Scotts Valley Water District
Scotts Valley, California

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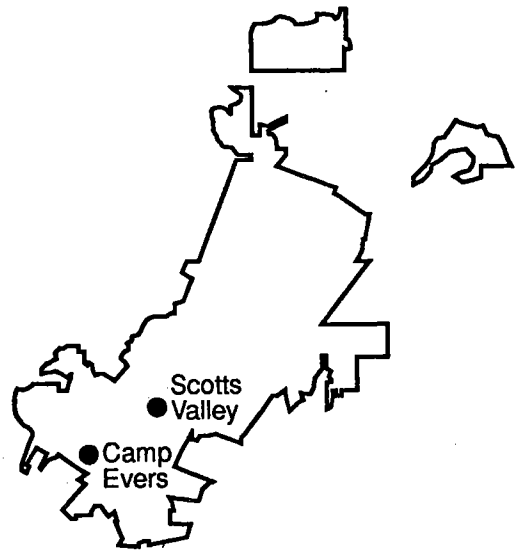
# SCOTTS VALLEY GROUNDWATER MANAGEMENT PLAN (AB 3030)

**July 1994**

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Scotts Valley Water District
Scotts Valley, California

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# GROUNDWATER MANAGEMENT PLAN
# (AB 3030)

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## Table of Contents


Page

Executive Summary.....ES1

1.0 Introduction..... 1
1.1 Background..... 1
1.2 Purpose..... 2
1.3 Scope..... 3
1.4 Acknowledgements..... 4

2.0 Hydrogeology of Scotts Valley..... 5
2.1 Geologic Units and Structure..... 5
2.2 Hydrogeology..... 7

3.0 Groundwater Supply..... 9
3.1 Current Monitoring Programs..... 9
Precipitation..... 9
Evaporation.....11
Streamflow.....11
Well Inventory.....12
Groundwater Levels.....12
Pumpage.....13
Groundwater Quality.....13
Wastewater Outflows.....14
Recommendations.....14
3.2 Groundwater Level Trends.....14
3.3 Perennial Yield and Groundwater Storage.....17
3.4 AMBAG Model.....19
Model Simulations.....20
Limitations.....21
Recent Simulations.....22
Recommendations.....24
3.5 Pumpage.....24
Well Inventory.....24
Groundwater Pumpage.....25
Summary of Pumpage.....30
Recommendations.....32
3.6 Replenishment of Groundwater.....33
Review of Previous Studies.....34
Current and Future Status of Wastewater Treatment.....39
Potential Replenishment Projects.....40
Mitigation of Pumpage Impacts.....50
Recommendations.....51

**Table of Contents**
**(continued)**

**Page**


4.0 Groundwater Quality.....54
4.1 Regulatory Responsibilities.....54
4.2 Groundwater Contamination.....57
Camp Evers.....57
El Pueblo Road.....62
Watkins-Johnson.....66
Other Identified Contamination Sites.....67
4.3 Groundwater Contamination Prevention.....67
Well Construction, Abandonment, and Destruction.....68
Hazardous Materials Management.....71
Underground Storage Tanks.....73
Septic Tank Disposal Systems.....77
City Planning and Zoning.....78
Summary.....79

5.0 Conclusions.....82

6.0 Recommendations.....87

7.0 References.....92

## List of Tables


Page

1. Summary of Scotts Valley Monitoring Programs.....10

2. Private Water Purveyors.....27

3. Current Groundwater Pumpage, AFY, Scotts Valley Groundwater Basin.....30

4. Minimum Treatment and Recharge Requirements for Wastewater Recycling.....42

5. Summary of Groundwater Replenishment Alternatives.....45

## List of Figures


**After Page**

1. Study Areas..... 1
2. Scotts Valley Water District Service Area..... 1
3. Cross Section Location..... 5
4. Hydrogeologic Cross Section..... 5
5. Monitoring Locations..... 9
6. Water Level Trends in Selected Wells.....14
7. Water Level Change, April 1986 - April 1993.....18
8. Groundwater Production, SVWD 1976-1993 and SLVWD 1987-1993.....25
9. Current Distribution of Groundwater Production.....30
10. Groundwater Quality Problems.....57
11. Possible Sources of Camp Evers Water Supply Well Contamination.....58
12. Benzene in Groundwater, Highest Concentration Detected 1993-1994.....61
13. Estimated Chlorobenzene Plume.....62
14. Water Well Locations in Scotts Valley Area.....69
15. Underground Storage Tank and Hazardous Material Locations.72
16. Wastewater Treatment and Disposal Facilities.....78
17. City of Scotts Valley Zoning.....78

## EXECUTIVE SUMMARY

The Scotts Valley Water District (SVWD) holds the primary responsibility for the management and supply of water to the Scotts Valley area of Santa Cruz County. In recognition of this responsibility, SVWD has directed a Water Resource Management Plan since 1983. On January 1, 1993, California Assembly Bill 3030 (AB 3030) was codified into law. This law encourages local water agencies to manage groundwater resources within their jurisdictions and outlines guidelines for a groundwater management plan. In accordance with these guidelines, SVWD held a public hearing on September 9, 1993 to declare their intention to develop a groundwater management plan.

