance from Canal site to Antioch is 10 miles one way, compared to 26 miles one way to Tracy).

CO_2, CH_4 and N_2O factors for highway vehicles are available from EPA. Global Warming Potential (GWP) for CH_4 =21 and GWP for N_2O = 310. As such, CO_2equivalents are calculated as $CO_2 + CH_4 * 21 + N_2O * 310$.

Emissions factors for CO_2, CH_4 and N_2O are as follows:

- CO_2 factor: 10.21 kg/gallon at 8.0 mpg = 1276.25 g/mile[19]
- CH_4 factor: 0.0327 g/mile = 0.0327*21 = 0.6867 g/mile[20]
- N_2O factor: 0.0169 g/mile = 0.0169*310 = 5.239 g/mile[19]

Total CO_2equivalents are calculated as follows:
(1276.25 + 0.69 + 5.24) g/mile = 1282 g/mile = 2.8 pounds/mile[21]

As such, reducing the hauling distance reduces GHG emissions by approximately 448,000 pounds (5,000 truckloads * 32 miles / truckload * 2.8 pounds / mile).

In total, the proposed project will conserve 448,000 pounds of CO2 during construction and 9,670 pounds per year thereafter, for a total of 1,415,000 pounds (708 tons) over the 100-year life of the project.

Other Benefits

Currently, the open Canal presents a risk for drowning or other accidents. This is of particular concern because the area is being developed rapidly for residential use, with up to 8,000 homes planned for the area and 25,000 residents. Enclosing the Canal will completely eliminate this risk. The proposed Project is expected to yield a portion of the following other benefits expected from the Contra Costa Canal Flood Protection and Levee Elimination Project:

OTH1: Reduced Security Risk

OTH1: Reduced Drowning Risk
According to CCWD's records, there have been a total of 70 drownings in the Canal since 1942 (70 drownings over 69 years). The accuracy of older records is uncertain, but records kept since 1972 indicate a total of at least 24 drownings have occurred in recent history (24 drownings over 39 years). This past history indicates a risk of at least 24 fatalities in 39 years, and possibly as many as 70 fatalities in 69 years. To be conservative, we have applied an average risk of 62 percent (24 / 39) that a drowning will occur in any given year. Enclosing the Canal in a pipeline will eliminate this risk.

In addition, the open Canal presents a security risk. To offset this risk, CCWD currently patrols the Canal. Replacing the open Canal with a pipeline will greatly reduce the need to patrol the Canal. Implementation of the proposed Project would enable approximately 450 feet of Canal to be encased in a pipeline; as such, the proposed Project would provide approximately 2.1% of the benefits described above.

[19] CO2 factor: US EPA (2011) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009, EPA 430-R-11-005. All Values are calculated from Tables A-97 through A-100
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html
[20] CH4 and N2O factor: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410 http://www.epa.gov/ghgreporting/documents/pdf/2009/GHG-MRR-FinalRule.pdf
[21] Calculation Method: Climate Registry General Reporting Protocol 2.0 http://www.theclimateregistry.org/downloads/2012/01/TCR-Draft-GRP-2.0-For-Public-Comment.pdf

Uncertainty of Benefits

The benefits claimed depend on implementation of two other projects, the CCWD Canal Levee Improvement and Flood Protection Project, which will ultimately encase 21,000 feet of the Contra Costa Canal in a buried pipeline and eliminate the berms that are currently being used for flood protection; and the Dutch Slough Tidal Marsh Restoration Project, a critical early implementation action for DWR. Should either of these projects not move forward, the benefits that depend upon implementation of these linked projects would also not move forward.

Project Adverse Effects

The project will have temporary, construction-related impacts. No long-term adverse effects are expected from this project; in contrast, the project will provide for sustainable use of fill from the Upper Sand Creek Flood Protection project. Any adverse effects will be fully mitigated.

Annual Project Physical Benefits

The following tables summarize the expected annual benefits from this project.

Table 9 – Annual Project Physical Benefits Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: WS1: Increase in Emergency Supply Measure of Benefit Claimed (Name of Units): AFY Additional Information About this Measure: Reflects average benefit realized in all years.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	19	19
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: WS2: Reduced Salinity-Driven CVP/SWP Releases / CVP/SWP Water Conserved Measure of Benefit Claimed (Name of Units): AFY Additional Information About this Measure: Reflects average benefit realized in all years.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	359	359
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: WS3: Reduced CVP/SWP Releases due to OMR Restrictions			
Measure of Benefit Claimed (Name of Units): AFY			
Additional Information About this Measure: Reflects average benefit realized in all years.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	120	120
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: WQ1: Reduced Levels of DBPs in Drinking Water			
Measure of Benefit Claimed (Name of Units): Cancer Cases / Year			
Additional Information About this Measure: Reflects average annual reduction in excess bromate-related cancer cases per year.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	0.002	0.002
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: WQ2: Decreased Agricultural Runoff			
Measure of Benefit Claimed (Name of Units): Acres			
Additional Information About this Measure: Reflects acres no longer contributing agricultural runoff with project implementation.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	12.6	12.6
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: WQ3: Decreased Risk in Fecal Borne Pathogens Transported into the Canal			
Measure of Benefit Claimed (Name of Units): Reduction in Acres Contributing Agricultural Runoff			
Additional Information About this Measure: Reflects average benefit realized in all years.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	12.6	12.6
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: WQ4: Decreased Turbidity and Associated Solids Handling Requirements			
Measure of Benefit Claimed (Name of Units): %			
Additional Information About this Measure: Reflects average annual percent reduction in solids handling requirements.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0	0.02%	0.02%
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project.			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD1: Average Number of Residential Structures Protected from Flooding Per Year			
Measure of Benefit Claimed (Name of Units): Number of Strutures Per Year			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	4	1	3
Comments: Reflects 2.1%of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrolog. Event	Event Exceed. Probab.	# Structs Damaged if Flood Structs Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	130	0.33	0	43	0					
50-year	0.02	130	0.75	0	97	0	0.02	70	0	1	0
100-year	0.01	131	0.85	0	112	0	0.01	105	0	1	0
500-year	0.002	167	1	1	167	167	0.008	140	84	1	1
Expected Annual Damages, Without and With Project										4	1

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD2: Acres of Farmland Inundated			
Measure of Benefit Claimed (Name of Units): Acres Inundated Per Year			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0.4	0.1	0.3
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Acres Inundated if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	5	0.33	0	2	0					
50-year	0.02	12	0.75	0	9	0	0.02	5	0	0	0
100-year	0.01	18	0.85	0	16	0	0.01	12	0	0	0
500-year	0.002	22	1	1	22	22	0.008	19	11	0	0
Expected Annual Damages, Without and With Project										0	0

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD3: Loss of Gas Production			
Measure of Benefit Claimed (Name of Units): Average Mcf / d			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	16	3	14
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Gas Production Lost if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	475	0.33	0	157	0					
50-year	0.02	633	0.75	0	475	0	0.02	316	0	6	0
100-year	0.01	633	0.85	0	538	0	0.01	506	0	5	0
500-year	0.002	633	1	1	633	633	0.008	585	316	5	3
Expected Annual Damages, Without and With Project										16	3

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD4: Acres of Dutch Slough Property Inundated			
Measure of Benefit Claimed (Name of Units): Average Acres Inundated / Year			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	1	0	1
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Acres Inundated if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	25	0.33	0	8	0					
50-year	0.02	25	0.75	0	19	0	0.02	14	0	0	0
100-year	0.01	25	0.85	0	21	0	0.01	20	0	0	0
500-year	0.002	25	1	1	25	25	0.008	23	13	0	0
Expected Annual Damages, Without and With Project										1	0

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD5: Roads Inundated			
Measure of Benefit Claimed (Name of Units): Average Miles Inundated / Year			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0.018	0.004	0.014
Comments: Reflects 2.1 percent of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Miles Inundated if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	0.5	0.33	0	0	0					
50-year	0.02	0.6	0.75	0	0	0	0.02	0	0	0.006	0.000
100-year	0.01	0.8	0.85	0	1	0	0.01	1	0	0.006	0.000
500-year	0.002	0.9	1	1	1	1	0.008	1	0	0.006	0.004
Expected Annual Damages, Without and With Project										0.018	0.004

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD6: Time to Respond to a 50' Levee Breach			
Measure of Benefit Claimed (Name of Units): Average Days / Year			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	0.01	0.00	0.01
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Days Required to Respond to a 50' Breach if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	0.4	0.33	0	0	0					
50-year	0.02	0.4	0.75	0	0	0	0.02	0	0	0.005	0.000
100-year	0.01	0.4	0.85	0	0	0	0.01	0	0	0.003	0.000
500-year	0.002	0.4	1	1	0	0	0.008	0	0	0.003	0.002
Expected Annual Damages, Without and With Project										0.01	0.00

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project			
Type of Benefit Claimed: FD7: Supply Replacement Needs			
Measure of Benefit Claimed (Name of Units): AFY			
Additional Information About this Measure: Reflects average annual benefit, calculated as shown below.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	2.6	0.4	2
Comments: Reflects 2.1% of benefit from full Contra Costa Canal Flood Protection and Levee Elimination Project. This benefit is only realized in the event of a flood. To calculate the average annual benefit, the degree of benefit for four hydrologic events was assessed, as shown in Table 7-2b. In actuality, the benefit would either not be realized (if no flooding occurs), or a greater benefit than that shown here would be achieved (dependent on the severity of flooding and difference between with- and without-Project conditions).			