This report outlines the proposed Groundwater Management Plan for SVWD, and addresses two major areas of concern in Scotts Valley: (1) management of groundwater supplies to meet present and future demands, and to provide for downstream water rights and instream uses; and (2) protection of water quality and remediation of existing groundwater contamination. The report also includes a brief discussion of the hydrogeology of Scotts Valley. Major conclusions and recommendations are presented. If this report is adopted in accordance with the AB 3030 law as the Groundwater Management Plan for Scotts Valley Water District, the conclusions and recommendations would serve as guidelines for groundwater management by SVWD.

Major findings and recommendations of the report are summarized briefly in the paragraphs below, followed by a complete listing of the Conclusions and Recommendations.

### Hydrogeology

The hydrogeologic investigations have revealed that the areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited. In such a situation, effective groundwater basin management must be based on extensive groundwater exploration and comprehensive but detailed hydrogeologic investigations. Accordingly, the Groundwater Management Plan recommends that groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with the neighboring San Lorenzo Valley Water District (SLVWD) and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

**Groundwater Supply**

The groundwater supply section includes a summary of the current groundwater supply status of the basin. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and locally decreased groundwater quality. Along with groundwater level declines, groundwater storage in the developed portion of the basin declined between April 1986 and April 1994 by an estimated 550 to 600 acre-feet per year (AFY), or about 10 percent of estimated total groundwater storage. Although the recent 1992-1993 season was wet, it resulted only in a moderation of the extent and severity of localized groundwater level declines. However, the major natural drain for the basin, Bean Creek, responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

The report also updates groundwater production in the basin. About 70 percent of the total groundwater production is metered, while the remainder had to be estimated, including groundwater production by landscape irrigators, private water purveyors, commercial and industrial firms, and domestic users. The total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks. The perennial yield for the Scotts Valley groundwater basin had been estimated previously to be 4,200 AFY. Accordingly, estimated groundwater production amounts to over 80 percent of the estimated perennial yield. In addition, the preponderance of pumpage is concentrated in a small portion of the groundwater basin.

In response to concerns over the long-term groundwater supply, the report evaluates current groundwater basin management and makes recommendations for future action. The report summarizes the SVWD monitoring program, finding it to be comprehensive, with an appropriate focus on the developed portions of the basin. In addition, the existing Santa Margarita groundwater basin computer model is evaluated. Although requiring periodic updating and refinement, the model can be used to observe effects of proposed well locations and pumping configurations, and potential recharge projects, consequently aiding in groundwater management. In addition, the model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

The Groundwater Management Plan notes that the current estimate of perennial yield is an annual average value. Given the variability of rainfall and recharge in recent years, the perennial yield should be evaluated to provide more specific information on the effect of varied rainfall on groundwater recharge. Recommendations also are provided for more accurate evaluation of

basin-wide groundwater storage in light of increased knowledge of the hydrogeology of the area.

The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. Accordingly, SVWD efforts should be supplemented by actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each. More than one such project would be needed to mitigate the current groundwater level declines, and additional conservation, management, and replenishment efforts would be required for any additional increase in local water demands. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated with SLVWD, Santa Cruz County, and major groundwater producers. Accordingly, roundtable meetings are recommended for the major groundwater producers in Scotts Valley to discuss and coordinate means to mitigate groundwater level decline problems. The report also recommends continued efforts toward water conservation and wastewater reclamation and reuse.

**Groundwater Quality**

The portion of the report addressing groundwater quality presents the regulatory framework for the identification and remediation of contamination problems, discusses existing contamination, and reviews groundwater contamination prevention programs. Recommendations are presented for specific action by SVWD and for cooperation with other agencies.

In brief, the agencies with regulatory responsibility for groundwater contamination in Scotts Valley are the United States Environmental Protection Agency (USEPA), the Department of Toxic Substance Control of the California Environmental Protection Agency (Cal-EPA), Regional Water Quality Control Board (RWQCB), and Scotts Valley Fire Protection District. SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of water satisfying state and federal drinking water standards. In addition, it holds responsibility for enforcement of standards for construction, abandonment, and destruction of water supply wells.

Areas of known groundwater contamination are described briefly in the report, including the benzene plume in the Camp Evers area, three problems in the El Pueblo Road area, and the Watkins-Johnson plume. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible

sources. Cal-EPA is the lead agency overseeing the investigation and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the trichloroethene (TCE) and chlorobenzene problems. Of seven possible sources, one site has been identified as a possible source of TCE contamination. A remedial investigation and feasibility study for the site has been prepared, while a remedial action plan remains to be drafted and approved. The USEPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

The existence of potential sources of groundwater contamination in Scotts Valley are identified, including 64 facilities using hazardous materials and 37 active underground storage tanks (USTs), of which 22 are double-walled and meet new tank standards. Septic tanks also are potential sources of contamination.

Given the existence of contamination and the susceptibility of local aquifers to contamination, the report also reviews means to prevent groundwater contamination problems. These include well construction, abandonment, and destruction; hazardous materials management; regulation of underground storage tanks; sewering of areas dependent on septic tanks; and city planning and zoning. In terms of standards for well construction, abandonment, and destruction, SVWD is encouraged to strengthen its enforcement of standards. This would involve updating the well inventory database, tracking the status of wells within SVWD, establishing a notification system to alert private groundwater users of contamination problems, and implementing well construction standards to prevent cross-contamination of aquifers.

In accordance with its responsibility to provide water satisfying state and federal drinking water standards, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination. SVWD also should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

The report notes that no single agency has a regional outlook on groundwater contamination. Given SVWD's existing role in monitoring and managing local water resources and its key role in providing safe drinking water, SVWD can help provide such a regional overview, through cooperation with the regulatory agencies and information sharing.

## Conclusions

### Hydrogeology

1. The areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited.

2. Much valuable information is available on the hydrogeology of the margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

### Groundwater Supply

3. The water resource monitoring program is comprehensive, with an appropriate focus on the developed portions of the basin.

4. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and a somewhat lower groundwater quality.

5. The wet 1992-1993 season resulted only in a moderation of the extent and severity of localized groundwater level declines.

6. Although affected by recent drought, Bean Creek responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

7. Perennial yield for the Scotts Valley groundwater basin has been estimated to be 4,200 AFY. This is an annual average value and is relevant to the area of the Scotts Valley groundwater basin.

8. Groundwater storage in the developed portion of the basin has declined between April 1986 and April 1994 by an estimated 550 to 600 AFY, or about 10 percent of estimated total groundwater storage.

9. The Santa Margarita groundwater basin computer model can be used to observe effects of proposed well locations and pumping configurations, consequently aiding in optimization of the distribution of pumping.

10. The model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

11. About 70 percent of the total estimated groundwater production is metered by SVWD, SLVWD, Watkins-Johnson, and the Mount Hermon Association. Groundwater production was estimated for other groundwater users, including landscape irrigators, private water purveyors, commercial and industrial firms, and domestic users.

12. Total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks.

13. The estimated total groundwater pumpage amounts to over 80 percent of the estimated 4,200 AFY of perennial yield for the Scotts Valley groundwater basin, and is concentrated in the southeast one-quarter of the groundwater basin.

14. The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. SVWD efforts should be supplemented by actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs.

15. More than one replenishment program will be needed to mitigate localized groundwater level declines and to ensure long-term groundwater supply.

16. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each.

**Groundwater Quality**

17. The Scotts Valley Fire Protection District oversees the City of Scotts Valley's hazardous materials management program, implements state regulations of underground storage tanks, oversees monitoring and soil boring installation and destruction, and responds first to a hazardous material release.

18. The RWQCB regulates sites where groundwater contamination occurs from underground tanks or other sources.

19. The Cal-EPA oversees groundwater contamination sites where the potentially responsible party is not known or is not financially solvent.

20. The USEPA oversees sites that are on or proposed for the Superfund list.

21. SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of

water satisfying state and federal drinking water standards.

22. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible sources.

23. Cal-EPA is the lead agency overseeing the characterization and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the TCE and chlorobenzene problems. Of seven possible sources, Scotts Valley Circuits has been identified as a possible source of TCE contamination. A remedial investigation and feasibility study for the site has been prepared; a remedial action plan remains to be drafted and approved.

24. The USEPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

25. Prevention of groundwater contamination in Scotts Valley is important because of the susceptibility of aquifers to contamination, difficulty in determining sources of contamination, extended time and high costs to remediate contamination, and added costs of wellhead treatment by water purveyors.

26. Improperly constructed or abandoned wells can provide conduits for downward migration of contaminants from the ground surface.

27. SVWD and Santa Cruz County share responsibility for enforcing standards for permitting, construction, abandonment, and destruction of water supply wells.

28. Sixty-four facilities using hazardous materials exist in Scotts Valley, located mostly along Scotts Valley Drive.

29. Thirty-seven active underground storage tanks have been identified in Scott Valley, of which 22 are double-walled and meet new tank standards.

30. Septic tanks represent other potential sources of contamination.

## Recommendations

### Hydrogeology

1. Groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

### Groundwater Supply

2. SVWD should continue data compilation on wells and geology and the program of climatic, surface water, and groundwater monitoring with annual reporting.

3. Groundwater level monitoring by all agencies should be coordinated so that the quarterly measurements occur within a small time period, such as one week.

4. SVWD in cooperation with other agencies should expand data compilation and monitoring as groundwater exploration and production are extended into new areas, or as needed for groundwater replenishment projects or for groundwater contamination investigations or remediation.

5. The perennial yield and groundwater storage of the Scotts Valley groundwater basin should be reevaluated in greater detail.

6. The computer model should be maintained, but revised as additional hydrogeologic data become available.

7. Information on wells and metered groundwater production should be compiled and updated regularly. Groundwater production by large groundwater users should be measured.

8. Following metering of major groundwater producers, consumptive use of groundwater should be analyzed.

9. SVWD should continue its efforts to redistribute its pumpage throughout its service area.

10. Roundtable meetings should be convened by the major groundwater producers to discuss means to analyze and mitigate groundwater level declines.

11. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

12. The conceptual replenishment projects, in addition to others that may be suggested, should be considered in greater depth.Additional investigations would include field work, computer modeling, cost/benefit analysis, and assessment of environmental impacts.

13. SVWD, SLVWD, and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.

14. SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

**Groundwater Quality**

In order to aid in groundwater contamination prevention, SVWD should strengthen its enforcement of standards for construction, abandonment, and destruction of water supply wells, including the following:

15. Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.