Table 7-1b – Example Calculation of Expected Annual Damage											
Hydrologic Event	Event Exceedance Probability	Supply Replacement Needed if Flood Structures Fail	Probab. Struct. Failure		Expected Event Damage		Interval Prob.	Average Damage in Interval		Average Damage in Interval times Interval Probability	
			W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.		W/o Proj.	W/ Proj.	W/o Proj.	W/ Proj.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(i)	(j)	(k)	(l)	(m)
25-year	0.04	98	0.33	0	32	0					
50-year	0.02	98	0.75	0	73	0	0.02	53	0	1	0
100-year	0.01	98	0.85	0	83	0	0.01	78	0	1	0
500-year	0.002	98	1	1	98	98	0.008	90	49	1	0
Expected Annual Damages, Without and With Project										3	0

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: ENV1: Accelerated Dutch Slough Implementation Measure of Benefit Claimed (Name of Units): Years Additional Information About this Measure: By replacing the open canal with a pipeline, the Dutch Slough Project can move forward 10 years sooner than without the project.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2023	0	10	10
Comments:			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: ENV2: Reduction in Herbicide Application Measure of Benefit Claimed (Name of Units): ug/L Sonar applied per year Additional Information About this Measure: By replacing the open canal with a pipeline, Sonar application is avoided.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	20	0	20
Comments:			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: REC1: Accelerated Recreation Benefits from Dutch Slough Project Measure of Benefit Claimed (Name of Units): Years Additional Information About this Measure: By replacing the open canal with a pipeline, the Dutch Slough Project can move forward 5 years sooner than without the project.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018	0	5	5
Comments:			

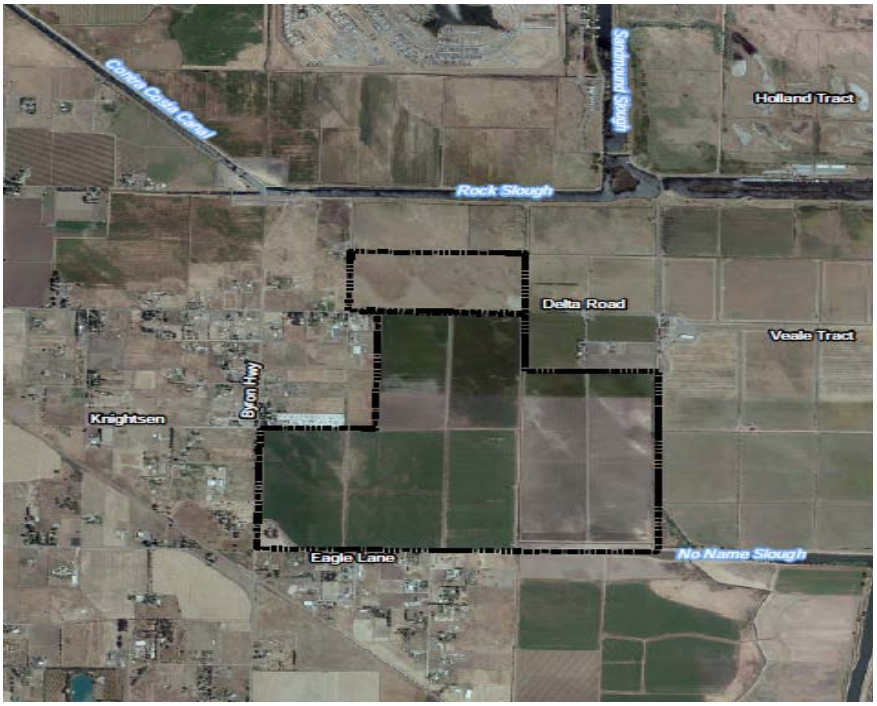
Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: REC2: Accelerated Implementation of 62.5 Acre Park in the City of Antioch Measure of Benefit Claimed (Name of Units): Years Additional Information About this Measure: The project will allow the benefits of the USCB Flood Control Project, including construction of a 62.5-acre park, to be realized 5 years soner than without the project.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018	0	5	5
Comments:			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: ERG1: Energy Reduction Measure of Benefit Claimed (Name of Units): MWH/year Additional Information About this Measure: The project will reduce operational pumping requirements by approximately 490 MWH/year for the full project, or 10 MWH/yr attributable to the proposed project.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2016 - 2115	10	0	10
Comments:			

Table 9 – Annual Project Physical Benefits			
Project Name: Integrated Regional Flood Protection and Water Quality Improvement Project Type of Benefit Claimed: ERG2: Greenhouse Gas Emission Reduction Measure of Benefit Claimed (Name of Units): lb CO2 / year reduction Additional Information About this Measure: Reduction in GHG emissions due to reduced pumping and reduced hauling distance.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2015	0	448,000	448,000
2016 - 2115	0	9,670	9,670
Comments:			

Project 4: Knightsen Wetland Restoration and Flood Protection

This project is needed to create a wetland complex to retain, and safely discharge (if needed) treated water into No Name Slough while also restoring a mosaic of habitats on site including but not limited to: Delta freshwater marsh, freshwater wetland, alkali wetland and tidally influenced sloughs.



Knightsen Wetland Restoration Project Site

The Knightsen Wetland Restoration and Flood Protection Project includes the following elements:

1. Acquisition of an existing 645-acre parcel to treat and manage stormwater from the area.
2. Completion of the design of a 30-acre wetland habitat with stormwater storage/treatment features.

This multi-objective project will restore wetlands and treat contaminated flood/storm water near the unincorporated town of Knightsen. This restoration project will provide environmental (habitat and species) benefits as well as substantial water quality by removing contaminants from urban and agricultural run-off as well as flood control benefits.

A 2002 feasibility study by PWA identified the current parcel/location of the project as an ideal area for the creation of wetland features to attenuate flooding in the Knightsen area as well as store and naturally treat flood waters to reduce pollutants from entering the fragile Delta ecosystem. With the adoption of the East Contra Cost a County Habitat Conservation Plan / Natural Community Conservation Plan (HCP/NCCP) and a growing statewide interest in protecting the west Delta ecosystem, more agencies are working to conserve and restore habitat in this region.

In 2012, the East Contra Cost County Habitat Conservancy partnered with Knightsen Community Services District to commission a 2nd feasibility study to evaluate the restoration potential of the available parcel. The feasibility study indicated that the 645 acre parcel could function to serve the Knightsen area flood control needs as well as provide up to:

- 320 acres of Freshwater Tidal Marsh
- 140 acres of (Alkali) Seasonal Wetland Complex
- 22 acres of Stabilized Interior Dune
- 157 acres of Oak Savanna

The opportunity to address Knightsen's flood control/stormwater management needs and habitat restoration efforts can be realized through this integrated project. The project will acquire the parcel, plan and design the restoration project and construct the initial wetland habitats. The subsequent phase will construct additional habitat, drainage improvements and fund ongoing management and maintenance of the improvements.

Existing Data and Studies

The Project is supported by a series of studies documenting the potential project benefits, including:

- Knightsen Water Quality Wetland Feasibility Assessment (2002) – Appendix 4-1
- Knightsen Habitat Restoration Feasibility Study (2013) – Appendix 4-2
- Property appraisal (confidential)

Summary of Benefits

The projected project benefits include:

- **Water Quality:** The Project will improve water quality for Knightsen's 1,500 residents who rely on groundwater supplies by preventing contamination from agricultural tailwater, stormwater, and overflowing septic systems that contaminate wells in flood events. It will also improve water quality for CCWD's customers by treating runoff adjacent to CCWD's Rock Slough water intake.
- **Flood Damage Reduction:** The project will establish a treatment wetland that will treat and manage approximately 17 AF of stormwater, reducing storm peaks and associated flood damages. The average 10 year storm causes up to $5,000,000 to homes, businesses, local infrastructure and agricultural lands.
- **Environmental Resources:** The project will restore habitat and create a 30-acre wetland on a parcel that is currently used for irrigated agriculture, but which was historically a mosaic of habitats that could support a number of threatened and endangered species. Restoration of this mosaic will provide improvements to the above mentioned water quality issues as well as provide habitat for endangered and threatened species such as the California red legged frog, California tiger salamander, Giant garter snake, Swainson's Hawk, Silvery legless lizard, alkali plants, dune plants, and many more. This proposed phase of the project will secure the acquisition and the creation of the wetland mosaic for environmental and stormwater management benefits.

These benefits are summarized in the following table.

Table 7-19: Project Benefit Summary

Category	Benefit Summary
Water Supply	• No quantified physical benefits
Water Quality	• Approximately 17 AFY of stormwater treated per storm event
Flood Damage Reduction	• Approximately 17 AFY managed to reduce flooding per storm event
Environmental Resources	• 30 acres of wetlands created
Recreation/Public Access	• No quantified physical benefits
Energy	• No quantified physical benefits
Other Physical Benefits	• No quantified physical benefits

Background / Recent and Historical Conditions

As discussed on pages 1-2 of the 2013 Knightsen Habitat Restoration Feasibility Study (Appendix 4-2), the existing land cover types on the Knightsen project area consist primarily of irrigated agriculture. The property also includes a portion of No Name Slough, irrigation ditches and remnant sand dunes. Delta Road bisects a northern parcel from the southern parcel. Eagle Lane defines the southern boundary, along with No Name Slough, which enters the south-eastern portion of project site. Two unnamed irrigation ditches extend north to south bisecting agricultural fields and marking western boundary of the southern portion of project site. South of Delta Road, the western boundary is bordered by Byron Highway and neighboring business and residential properties, while north of Delta Road the site is bordered by two residential properties. Several easements for power lines, transmission lines, and irrigation ditches bisect the property.