16. Conduct a survey to document the status of wells within SVWD boundaries, and to identify both active and destroyed wells.

17. Once the well survey is complete, establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

18. Given the existence of multiple aquifer systems within SVWD, implement well construction standards to prevent cross-contamination of aquifers.

19. Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.

20. Establish a program to identify and encourage the proper destruction of abandoned wells within SVWD.

21. In accordance with its responsibility to provide water satisfying state and federal drinking water standards, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination, and should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

Overall, SVWD should encourage and cooperate fully with responsible agencies in the investigation and remediation of

contamination sites, identification of potentially responsible parties, and prevention of groundwater contamination. SVWD also can provide a regional groundwater management overview and can aid in information sharing among agencies. Accordingly, SVWD and other agencies should:

Hazardous Materials Management

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Institute stricter regulations for sites which use hazardous materials.

Underground Storage Tanks

- Develop more stringent local standard for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

Septic Tank Disposal Systems

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system.
- Encourage hookup of all businesses and residences not currently connected to the sanitary sewer system.

City Planning and Zoning

- Limit future industrial and commercial service development to existing areas.
- Encourage consideration by City planners of groundwater protection issues in land use planning.

# Section 1

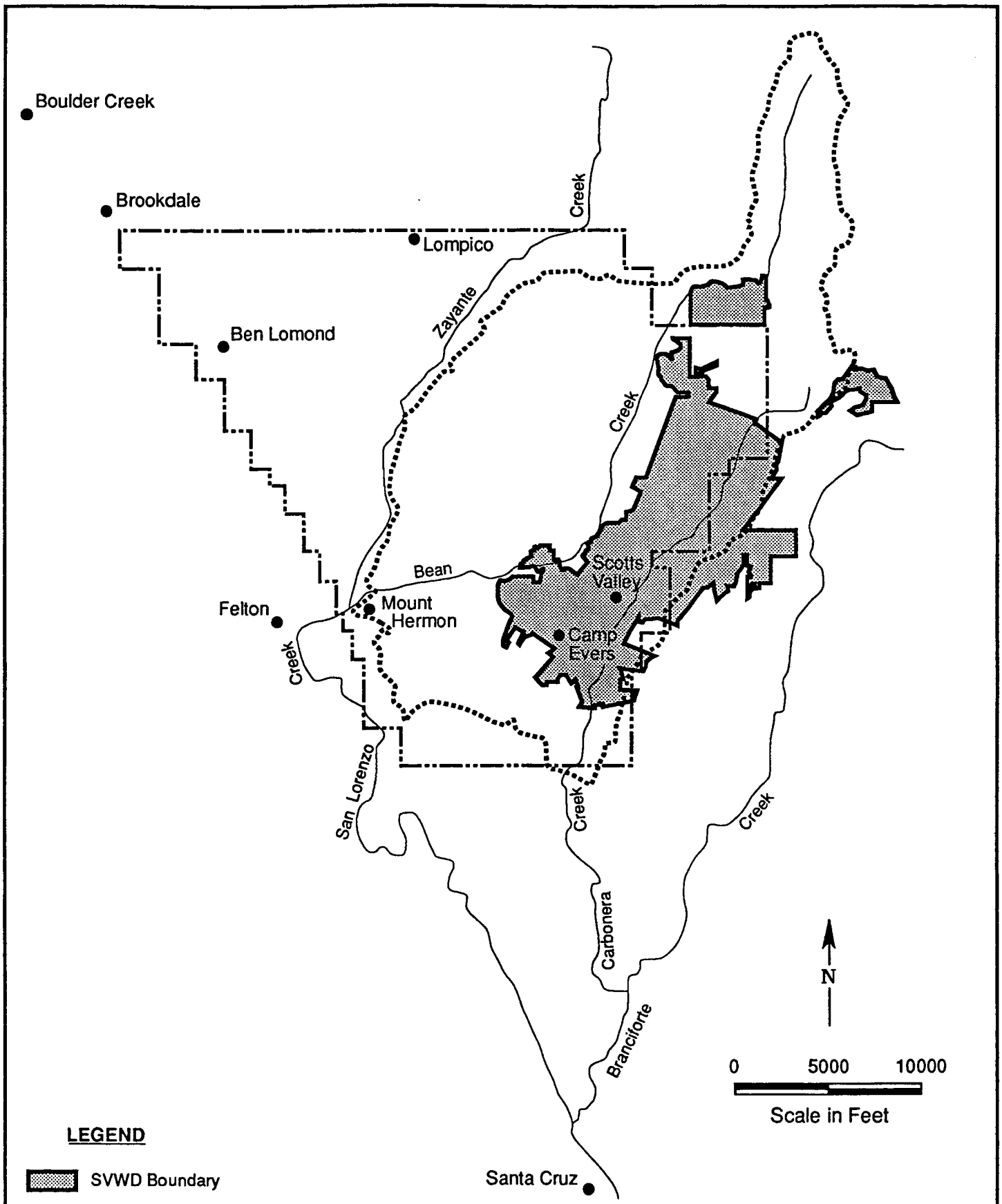
# INTRODUCTION

## 1.1 Background

The Scotts Valley Water District (SVWD) is a public agency responsible for management and supply of water to the Scotts Valley area. The SVWD service areas includes most of the City of Scotts Valley and some areas outside the city limits (Figures 1 and 2). The City of Scotts Valley is situated in the Santa Cruz Mountains along Highway 17 in Santa Cruz County, north of the City of Santa Cruz, California.

The Scotts Valley area is underlain by the Santa Margarita groundwater basin which was designated as a sole source aquifer by the U.S. Environmental Protection Agency (USEPA) in 1982. This means that the City of Scotts Valley and nearby communities use this aquifer as their sole or principal water supply. Therefore, it is deserving of special protection.

Extensive work toward groundwater management of the Scotts Valley groundwater basin (California Department of Water Resources, 1975) already has been accomplished. SVWD has directed a Water Resource Management Plan since 1983 (Todd Engineers, 1984-1994). In addition, a computer model of the basin was recently developed for a groundwater management study initiated by the Association of Monterey Bay Area Governments (Watkins-Johnson Environmental, Inc., September 1993). The adjacent San Lorenzo Valley Water District (SLVWD) also has conducted a program of groundwater monitoring and




**LEGEND**

- SVWD Boundary
- DKT 1987 Study Area for Perennial Yield
- AMBAG Model Boundary

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**Figure 1**
**Study Areas**

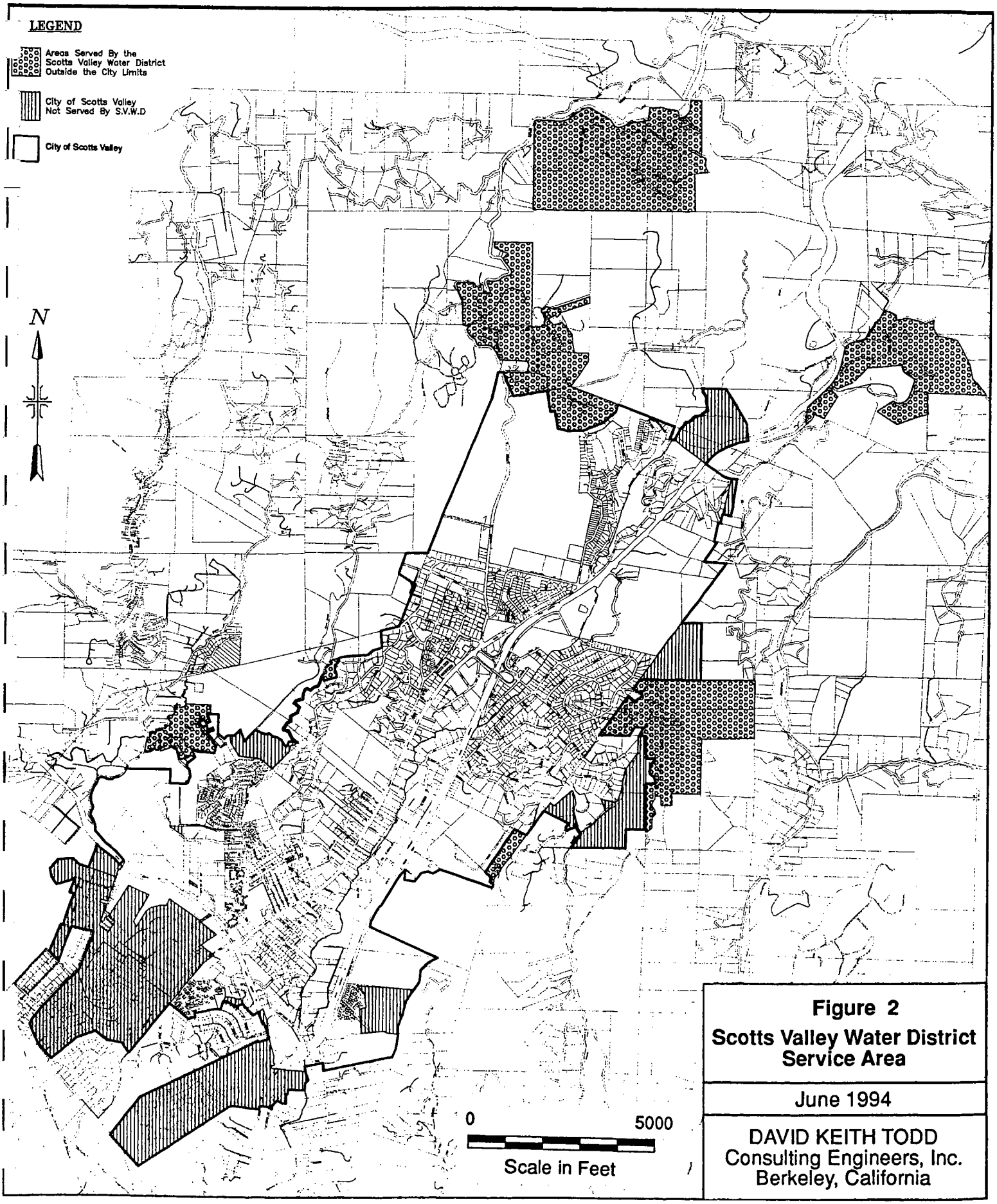


**Figure 2**
**Scotts Valley Water District Service Area**

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specific studies for its portion of the groundwater basin.