Soils on site consist of sand, loam and clay, including Marcuse clay, piper fine sandy loam, Sacramento clay (a sodic or “alkaline” soil type), and Delhi sand. The presence of clay, sand and sodic soils are indicative of historical habitats on the site including tidal marsh, interior sand dunes, alkali seasonal wetlands, and oak savanna. Soil samples from areas with clay and/or sand soils throughout the site were tested to determine whether the soil pH indicates alkaline soils that would support some of the specific target restoration habitat (see description of seasonal alkali wetland below). Using the Leaf Luster Rapitest pH test kit, the soil pH from 6 soils characterized as clay or clay loam and 4 characterized as sand or sandy clay loam were tested. All of the samples taken in clay soils have a soil pH of approximately 7.5 and indicate alkaline soils. Samples characterized as sand or sandy clay loam (taken from remnant dunes) had pH of 7.0. In addition to testing the soil pH, two samples were sent to a soils lab for further testing. Results indicate that the clay soils on site are slightly saline but not sodic or sodic-saline.

The site elevation ranges from 1-20 feet North American Vertical Datum (NAVD), indicating that the site historically supported a wide spectrum of habitats from tidal wetlands (elevations approximately 6 feet to 3 feet NAVD) to seasonal wetland and upland habitats (elevations greater than 6 feet NAVD). Existing groundwater elevation is approximately 6.5 to 7.5 NAVD 88. Stormwater generally flows from north to southeast making the site a potential capture area for stormwater flow from the town of Knightsen.

Existing vegetation along ditches and sloughs is dominated by an herbaceous understory with an occasional tree or shrub in the overstory. Native species observed on site include: sedges (Carex sp.), stinging nettle (Urtica dioica), salt grass (Distichlis spicata), mugwort (Artemisia douglasiana), alkali heath (Frankenia salina), Western flat-topped goldenrod (Euthamia occidentalis), creeping wild rye

(Elymus tridicodies), cattails (Typha angustifolia), and bullrush (Schnoplectus acutus) and an occasional willow (Salix sp.). Non-native species include Bermuda grass (Cynodon dactylon), Himalayan blackberry (Rubus discolor), and giant reed (Arundo donax).

Vegetation on the northern parcels includes several plant species indicative of sand dunes and alkali seasonal wetlands. Previous surveys indicate the presence of plant species characteristic of sand dunes including California croton (Croton californicus) (Abigail Fateman pers. comm. December 2012). Seasonal wetland species observed on the December 2012 field visit include: alkali heath (Frankenia salina), alkali weed (Cressa truxillensis), rushes (Juncus sp.), sedge (Carex sp.), alkali mallow (Malvella leprosa). Lastly, a large heritage oak tree is present on the southern parcel, indicative of historical oak savanna habitat type.

The habitat restoration of the site will include a mosaic of habitats historically present on the site. These include oak savanna, interior sand dune, fresh water marsh, and seasonal wetlands that also function as bioswales to store and treat stormwater from the Knightsen watershed.

The existing site topography, soils, and existing vegetation indicate the site is well suited to accommodate the full range of historical habitats from tidal marsh to upland habitats. The site topography has not been greatly altered from natural elevations, site soils have been only slightly modified and the potential hydrological parameters are available. With low gradient slopes and elevations suitable to support tidal marsh to upland habitats, minimal site grading would be required. The site is suitable not only for the target habitats in the short term, but also over the long term. With a low gradient slopes and no barriers to estuarine transgression, there is potential for tidal wetlands to transgress landward as sea level rises. Since many existing tidal wetland to upland transition zones within the San Francisco Bay and Delta are disconnected because of roads, development or other infrastructure, locations than can accommodate estuarine transgression are increasingly important to restore.

Knightsen routinely suffers from flooding. The acquisition of the property and construction of the habitat features and bioswales will provide a location to store and treat floodwaters. Damages to homes, businesses, local infrastructure and agricultural lands from the average 100-year storm event (per insurance claims filed) are up to $5,000,000. These numbers are from the Spatial Hazard Events and Losses Database for the United States. Flooding and Severe Weather are the top hazards listed in the Knightsen Town Hazard Mitigation Plan.

Without Project Conditions

Without the proposed project, conditions will remain as is.

Stormwater from the greater Knightsen area will regularly flood the town of Knightsen and agricultural areas (see Figure 7-6). The water, contaminated by agricultural and rural residential point (septic) and non-point sources, will be drained and pumped into Delta sloughs directly upstream from CCWD's water intake. The stormwater has historically caused property damage, contamination of groundwater/drinking water well sources, and direct pollution of the Delta sloughs.

The opportunity to protect and restore a mosaic of habitat that benefit water quality and listed species would be missed. Large parcels do not become available for sale frequently; often only once a generation. This parcel was identified in the 2002 Feasibility Assessment as a preferred location to store

and treat stormwater (See Appendix 4-1). In 2012, Knightsen and the East Contra Costa County Habitat Conservancy funded a follow up feasibility study (Appendix 4-2) to examine the habitat restoration potential on the site. Without the project there will be no habitat restoration and the parcel may remain irrigated agriculture.

Figure 7-6: Photo Illustrating Ponded Agricultural Tailwater Flooding the Community of Knightsen and Draining to No Name Slough and Rock Slough (1997)

Relationship to Other Proposed Projects

As discussed in Attachment 3, the projects included in this proposal are all intrinsically linked through the objectives of the East County Integrated Regional Water Management Program. However, no other projects in this proposal must be implemented to achieve the benefits claimed for this Project. The Project is related to the Integrated Regional Flood Protection and Water Quality Improvement Project, as both projects will improve water quality at Rock Slough by reducing untreated agricultural runoff.

Description of Benefits and Methods to Estimate Benefits

The following sections summarize project benefits and methods used to estimate benefits in the following areas:

- Water Quality
- Flood Damage Reduction
- Environmental Resources

Uncertainty of the benefits, and factors that lead to uncertainty and quantified estimates of physical benefits described using PSP Table 7 are provided in later sections of this attachment.

Water Quality Benefits

As discussed on pages 6 – 7 of the Knightsen Habitat Restoration Feasibility Study (Appendix 4-2), previous studies identified the 645 acre Knightsen property as an excellent site to treat stormwater using treatment wetlands and biofilter swales. Treatment wetlands detain water and are sized based on an expected stormwater volume whereas biofilter swales allow stormwater to slowly flow through vegetation while infiltrating and are sized on a flow rate/velocity basis.

Because standing water has been observed on parcels immediately south of Delta Road, this area may be particularly well-suited to host treatment wetlands or biofilter swales. The areas to the north have potential as well assuming this does not conflict with dune restoration and seasonal wetland enhancement.

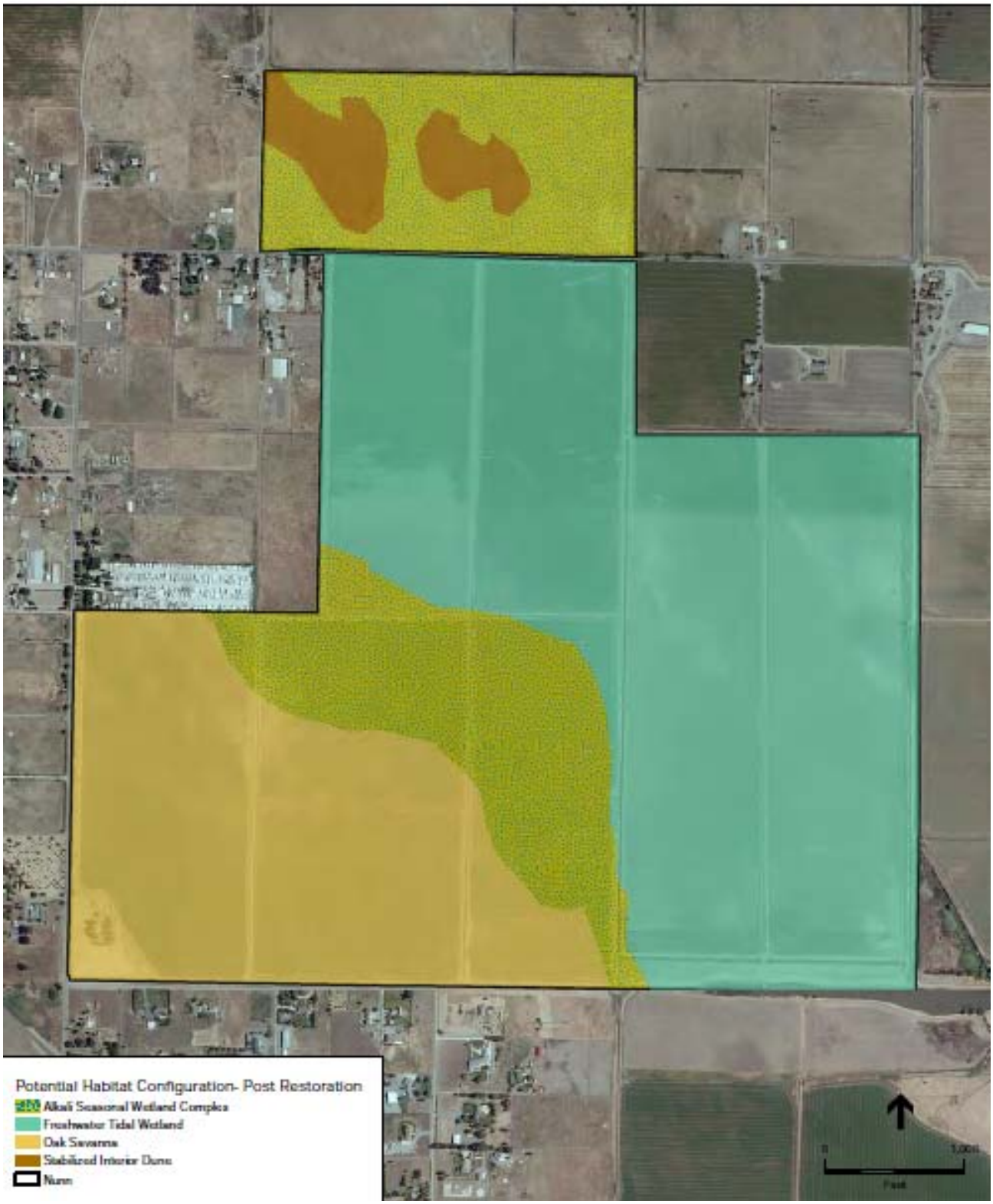
If the location of the water quality treatment site is within tidal elevation ranges (as is the case with the area immediately south of Delta Road) biofilter swales and treatment wetland features will need to be hydrologically disconnected from tidal wetlands in order for the these feature to function properly, filter pollutants and to prevent the area from converting to tidal marsh. Treated stormwater could be pumped out or discharged from the stormwater treatment features, but tidal exchange would need to be prevented.