Assembly Bill 3030 (AB 3030), codified into law on January 1, 1993, permits local agencies to adopt significant programs to manage groundwater. The purpose of AB 3030 is to "encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions". Accordingly the bill outlines a procedure to develop a groundwater management plan for any local public agency that provides water service to all or a portion of its service area. In accordance with guidelines for the development of a groundwater management plan, a public hearing was held by SVWD on September 9, 1993 to declare their intention to develop a groundwater management plan.

## 1.2 Purpose

The purpose of this groundwater management plan is to address two major areas of concern in Scotts Valley: (1) management of groundwater supplies to meet present and future demands, and to provide for downstream water rights and instream uses; and (2) protection of water quality and remediation of existing groundwater contamination. By implementation of a groundwater management plan for Scotts Valley, SVWD hopes to preserve and enhance the groundwater resource in terms of quality and quantity, and to minimize the cost of management by coordination of efforts among agencies.

## 1.3 Scope

The area served by SVWD is the focus of this study. However, it is necessary in some cases to extend the field of study to areas surrounding SVWD boundaries in order to provide a meaningful discussion of hydrogeologic processes and to support basin management planning strategies. Three differing study areas are depicted on Figure 1. The shaded area is within SVWD boundaries while the dotted line outlines the study area defined for the Water Resources Management Plan, which includes hydrogeologically significant regions. The third area is the area encompassed in a groundwater flow model developed for the Santa Margarita basin (Watkins-Johnson Environmental, Inc., September 1993).

This groundwater management plan begins with a brief review of the current understanding of hydrogeologic conditions encountered in the Santa Margarita basin. These hydrogeologic processes influence groundwater recharge and flow patterns, and the potential for groundwater contamination. The plan then proceeds to focus on the management of groundwater supply and groundwater quality.

The groundwater supply section begins by evaluating the monitoring programs in the Water Resources Management Plan. Following this is a description of groundwater level trends and subsequent storage volumes in the Santa Margarita basin. The application and uses of the Santa Margarita groundwater basin flow model for simulating future scenarios is discussed. A section on groundwater replenishment discusses various options for direct or in-lieu groundwater recharge.

The discussion of groundwater quality focusses on: (1) documenting existing groundwater contamination and the status of remediation, and (2) prevention of groundwater contamination in the future. Several items are discussed under the topic of prevention including: hazardous materials management program, underground storage tank programs, well construction and destruction standards, septic systems, and city planning and zoning.

Finally, the conclusions reached in the study are presented. Recommendations for improved management of groundwater supply and quality are suggested.

### 1.4 Acknowledgements

A number of agencies have been helpful in providing information for this report including: the Scotts Valley Water District, the City of Scotts Valley City Hall, the Scotts Valley Department of Public Works, the Scotts Valley Fire Protection District, The Scotts Valley Building Department, the Santa Cruz County Health Department, the California Regional Water Quality Control Board, the State Water Resources Control Board, the State Department of Water Resources, the California Environmental Protection Agency Toxic Substances Control Division, and the U.S. Environmental Protection Agency.

This report was prepared by Iris Priestaf, Peter Leffler, Sally McCraven, and Katherine White under the supervision of David Keith Todd.

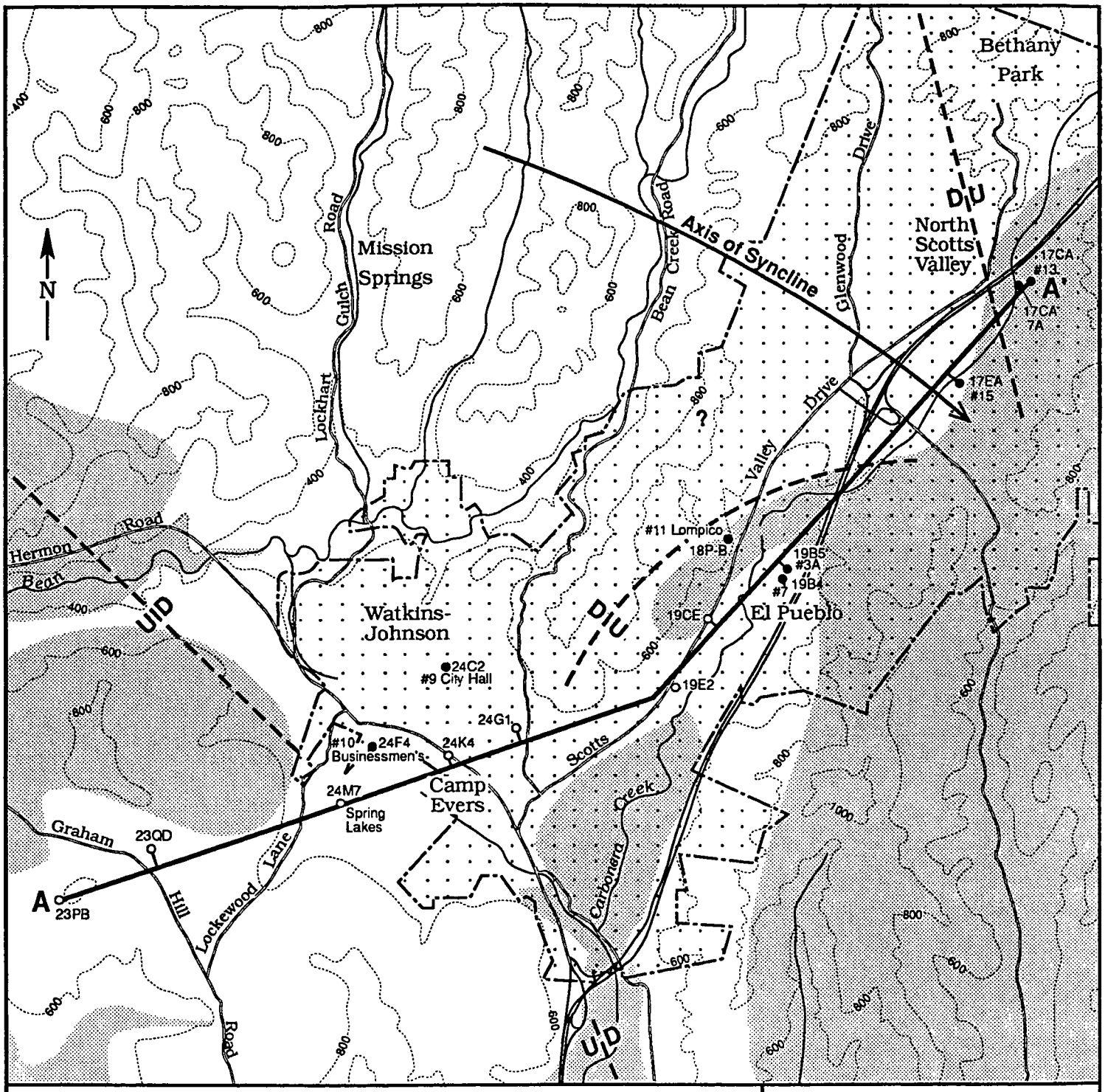
## Section 2

## HYDROGEOLOGY OF SCOTTS VALLEY

### 2.1 Geologic Units and Structure

A detailed geologic cross-section has been prepared trending northeast-southwest through the most developed portion of Scotts Valley (see Figure 3). This cross-section shows seven major geologic units (Figure 4). The oldest unit consists of pre-Tertiary age granite that underlies Tertiary sedimentary units and Quaternary alluvium in the region. The Lompico sandstone is a major unit in the area with thicknesses of up to several hundred feet. The Monterey shale overlies the Lompico and consists primarily of shale with sandstone interbeds in the lower portion. As shown on Figure 4, the thickness of the Monterey shale varies from locally absent or very thin (less than 20 feet) to as much as 600 feet. This variation is due to structural folding and faulting and erosion of the Monterey shale, resulting in a surface with considerable relief.

The Santa Margarita sandstone was deposited subsequently on top of the irregular Monterey shale surface. As a result, the Santa Margarita tends to thin markedly and locally pinch out in areas where the underlying granite or shale forms a relative "high". The thickness of Santa Margarita ranges up to 350 feet. Overlying the Santa Margarita in some areas is the Santa Cruz mudstone. Deposits of Quaternary alluvium are present in the major valleys.




## Legend

- ○ Well
- ● SVWD Production Well
- SVWD Boundary
- Unsaturated Santa Margarita Sandstone