The size of the wetland treatment facility will be determined based on the contributing watershed area. These may range from the immediate adjacent subwatersheds that flow into the site or eventually, all stormwater from the central and southwestern regions of Knightsen. The ultimate site design can be flexible in this, perhaps initially treating runoff from a smaller area, then expanding as various stormwater conveyance improvements are made in the more developed parts of Knightsen. Potential locations and water quality treatment volumes (in acre feet) from individual subwatershed or for regions were identified in an earlier study. Watersheds 4 and 9 are immediately adjacent to the project site, which would require treatment of 12.3 and 8.5 acre-feet respectively. The site could also be used to treat 28 and 54 acre feet of stormwater from central and southwest Knightsen (Figure 7-7). Based on an approximate treatment depth of 1- to 2-ft, approximately 40-80 acres of the site could be used for the treatment wetland. This area would have a seasonally-varying habitat function, ranging from season-freshwater marsh to shallow freshwater pond. It would likely include extensive fresh and brackish marsh vegetation in the perennially wet areas, transitioning to alkali marsh vegetation in the drying areas.

The ultimate project will treat 28 – 54 AF of stormwater in a 50 – 80 acre wetland. The project being proposed in this application would create a 30-acre wetland capable of treating approximately 17 AF (28 * 30 / 50).

It is difficult to quantify the specific outcomes in terms of pollution reduction because water quality monitoring has not been conducted in Knightsen in the past. However, because the land use in the area is largely agricultural it can be assumed that runoff currently contains the following pollutants: pesticides, fertilizers, heavy metals, and E. coli. These and other pollutants that may be in the area currently run off or are pumped directly into No Name Slough and other Delta waterways that are sources of agricultural, industrial, and municipal water for the region and State. Ultimately, restoration of wetlands in this area will reduce/eliminate agricultural pollutants entering the Delta, eliminate septic overflow/groundwater contamination and restore wetlands and conserve rare and threatened habitats that support special status species in the region.

Figure 7-7: Potential Post-Restoration Habitat Configuration



Flood Damage Reduction Benefits

Flood hazard has been a concern in this area for generations. As discussed on page 1 of the Knightsen Water Quality Wetland Feasibility Assessment (Appendix 4-1), the CALFED Veale/Byron Tract Work Group worked with the community of Knightsen to develop a plan to improve storm water quality and reduce flood hazards in the Knightsen area. The plan administered by the Contra Costa County Flood Control and Water Conservation District included developing a Community Services District (which has been done), establishing assessments for drainage infrastructure maintenance (done), and assessing the feasibility of building water quality facilities such as wetland biofilters to treat runoff from the Knightsen area (done). The next step is to implement flood control projects in the region. With one of the preferred parcels identified in the feasibility study (2002) for sale, an opportunity to leverage federal funding awarded to the East Contra Costa County Habitat Conservancy for land acquisition, and a growing interest and concern about habitat restoration in the Delta, the advancement of this multi-objective project to address habitat, flood control and water quality is well-poised to move to design and construction.

Beginning on page 15, the Knightsen Water Quality Wetland Feasibility Assessment (Appendix 4-1) discusses alternatives considered for water quality and stormwater management. Four types of stormwater quality facilities were considered for the Knightsen project: constructed treatment wetland, extended detention basin, wet pond, and biofilter swale. The report recommended that either constructed treatment wetlands or extended detention basins be constructed to meet the objectives of the project. A preliminary estimate of the volume of water that would need to be captured and stored in order provide BMP treatment for runoff from each sub-watershed area was developed, and is presented in Table 5 on page 19 of the Knightsen Water Quality Wetland Feasibility Assessment (Appendix 4-1) and shown in Table 7-15 below. Based on this assessment, it was determined that the site could be used to treat 28 and 54 AF of stormwater from central and southwest Knightsen with an approximate treatment depth of 1- to 2-ft (refer to Appendix 4-2, page 6, Table 2). The historical on-site habitats provide a guide to what is possible to recreate in this area to manage the stormwater in the region.

Table 7-20: Estimated Water Quality Volume by Area

Watershed	Area (Acres)	Water Quality Volume (AF)
Northern Knightsen (WS# I, #2)	1346	24.2
Central Knightsen (WS#4, #7, #8, #9)	1581	28.4
Southwest Knightsen (WS#3, #5, #6)	3004	54.1

<u>Central Knightsen</u>

The Central Knightsen area includes the Tule Lane, Delta Road, Byron Highway, and the Veale Tract sub-watersheds. The combined water quality volume estimate for this area totals 28 AF and requires approximately 14 to 28 acres of land devoted to water quality treatment.

Surface elevations in the potential seasonal wetland area south of Delta Road range from 0.5- to I-feet NGVD. Therefore, this water quality treatment facility will drain via gravity flow to No Name Slough only when water levels in No Name Slough were near or below average levels. During significant storms or high tides, the facility will store treated water until tidal/flood waters recede and water levels in the slough return to average levels.

Southwest Knightsen

The Central, South, and Southwest Knightsen sub-watersheds combine at the culvert crossing the Santa Fe railroad tracks north of Sunset Road (C#4). Based on completed hydrologic assessment, the majority of the runoff that enters the "Knightsen Triangle" between Byron Highway and Delta Road passes through this culvert. Therefore, diverting flow from culvert C#4 directly to water quality facilities and eventually to No Name Slough will tend to reduce flood hazards in the "Knightsen Triangle." A wide, shallow, vegetated diversion channel to convey water from this culvert eastward across Byron Highway would also help to maximize water quality benefits.

Environmental Benefits

The identified parcel currently is irrigated agriculture. It was historically a mosaic of habitats that could support a number of threatened and endangered species. Wetland, freshwater marsh, interior dune and oak savanna used to exist on this parcel. Restoration of this mosaic will provide improvements to the above mentioned water quality issues as well as provide habitat for California red legged frog, California tiger salamander, Giant garter snake, Swainson's Hawk, silvery legless lizard, alkali plants, and dune plants, among others.

As discussed in the Knightsen Habitat Restoration Feasibility Study on pages 2 through 6 (Appendix 4-2), the Conservancy and its partners are interested in restoring or creating the following habitat types on site:

(1) seasonal alkali wetlands
(2) stabilized interior dune
(3) oak savanna
(4) freshwater tidal marsh

The key components of each habitat type and the opportunities and constraints of restoring these features at the project site are summarized below.

Alkali Seasonal Wetland Complex

Historically, alkali seasonal wetlands occurred on the project site and the presence of seasonal alkali vegetation adjacent to current farmed areas indicates the potential to support this habitat following restoration. Alkali seasonal wetlands are characterized by hummocky, varied micro topography which supports a mosaic of salt-influenced habitats including small brackish ponds/pools, alkali flats, alkali sink-scrub and seasonally inundated alkali meadow. Alkali seasonal wetlands are seasonally inundated from a couple of inches (meadow features) to one foot or more (pond/pool features). Alkaline habitats are characterized by having sodic soils. There are several characteristics of sodic soils including:

- Alkaline pH (greater than 8.5 pH)
- The "sod" in sodic refers to sodium (Na), which is prevalent on the cation exchange complex (CEC). But Na is not the only reason for alkalinity. Bicarbonate and borates can also cause the high pH, so sodic soils can have Ca, K and/or Mg as well. Sodium Adsorption Ratio (SAR) of sodic soils is typically greater than 13-15.
- There are two classes of sodic soils, sodic and saline-sodic. The latter has an Electrical Conductivity (EC) > 4, or greater than 2 mmhos/cm.
- Sodic soils typically have high clay content.

Soil testing indicates clay soils are not sodic or saline-sodic but have some characteristics of saline soils (Appendix B of the report provided in Appendix4-2). Soils have a slightly alkaline pH (7.3-7.4 pH) and high percent cation saturation of magnesium (Mg) (35-41%) and moderate percentage cation saturation

of potassium (K) (3.2-3.6%), and moderate to high percent cation saturation of sodium (Na) (4.6-8.2%), and low percent cation saturation of calcium (47-56%). Soils are slightly saline with high to moderate concentrations of soluble salts (1.6-2.1 mmhos/cm). The sodium adsorption ratio, however, is significantly lower than characteristic of sodic soils (3.8-4.9). Results can vary seasonally as rainfall and seasonal flooding can decrease sodium concentrations. Further, soils may become more saline following restoration of seasonal wetlands. In particular, as water evaporates and leaves behind salts, soils may become increasingly saline.

Despite the lack of sodic soils, vegetation typical of alkaline wetlands already occurs on site, indicating the soils are suitable to support alkali vegetation. Expected vegetation within alkali seasonal wetlands includes salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), alkali weed (*Cressa truxillensis*), pickleweed (*Salicornia* sp.), rushes (*Juncus* sp.), sedge (*Carex* sp.), alkali mallow (*Malvella leprosa*), and saltbush (*Atriplex* sp.). Several of these species were present within the northern parcels of the property between the dune communities and adjacent to sloughs and ditches on the southern parcels.

The presence of alkali vegetation currently on site indicates that portions of the site have suitable soils and hydrology to support seasonal alkali wetland features. Restoring and managing tidal flows to the site may further assist in seasonal wetland development as extreme high tides may inundate seasonal wetlands and allow for a more dynamic hydrologic system. This tidal to seasonal wetland transition zone is likely to shift landward as sea level rises, known as estuarine transgression. Maintaining hydrological connection between seasonal wetlands and tidal wetlands is an important aspect in making it possible for estuarine transgression to occur.

Stabilized Interior Dune

Historical interior dune features in this area were created as a result of windblown processes during the Pleistocene. Two historical dune features are present in the northern portion of the property and are characterized by sandy soils. Historically, the sand dune features on the project site were probably sparsely vegetated but little historical reference data exists to characterize the vegetation (Stanford et. al. 2011). Based on sources available, stabilized interior due vegetation includes silver bush lupine (*Lupinus albifrons*), California croton (*Croton californicus*), slender buckwheat (*Erogonum gracil),* and valley lessingia *(Lessingia gladulifera).* California croton has been observed on site. In addition, non-native invasive grass species have extensively colonized the dune.

The existing site topography, presence of sandy soil, and presence of target vegetation indicates a good opportunity to restore or enhance the existing dune features. The existing native vegetation on both the dune and seasonal wetland habitats in the northern parcels indicates that the entire northern parcel could require a less intensive approach to restoration..

Oak Savanna

Oak savanna habitat features are characterized by widely spaced valley oak (*Quercus lobata)* or blue oak (*Quercus douglasii*) (between 10-30% canopy cover), and an herbaceous understory (Sawyer et. al 2009). While the elevations are suitable to support oak savanna, the poorly drained clay soils that dominate the site may be unsuitable to support blue oaks. There is potential to support valley oak woodland*,* as they can tolerate seasonally saturated soils and alluvial or residual soils. Further, the presence of what appears to be a large heritage valley oak, perhaps remnant from when the south western parcels were oak savanna indicates the potential to restore oak savanna.

Freshwater Tidal Marsh

Historically freshwater tidal marsh occurred on site. Key components of freshwater tidal wetlands include a complexity of channels and low to high marsh vegetation, and hydric soils. Elevations necessary to support a variety of low to high marsh vegetation are approximately 2-6 feet NAVD (Table 7-16) and occur on site. Soils are typically high in clay content, which is also found throughout the site. Expected vegetation within these features is characterized below.

Table 7-16: Local Tidal Datums at Dutch Slough

	Feet NGVD	Feet NAVD
Mean Higher High Water (MHHW)	3.15	5.97
Mean High Water (MHW)	2.7	5.48
Mean Tide Level (MTL)	1.47	4.29
Mean Low Water (MLW)	0.23	3.11
Mean Lower Low Water (MLLW)	-0.29	2.58

Based on local reference site at nearby Sand Mound Slough, a diversity of vegetation may have potential to be supported on site. Low marsh to mid marsh areas have potential to support emergent vegetation such as California bulrush (*Scirpus californicus*) and cattail (*Typha* spp.), tule (*Scirpus acutus*).

Mid to high marsh vegetation may include silverweed (*Potentilla anserine),* Western flat-topped goldenrod *(Euthamia occidentalis),* seaside arrow grass *(Triglochin maritima),* willow herb *(Epilobium cilatum),* marsh fleabane *(Pluchea odorata),* spikerush *(Eleocharis macrostachya),* water smartweed *(Persicaria punctata),* California loosestrife *(Lythrum californicum),* bur marigold *(Bidens laevis),* panicle bulrush *(Scirpus microcarpus)*, slough sedge (*Carex obnupta)* and Baltic rush (*Juncus balticus*). In small patches, woody species including dogwood *(Cornus sericeus),* arroyo willow *(Salix lasiolepis),* and cottonwood *(Populus fremontii)* have potential to establish on site. Future studies that characterize vegetation at Sand Mound Slough in relation to tidal datums would be helpful to develop refine revegetation plans at the project site.

The property's historic habitats, existing elevations relative to tides, and alkali soils make it well suited for the restoration of habitats to benefit species and water quality.

Table 7-21 presents the potential acreage per habitat type for the full project, as shown page 9 of the Knightsen Habitat Restoration Feasibility Study.

Table 7-21: Potential Acreage per Habitat Type – Ultimate Project

Habitat Type	**Potential Acres**
Freshwater Tidal Marsh	320
(Alkali) Season Wetland Complex	140
Stabilized Interior Dune	22
Oak Savanna	157
Total	**639**

Recreation/Public Access Benefits

The completed project (all phases) will provide a trail system for hikers and equestrians in the proposed uplands and along berms in the wetlands. Access to Delta water ways for person, non-motorized watercraft is also proposed. These benefits have not been quantified.

Energy-Related Benefits

No quantifiable energy-related benefits are claimed as a result of project implementation.

Other Physical Benefits

No other quantifiable physical benefits are claimed as a result of project implementation.

Facilities Required to Achieve Benefits

The Project must be implemented to achieve the benefits claimed, including implementation of the following elements:

- Acquisition of an existing 645-acre parcel to treat and manage stormwater from the area,
- Completion of the design of the 30-acre wetland habitat and stormwater storage/treatment features ; and
- Completion of construction of the 30-acre wetland habitat and stormwater storage/treatment features.

Uncertainty of Benefits

Because historical runoff quality monitoring has not been performed, the quality of existing runoff, and the expected improvement in quality, is currently uncertain.

Project Adverse Effects

As a restoration project, this project is not expected to have any long-term adverse impacts. The project may have temporary, construction-related impacts.

Annual Project Physical Benefits

The following tables summarize the expected annual benefits from this project.

Table 9 – Annual Project Physical Benefits

Project Name: Knightsen Wetland Restoration and Flood Protection

Type of Benefit Claimed: WQ1: Water Volume Treated Per Storm

Measure of Benefit Claimed (Name of Units): AF per Storm

Additional Information About this Measure: Reflects wetlands stormwater treatment capacity.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	0	17	17

Table 9 – Annual Project Physical Benefits Project Name: Knightsen Wetland Restoration and Flood Protection Type of Benefit Claimed: FP1: Stormwater Detained per Storm Event Measure of Benefit Claimed (Name of Units): AF per Storm Additional Information About this Measure: Reflects stormwater detention capacity.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	0	17	17

Table 9 – Annual Project Physical Benefits Project Name: Knightsen Wetland Restoration and Flood Protection Type of Benefit Claimed: ENV1: Wetland Created Measure of Benefit Claimed (Name of Units): Wetland Acres Creates Additional Information About this Measure: Reflects acres of wetlands created			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	0	30	30

Project 5: Recycled Water Salinity Reduction and Distribution System Expansion Project

DDSD Recycled Water Used for Parks Irrigation

The Recycled Water Salinity Reduction and Distribution System Expansion Project will improve recycled water quality and provide operational benefits, cost savings, and expand recycled water capacity by reducing TDS concentration in recycled water produced at DDSD. This project involves the installation of approximately 9,200 lineal feet of 6-inch high density polyethylene (HDPE) pipe and appurtenances to redirect a high TDS brine line from Dow to the DDSD wastewater treatment plant downstream of the recycled water facility. This will reduce recycled water TDS concentrations by 15% to 20%, which will improve industrial and irrigation uses and allow increased cycling ratios for cooling purposes, thus freeing up recycled water capacity for other users. New recycled water service will also be established for several use sites for landscape irrigation and for industrial purposes located in DACs in the Cities of Antioch and Pittsburg.

Existing Data and Studies

The Project is supported by a series of studies documenting the potential project benefits, including:

- Recycled Water Master Plan (Jan. 2013) – Appendix 5-1
- TDS Reduction Advanced Treatment Feasibility Study (Feb. 2012) – Appendix 5-2
- Technical Memorandum, Final Effluent Quality Analysis with Dow Industrial Waste Relocation, (November 2012) Appendix 5-3
- Regional Water Quality Control Board approval letter, February 28, 2013 – Appendix 5-4
- Final Biological Assessment and the Cultural Resources Inventory Report, March 2013 (prepared in support of the Recycled Water Master Plan/Title XVI Feasibility Study Report) – Appendix 5-5

Summary of Benefits

The projected project benefits include:

- **Water Supply:** Connecting new users to recycled water will reduce potable water service within the Cities of Antioch and Pittsburg, offsetting that potable water supply for other users.
- **Water Quality:** DDSD's wastewater discharges will be reduced as a result of the project, and will therefore cause a reduction in mass of pollutants discharged to the environment. In addition, water quality of all of DDSD's recycled water supplies will be improved, with TDS reduced from 960 mg/L to 760 mg/L, on average.

- **Environmental:** One of the new recycled water users to be connected as part of the project is the Dow Wetlands project. The recycled water will be used to maintain wetland habitat through augmentation of water supply. The Dow Wetlands are approximately 471 acres and home to endangered species (salt marsh harvest mouse, Mason's lileaopsis, Suisun aster) and threatened species (black shouldered kites, northern harrier).
- **Energy:** Recycled water production and distribution requires less energy than Delta supplies. As such, by offsetting Delta supplies with recycled water supplies, energy consumption and associated greenhouse gas emissions are reduced.
- **Other Physical Benefits:** Recycled water is higher in nutrients than Delta supplies. Therefore, use of recycled water for irrigation in lieu of Delta supplies will reduce the need for fertilizer application.

Recycled Water Irrigation in the City of Pittsburg

These benefits are summarized in the following table.

Table 7-22: Project Benefit Summary

Category	Benefit Summary
Water Supply	• 75.6 AFY of Delta supply offset with recycled water
Water Quality	• No quantified physical benefits
Flood Damage Reduction	• No quantified physical benefits
Environmental Resources	• 471 acres of Dow Wetlands supported with 1 AFY of recycled water
Recreation/Public Access	• No quantified physical benefits
Energy	• 336 MT CO_2 emissions avoided
Other Physical Benefits	• Reduction in nutrient application requirements: o 359,100 lbs of nitrogen o 756 lbs of phosphorus o 64,260 lbs of potassium

Background / Recent and Historical Conditions

DDSD's two major recycled water users, Los Medanos Energy Center (LMEC) and Delta Energy Center (DEC), are currently constrained in their cooling tower operations due to the quality of the recycled water they use for make-up water supply. High TDS in the recycled water requires more frequent blowdown discharge, increasing the overall water demand for cooling tower operations. Also, high TDS

reflects the higher concentration of specific constituents that contribute to corrosion and biogrowth within the cooling tower, requiring more use of conditioning chemicals. Reducing the TDS in the recycled water allows LMEC and DEC to concentrate the water within the cooling tower more before blowdown discharge, reducing the amount of water they purchase and reducing the amount of chemicals needed for conditioning within the cooling towers.

The reduction in water demand at LMEC and DEC allows for more available recycled water for other potential users. This benefit has multiple aspects:

- Reducing demand at LMEC and DEC reduces treatment capacity requirements, which is particularly beneficial during peak days and peak hours. More recycled water can be produced during high demand periods with less chance of supply cut backs for interruptible users, such as landscape irrigation users.
- Reducing demand at LMEC and DEC frees up transmission capacity within the existing distribution system, allowing more users to be served without excessive headloss in the pipelines and higher energy use by the distribution pumps.
- Freeing up capacity during peak days and hours provides a broader benefit of adding new users that purchase recycled water over a larger portion of the year, therefore increasing revenue from recycled water sales and diversifying the customer base.

The Project will construct new lateral connections to new users, increasing the amount of recycled water used. In so doing, the Project will offset potable water demand. Diverting wastewater for recycled water treatment and reuse will reduce the amount of wastewater effluent discharged to the environment. As a result, the mass of pollutants, such as ammonia, metals, suspended solids, biological oxygen demand, and other constituents, that are discharged to the environment will be reduced. While the levels of these constituents in DDSD's wastewater are already below regulatory limits, any reduction in wastewater discharges and thus reduction in the mass of these constituents released to the environment provides benefits to the aquatic ecosystems in the Delta.

Without Project Conditions

There are two main components to the Project: the TDS reduction component and the new user connections component. Without-Project conditions for each are discussed below.

- **TDS reduction component:** Without the Project, sidestream reverse osmosis (RO) treatment would be implemented to reduce TDS in the brine line from Dow to the DDSD wastewater treatment plant. As such, without the Project, TDS would continue to be reduced by approximately 200 mg/L, however at a much higher cost.
- **New user connections:** Without the Project, new recycled water service would not be established for landscape irrigation and / or industrial purposes located in disadvantaged communities in the Cities of Antioch and Pittsburg. No new users would be connected, and no additional recycled water would be served over current quantities. DDSD would discharge the same quantity of treated effluent, on average, and the same mass of constituents to the environment, as is currently discharged. Because the use of Delta water requires more energy than the use of recycled water, CO_2 emissions would continue to be greater than they would be with project implementation. In addition, when potable water is used for irrigation, irrigators must apply additional fertilizer because the potable water does not contain common fertilizing constituents common in recycled water (e.g., nitrogen, phosphorus, & potassium). This would

result in increased fertilizer costs to the schools and other city use sites. Recycled water is a drought-resistant supply, increasing reliability and availability during potable water shortages.

Relationship to Other Proposed Projects

This project is not intrinsically linked to any other projects in the proposal and will provide all claimed benefits on implementation. However, it is critical to the Region's commitment to assisting the Region in meeting critical water-related needs of DACs, one of the key objectives of this Proposal.

Description of Benefits and Methods to Estimate Benefits

The following sections summarize project benefits and methods used to estimate benefits in the following areas:

- Water Supply
- Water Quality
- Flood Damage Reduction
- Environmental Resources
- Recreation/Public Access
- Energy
- Other Physical Benefits

Uncertainty of the benefits, and factors that lead to uncertainty and quantified estimates of physical benefits described using PSP Table 7 are provided in later sections of this attachment.

Water Supply Benefits

The proposed Project would offset 75.6 AFY of Delta supplies in the Cities of Pittsburg and Antioch with recycled water supplies. Over the 50 year project life, this equates to 3,780 AF of Delta supplies offset. Table 7-23 below identifies the new recycled water users to be connected and their average annual projected recycled water demand

Table 7-23: New Recycled Water Users and Projected Average Annual Demands

New Recycled Water User	Average Annual Recycled Water Demand (AFY)
Pittsburg High School	22.7
Rancho Medanos Jr. High School	9.5
Dow Wetlands	1.0
Parkside Elementary School	13.9
Recycling Center and Transfer Station	28.5
Total	**75.6**

Note: This table reflects updates to projected demands presented on pages 3-6 and 3-10 of the DDSD Recycled Water Master Plan (RWMP)/ Title XVI Feasibility Study Report (provided as Appendix 5-1 to this Attachment)

In addition, high TDS in recycled water requires more frequent blowdown discharge, increasing the overall water demand for cooling tower operations. Reducing recycled water TDS will reduce the cooling water required by LMEC and DEC, freeing up needed capacity for DDSD and allowing DDSD to reliably meet recycled water demands in peak months. Both the with- and without-Project condition (implementing sidestream RO treatment) would provide these benefits. As such, there is no incremental

reduction in TDS associated with the Project compared to the without-Project condition, but both conditions will provide a significant reduction compared to current conditions.

Reducing the recycled water TDS will allow LMEC and DEC to concentrate the water within the cooling tower more before blowdown discharge, reducing recycled water demands for both the with-Project and without-Project (sidestream RO) conditions. As discussed on page 4-13 of the TDS Reduction Advanced Treatment Feasibility Study (provided as Appendix 5-2), the reduction in TDS will result in an annual demand reduction of 170 AFY. Over the 50-year project life, this equates to a total savings of 8,500 AF of recycled water which can be used to meet additional potable demands for both the with- and without-Project conditions. In addition, recycled water customers systemwide will benefit from the reduced delivered recycled water TDS. Because these benefits are achieved in both the with- and without-Project conditions, it cannot be counted as a physical benefit.

Water Quality Benefits

As described on page 10 of the Final Effluent Quality Analysis with Dow Industrial Waste Relocation Draft Report, the implementation of the Project will reduce TDS in DDSD's recycled water supply from approximately 960 mg/L to 760 mg/L. Without the Project, this benefit would be achieved through implementation of sidestream RO.

Based on personal communication with DDSD staff, total DDSD recycled water use in 2012 was 8,132 AFY, up from 6,384 AFY in 2011. For the purposes of this analysis, it is conservatively assumed that 2011 production is representative of current recycled water demands, and that demands increase by 75.6 AFY due to new connections but decrease by 170 AFY due to increased industrial cooling efficiency for a net decrease of 94.4 AFY (for a total of 6,290 AFY beginning in 2016) due to implementation of the proposed project in 2016. Without the Project, recycled water TDS would remain at 960 mg/L (2,609 lb / AF) from 2013 through the end of the 50-year project life, for a total of 53 years. This equates to a total salt loading of 441,363 tons (2,609 lb / AF * 6,384 AFY * 53 years / 2,000).

With the Project, TDS loading would be reduced. To calculate TDS loading with the project, it is assumed that, with the Project, TDS remains at 960 mg/L (2,609 lb/AF) from 2013 through 2015, at which time recycled water use drops to 6,290 AFY and TDS drops to 760 mg/L (2,065 lbs/AF) for the next 50 years. This equates to a total salt loading of 349,763 tons (2,609 lb/AF * 6,384 AFY * 3 years / 2,000 + 2,065 lb/AF * 6,290 AFY * 50 years / 2,000).

As such, Project implementation would result in a reduction in TDS loading to the basin of 91,599 tons over the 50 year Project life. Because this benefit is achieved in both the with- and without-Project conditions, it cannot be counted as a physical benefit.

Environmental Benefits

As discussed on page 3-10 of the Recycled Water Master Plan (Appendix 5-1), the Dow Wetlands project will be one of the new recycled water users to be connected as part of the project. The 471-acre Dow Wetlands project will receive an average of 1 AFY of recycled water to maintain wetland habitat. The Dow Wetlands are home to endangered species (salt marsh harvest mouse, Mason's lileaopsis, Suisun aster) and threatened species (black shouldered kites, northern harrier).

Energy-Related Benefits

By offsetting Delta water demands with recycled water, the project will avoid emissions of CO_2 (a greenhouse gas) generated by the production of energy required to transport water from the Delta (via CCWD) to the Cities of Pittsburg and Antioch.

DDSD does not have specific data on the amount of energy (and associated carbon emissions) required to import water from the Delta (via CCWD) to the City of Pittsburg. However, this information is available for DWD. For this analysis, it is assumed that the energy required to transport water to DWD customers is approximately equal to that required to deliver Delta water to customers within the Cities of Pittsburg and Antioch.

DWD estimates that it requires 0.728 MWh to treat and deliver one AF of water from the Delta. Further, for every MWh of electricity used to import water, 0.222 MT of CO_2 are emitted. Thus, every AF of Delta water generates approximately 0.162 metric tons (MT) of CO_2 (0.728 MWh/AF multiplied by 0.222 MT/MWh). By avoiding the use of 75.6 AFY of Delta water per year, or 3,780 AF over the assumed 50-year project life, the project will avoid emission of 612 MT of CO_2.

Avoided carbon emissions will be offset to some extent by the energy required to pump and treat recycled water. Based on data provided by DDSD, 0.328 MWh are required to produce and distribute recycled water within the District. Using the same CO_2 emissions rate of 0.222 MT/MWh for every AF of recycled water delivered within the District, 0.073 MT of CO_2 are emitted (0.328 MWh/AF multiplied by 0.222 MT/MWh). Over the 50-year lifetime of the project, total CO_2 emissions associated with recycled water production and distribution will amount to 276 MT. Thus, with the project, net avoided carbon emissions will be 336 MT.

Other Physical Benefits

In absence of the project, potable water will continue to be used for the 75.6 AFY of irrigation that would be met through recycled water with following project implementation. Because recycled water contains higher concentrations of fertilizing compounds (e.g., nitrogen, phosphorous, potassium) than commonly contained in Delta supplies, offsetting Delta supplies with recycled water for irrigation will result in a decrease in fertilizer required.

DDSD's recycled water contains 95 lbs of nitrogen per AF, 0.2 lbs of phosphorous per AF, and 17 lbs of potassium per AF. Each year following project implementation, the project will avoid 7,182 lbs of nitrogen application, 15 lbs phosphorus application, and 1,285 lbs potassium application. Over the 50-year project life, this amounts to avoidance of 359,100 lbs of nitrogen application, 756 lbs phosphorus application, and 64,260 lbs potassium application.

Facilities Required to Achieve Benefits

In order to achieve the benefits described above, all Project facilities must be constructed, including:

- Installation of approximately 9,200 lineal feet of 6" high density polyethylene (HDPE) pipe and appurtenances to redirect a high TDS brine line from Dow to the DDSD wastewater treatment plant downstream of the recycled water facility
- Establishment of new recycled water service for landscape irrigation and for industrial purposes located in disadvantaged communities in the Cities of Antioch and Pittsburg

Uncertainty of Benefits

The following uncertainties have been identified that could affect the degree of benefit of the Project:

- DDSD is working closely with the Cities of Pittsburg and Antioch to establish user agreements with the new recycled water customers identified as part of the project. This coordination is proceeding as planned, and all indications are that the user agreements will be established and the users connected to recycled water. There is a very small risk that some users may reconsider participation in the recycled water program, but that chance is considered very small. Also, year-to-year natural variability in the weather can result in recycled water demands that are higher or lower than the estimated average demand.
- The reduction in quantity of wastewater discharged to the environment is directly related to the increase in recycled water use as a result of the project, so the uncertainty is similar to those for Benefit #3. If recycled water demand changes, due to more or fewer customers, or due to year-to-year variability in weather, wastewater discharges will change commensurately. In addition, wastewater discharges can change due to changing habits of sewer customers, from using more or less water, or from losing or gaining businesses connected to the collection system.

Project Adverse Effects

The project will have temporary, construction-related impacts. No long-term adverse effects are expected from this project, and any adverse project effects will be fully mitigated.

Annual Project Physical Benefits

The following tables summarize the expected annual benefits from this project.

Table 9 – Annual Project Physical Benefits

Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project

Type of Benefit Claimed: WS2: Delta Supplies Offset with Recycled Water

Measure of Benefit Claimed (Name of Units): AFY

Additional Information About this Measure: Reflects Delta supplies offset with new recycled water connections.

(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	0	75.6	75.6

Table 9 – Annual Project Physical Benefits			
Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project Type of Benefit Claimed: ENV1: Acres of Weltands Supported with Recycled Water Measure of Benefit Claimed (Name of Units):acres Additional Information About this Measure: Acres of wetlands supported with recycled water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	0	471	471

Table 9 – Annual Project Physical Benefits			
Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project Type of Benefit Claimed: ENE1: MT CO2 Emissions Avoided Measure of Benefit Claimed (Name of Units): MT CO2 Equivalents Additional Information About this Measure: MT CO2 Equivalents avoided by offsetting Delta supplies with recycled water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	612	276	336

Table 9 – Annual Project Physical Benefits			
Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project Type of Benefit Claimed: OTH1: Reduction in Nitrogen Application Requirements Measure of Benefit Claimed (Name of Units): Pounds Nitrogen Application Avoided Additional Information About this Measure: Pounds nitrogen application avoided by irrigating with recycled water in lieu of Delta water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	359,100	0	359,100

Table 9 – Annual Project Physical Benefits Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project Type of Benefit Claimed: OTH2: Reduction in Phosphorus Application Requirements Measure of Benefit Claimed (Name of Units): Pounds Phosphorus Application Avoided Additional Information About this Measure: Pounds phosphorus application avoided by irrigating with recycled water in lieu of Delta water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	756	0	756

Table 9 – Annual Project Physical Benefits Project Name: Recycled Water Salinity Reduction and Distribution System Expansion Project Type of Benefit Claimed: OTH2: Reduction in Potassium Application Requirements Measure of Benefit Claimed (Name of Units): Pounds Potassium Application Avoided Additional Information About this Measure: Pounds potassium application avoided by irrigating with recycled water in lieu of Delta water.			
(a)	(b)	(c)	(d)
	Physical Benefits		
Year	Without Project	With Project	Change Resulting from Project (b) – (c)
2018-2117	64,260	0	64,260

Appendices

The following Appendices have been provided on the CD included at the end of this proposal.

Appendix	Filename
Appendix 1 - Studies Supporting Project 1: Beacon West Arsenic Well & Tank	
Appendix 1-1: 1999 Investigation of Groundwater Resources	Att7_IG2_TechJust_2of20
Appendix 1-2: Diablo Water District Feasibility Study Beacon West Arsenic Well & Tank Replacement Project	Att7_IG2_TechJust_2of20
Appendix 1-3: DWD Urban Water Management Plan	Att7_IG2_TechJust_2of20
Appendix 1-4: Preliminary Design and Site Planning, 2013	
Appendix 2 - Studies Supporting Project 2: Rossmoor Well Replacement / Groundwater Monitoring System Expansion	
Appendix 2-1: Reports on Groundwater Monitoring Program (September 2009, February 2013)	Att7_IG2_TechJust_3of20
Appendix 2-2: Pittsburg Plain Groundwater Basin (2-4) CASGEM Monitoring Plan (December 2011)	Att7_IG2_TechJust_3of20
Appendix 2-3: Pittsburg Plain Groundwater Basin (2-4) Groundwater Management Plan (October 2012)	Att7_IG2_TechJust_3of20
Appendix 2-4: City of Pittsburg 2010 Urban Water Management Plan Update	Att7_IG2_TechJust_3of20
Appendix 2-5: CEQA Notice of Exemption	Att7_IG2_TechJust_3of20
Appendix 2-6: Cost comparison – Bodega and Rossmoor Wells	Att7_IG2_TechJust_3of20
Appendix 3 - Studies Supporting Project 3: Integrated Regional Flood Protection and Water Quality Improvement Borrow Area Project	
Appendix 3-1: Studies Supporting Upper Sand Creek Basin Portion of Project	
Appendix 3-1.1: Upper Sand Creek Basin Preliminary Soil Characterization Study, 2000	Att7_IG2_TechJust_3of20
Appendix 3-1.2: Upper San Creek Detention Basin Design Report, August 2010	Att7_IG2_TechJust_4of20
Appendix 3-1.3: CEQA analysis regarding hauling of fill from the Sand Creek Bain site by the Contra Costa County Flood Control & Water Conservation District, Approved by Contra Costa County Board of Supervisors on November 2010	Att7_IG2_TechJust_5of20
Appendix 3-1.4: Upper Sand Creek Basin Geotechnical Report, 2012	Att7_IG2_TechJust_5of20
Appendix 3-1.5: Upper Sand Creek Basin Project Plans and Specifications, 2012	Att7_IG2_TechJust_4of20
Appendix 3-1.6: Contra Costa Flood Control District Proposition 1E Round 1 Funding Application Work Plan and Economic Analysis – Upper Sand Creek Basin	Att7_IG2_TechJust_6of20
Appendix 3-2: Environmental & Permitting Documentation (Canal Portion of Project)	
Appendix 3-2.1: Negative Declaration (November 2006)	Att7_IG2_TechJust_6of20
Appendix 3-2.2: Mitigation Monitoring and Reporting Program for the Contra Costa Canal Replacement Project. State Clearinghouse # 2006042082. November 2006.	Att7_IG2_TechJust_6of20
Appendix 3-2.3: Final Mitigated Negative Declaration for the Contra	Att7_IG2_TechJust_6of20

Appendix	Filename
Costa Canal Replacement Project. November 2006.	
Appendix 3-2.4: Final Environmental Assessment Contra Costa Canal Replacement Project, contra Costa Cou8nty, California. June 2007.	Att7_IG2_TechJust_6of20
Appendix 3-2.5: Permits and agreements secured in 2007, including: Central Valley Regional Water Quality Control Board 401 Permit, CA Department of Fish and Game 1600 and 2081 Permits, State Historic Preservation Officer MOU, US Army Corps of Engineers 404 Permit, National Marine Fisheries Service Letters of Concurrence, US Fish and Wildlife Coordination Act Letter, and Bureau of Reclamation/Western Area Power Administration (WAPA) NEPA EA/FONSI	Att7_IG2_TechJust_6of20
Appendix 3-2.6: Conservation Easement Deed Holland Tract Preserve	Att7_IG2_TechJust_6of20
Appendix 3-3: Engineering & Design Documentation (Canal Portion of Project)	
Appendix 3-3.1: Geotechnical Engineering Investigation Contra Costa Water District Canal Replacement Project Oakley, CA. DCM Engineering/Carollo Engineers, November 2007.	Att7_IG2_TechJust_7of20
Appendix 3-3.2: Recommended Pipeline Alignment. Technical Memorandum. Brown & Caldwell. June 2011.	Att7_IG2_TechJust_7of20
Appendix 3-3.3: Canal Crossings. Technical Memorandum. Brown & Caldwell. June 2011.	Att7_IG2_TechJust_7of20
Appendix 3-3.4: Canal Levee Elimination and Flood Mitigation Project Phase 2 - Pipeline. Access Structure Structural Calculations. Brown and Caldwell. June 2011.	Att7_IG2_TechJust_7of20
Appendix 3-3.5: Cypress Grove Levee Protection. Technical Memorandum. Brown & Caldwell. June 2011	Att7_IG2_TechJust_8of20
Appendix 3-3.6: Pumping Plant 1 Test Report. Technical Memorandum. Brown & Caldwell, June 2011.	Att7_IG2_TechJust_8of20
Appendix 3-3.7: Final Grade Elevations and Imported Backfill. Technical Memorandum. Brown & Caldwell, June 2011.	Att7_IG2_TechJust_8of20
Appendix 3-3.8: 100% Design Drawings Segments 2 - 4	Att7_IG2_TechJust_8of20 *through* Att7_IG2_TechJust_11of20
Appendix 3-3.9: Volume-1-DIV-00-17-FULL	Att7_IG2_TechJust_11of20
Appendix 3-3.10: Volume-2-Appendices	Att7_IG2_TechJust_12of20 *and* Att7_IG2_TechJust_13of20
Appendix 3-3.11: Executed Prop 1E Agreement for Canal Project	Att7_IG2_TechJust_13of20
Appendix 3-4: Flood Benefits Documentation (Canal Portion of Project)	
Appendix 3-4.1: Photos and narrative description of historical flood damage: RD 1237, Contra Costa Water District Operations and Maintenance Staff	Att7_IG2_TechJust_14of20
Appendix 3-4.2: Flood frequency curves for Old River at Rock Slough and San Joaquin River at Antioch. Developed by Corps of Engineers, Sacramento California. February 1992.	Att7_IG2_TechJust_14of20
Appendix 3-4.3: FEMA inundation maps.	Att7_IG2_TechJust_14of20
Appendix 3-4.4: Water surface elevations measured at Rock Slough. http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=RSL	Att7_IG2_TechJust_14of20
Appendix 3-4.5: Application for Individual Permit Supplemental	Att7_IG2_TechJust_14of20

Appendix	Filename
Attachment. Dutch Slough Tidal Marsh Restoration (SPK-2004000043). Prepared for U.S. Army Corps of Engineers Sacramento District, Regulatory Division. Prepared by California Department of Water Resources. March 2012.	
Appendix 3-4.6: Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report. SCH # 2006042009. State of California Department of Water Resources. March 2010.	Att7_IG2_TechJust_14of20
Appendix 3-4.7: City of Oakley 2020 General Plan. Updated January 2010. http://www.ci.oakley.ca.us/UserFiles/file/GeneralPlan/General%20Plan%202020_Updated%20January%2026,%202010.pdf	Att7_IG2_TechJust_14of20
Appendix 3-4.8: City of Oakley East Cypress Corridor Specific Plan Final Supplemental Environmental Impact Report. January 2009. http://www.ci.oakley.ca.us/UserFiles/file/planning/East%20Cypress/ECC%20SP%20Draft%20EIR.pdf	Att7_IG2_TechJust_14of20
Appendix 3-5: Water Supply Benefits Documentation (Canal Portion of Project)	
Appendix 3-5.1: Spreadsheet of CCWD daily operations model output	Att7_IG2_TechJust_15of20
Appendix 3-5.2: Contra Costa Water District Daily Operations Model (WRSEL based linear program). Los Vaqueros Expansion Model Documentation. Technical Memorandum. MBK Engineers. November 3, 2010.	Att7_IG2_TechJust_15of20
Appendix 3-5.3: G-model used to estimate water savings to CVP/SWP associated with compliance with water quality standards. Accounting for Antecedent Conditions in Seawater Intrusion Modeling - Applications for the San Francisco Bay-Delta. Richard Denton, 1993. Hydraulic Engineering, Volume 1, ASCE, pp. 448-453.	Att7_IG2_TechJust_15of20
Appendix 3-5.4: Calculation of water savings based on Rock Slough salinity requirements, Contra Costa Water District, 2013	Att7_IG2_TechJust_15of20
Appendix 3-6: Water Quality Benefits Documentation (Canal Portion of Project)	
Appendix 3-6.1: Water Quality at Contra Costa Water District's Contra Costa Canal Intake: A Review of Rock Slough Water Quality Analyses. Contra Costa Water District Interoffice Memorandum. August 14, 2001.	Att7_IG2_TechJust_16of20
Appendix 3-6.2: Rock Slough Technical Memorandum Evaluating Veale Tract Discharge. FlowScience. December 19, 2003.	Att7_IG2_TechJust_16of20
Appendix 3-6.3: Identification of Water Quality Degradation Sources in Rock Slough and Unlined Portion of Contra Costa Canal. Contra Costa Water District Interoffice Memorandum. October 23, 2003.	Att7_IG2_TechJust_16of20
Appendix 3-6.4: Bay Area Water Quality & Supply Reliability Program. CALFED Bay Delta Program. May 2005.	Att7_IG2_TechJust_16of20
Appendix 3-6.5: Amy, G.L., M. Siddiqui, K. Ozekin, H.W. Zhu, and C. Wang, (1998). Empirically Based Models for Predicting Chlorination and Ozonation By-Product: Haloacetic Acids, Chloral Hydrate, and Bromate. EPA Report CX 819579. USEPA Office of Groundwater and Drinking Water: Cincinnati, OH, 1998.	Att7_IG2_TechJust_16of20
Appendix 3-6.6: Field data collected by Contra Costa Water District and	Att7_IG2_TechJust_17of20

Appendix	Filename
the Department of Water Resources	
Appendix 3-6.7: Beneficial Use Impact Study, Final Report Ironhouse Sanitary District, Oakley, California. Prepared by HydroFocus. December 2003	Att7_IG2_TechJust_17of20
Appendix 3-7: Environmental Benefits Documentation (Canal Portion of Project)	
Appendix 3-7.1: Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report. SCH # 2006042009. State of California Department of Water Resources. March 2010.	Att7_IG2_TechJust_18of20
Appendix 3-7.2: East Contra Costa County HCP/NCCP Mitigation Fee Audit. East Contra Costa County Habitat Conservancy, December 2012	Att7_IG2_TechJust_18of20
Appendix 3-7.3: East Contra Costa County Habitat Conservancy Governing Board Memorandum: Review and Adjustment of the HCP/NCCP Mitigation Fees, July 2011	Att7_IG2_TechJust_18of20
Appendix 3-8: Energy Related Benefits Documentation (Canal Portion of Project)	
Appendix 3-8.1: Spreadsheet of CCWD daily operations model output	Att7_IG2_TechJust_19of20
Appendix 4 - Studies Supporting Project 4: Knightsen Wetland Restoration and Flood Protection	
Appendix 4-1: Knightsen Water Quality Wetland Feasibility Assessment (2002)	Att7_IG2_TechJust_19of20
Appendix 4-2: Knightsen Habitat Restoration Feasibility Study (2013)	Att7_IG2_TechJust_19of20
Appendix 5 - Studies Supporting Project 5: Recycled Water Salinity Reduction and Distribution System Expansion Project	
Appendix 5-1: Recycled Water Master Plan (Jan. 2013)	Att7_IG2_TechJust_20of20
Appendix 5-2: TDS Reduction Advanced Treatment Feasibility Study (Feb. 2012)	Att7_IG2_TechJust_20of20
Appendix 5-3: Technical Memorandum, Final Effluent Quality Analysis with Dow Industrial Waste Relocation (November 2012)	Att7_IG2_TechJust_20of20
Appendix 5-4: Regional Water Quality Control Board approval letter, February 28, 2013	Att7_IG2_TechJust_20of20
Appendix 5-5: Final Biological Assessment and the Cultural Resources Inventory Report, March 2013 (prepared in support of the Recycled Water Master Plan/Title XVI Feasibility Study Report)	Att7_IG2_TechJust_20of20