Scale

0 2000 4000 feet

**Figure 3**
**Cross Section A - A'**
**Location Map**

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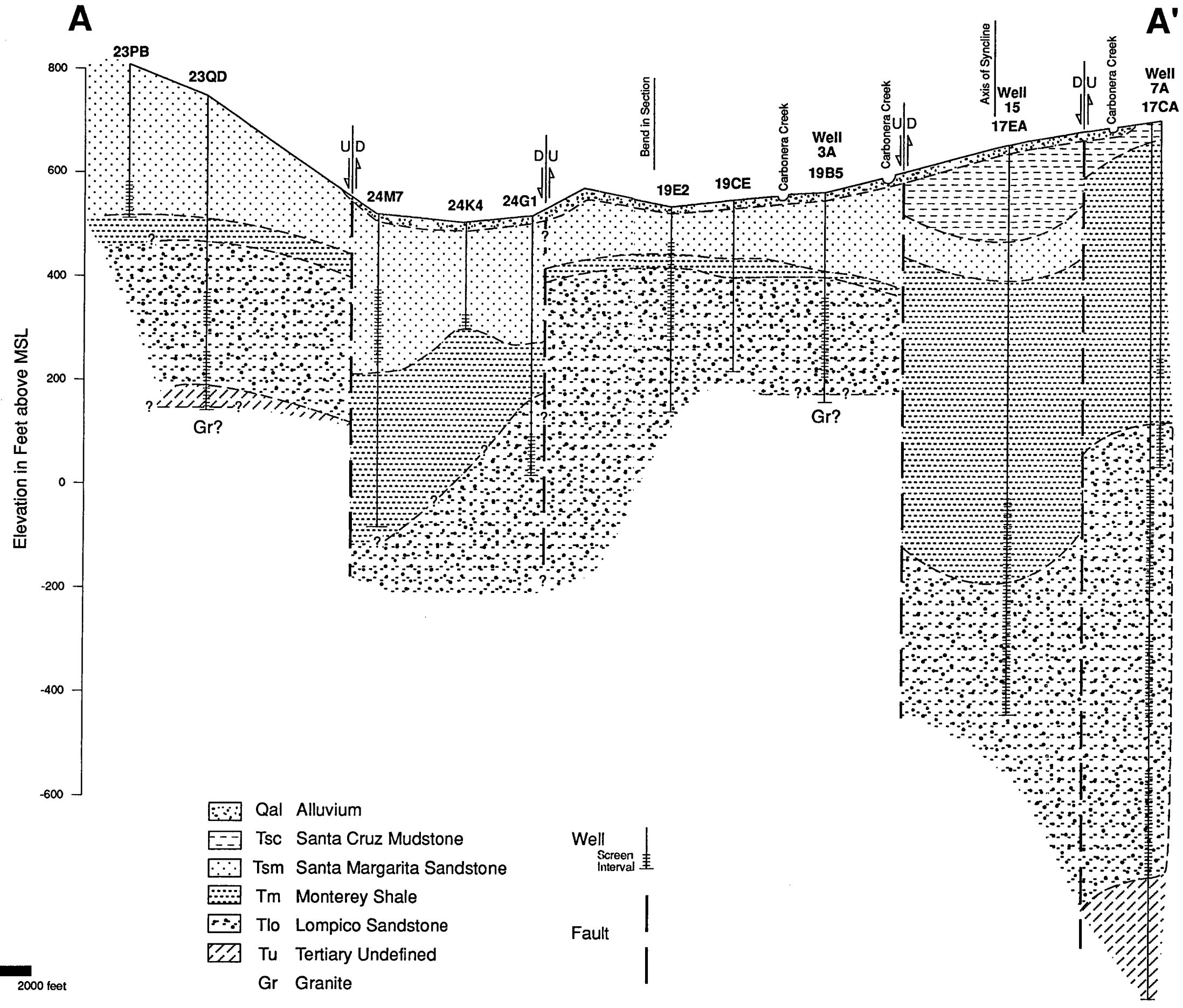


**Figure 4**
**Cross Section**
**A - A'**

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The major geologic structure in the area is Scotts Valley syncline, a gentle geologic downwarp that extends from Boulder Creek eastward through Scotts Valley. The syncline is characterized by gently dipping beds (0 to 6 degrees) on the south limb of the syncline and slightly steeper dips (0 to 20 degrees) on the northern limb. In the Scotts Valley area, the syncline becomes increasingly deep, and apparently flattens out to the east.

The location of the syncline is shown on Figure 3. In addition, the syncline is portrayed on Figure 4 as the downwarped geologic layers. As indicated, this downwarping has resulted in accumulation and preservation of the thickest part of the geologic formations along the synclinal axis with thinning along the limbs of the fold. This is particularly noticeable for the Monterey shale. Gentle folding in the overlying Santa Cruz mudstone indicates continued downwarping.

As indicated on Figure 4, the Scotts Valley syncline in this area is apparently broken by the two unnamed faults, which occur on either side of the syncline. The down-thrown side of each fault is located towards the synclinal axis, resulting in a down-thrown block. In addition, a second faulted and down-thrown block is apparent in the Camp Evers area. These faults significantly influence the thickness of the Monterey shale and depth to the Lompico sandstone. As shown, the down-thrown blocks are characterized by the thickest Monterey shale and the greatest depth to the Lompico sandstone. The up-thrown blocks are characterized by more extensively eroded and thinner Monterey shale and shallower

depths to the Lompico sandstone.

## 2.2 Hydrogeology

In essence, the Scotts Valley groundwater basin is like a bowl or bathtub, rimmed by granitic rocks and filled with sandstone and shale layers which contain groundwater. The two major aquifers in Scotts Valley are the Santa Margarita sandstone and the Lompico sandstone. Local groundwater exhibits unconfined conditions in the Santa Margarita aquifer, and semiconfined to confined conditions in the underlying Lompico sandstone. The two major aquifers are generally separated from each other by varying thicknesses of the Monterey shale. However, locally the Monterey shale is absent and the two sandstone units are not separated.

The Santa Margarita sandstone receives recharge from rainfall and streamflow where it crops out at the surface, plus subsurface inflow from overlying formations. The Monterey and Lompico formations are recharged at outcrops in northern portions of the basin, and also receive groundwater from overlying units.

According to groundwater level and flow maps, groundwater flow generally is from recharge areas toward Bean Creek, which serves as the basin's outlet. Available data suggest no other significant outlets except pumping wells, which have substantially altered local groundwater flow patterns. Carbonera Creek does not intersect the water table, and water table contours do not suggest subsurface outflow through the granitic rocks.

In recent years considerable hydrogeologic exploration and

assessment has been accomplished by SVWD, SLVWD, and private groundwater users. As a result, much valuable information now is available on the hydrogeology of the southeastern, southwestern, and western margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

The hydrogeologic investigations have revealed that the areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited. In such a situation, effective groundwater basin management must be based on extensive groundwater exploration and comprehensive but detailed hydrogeologic investigations. In the future, groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

## Section 3

## GROUNDWATER SUPPLY

### 3.1 Current Monitoring Programs

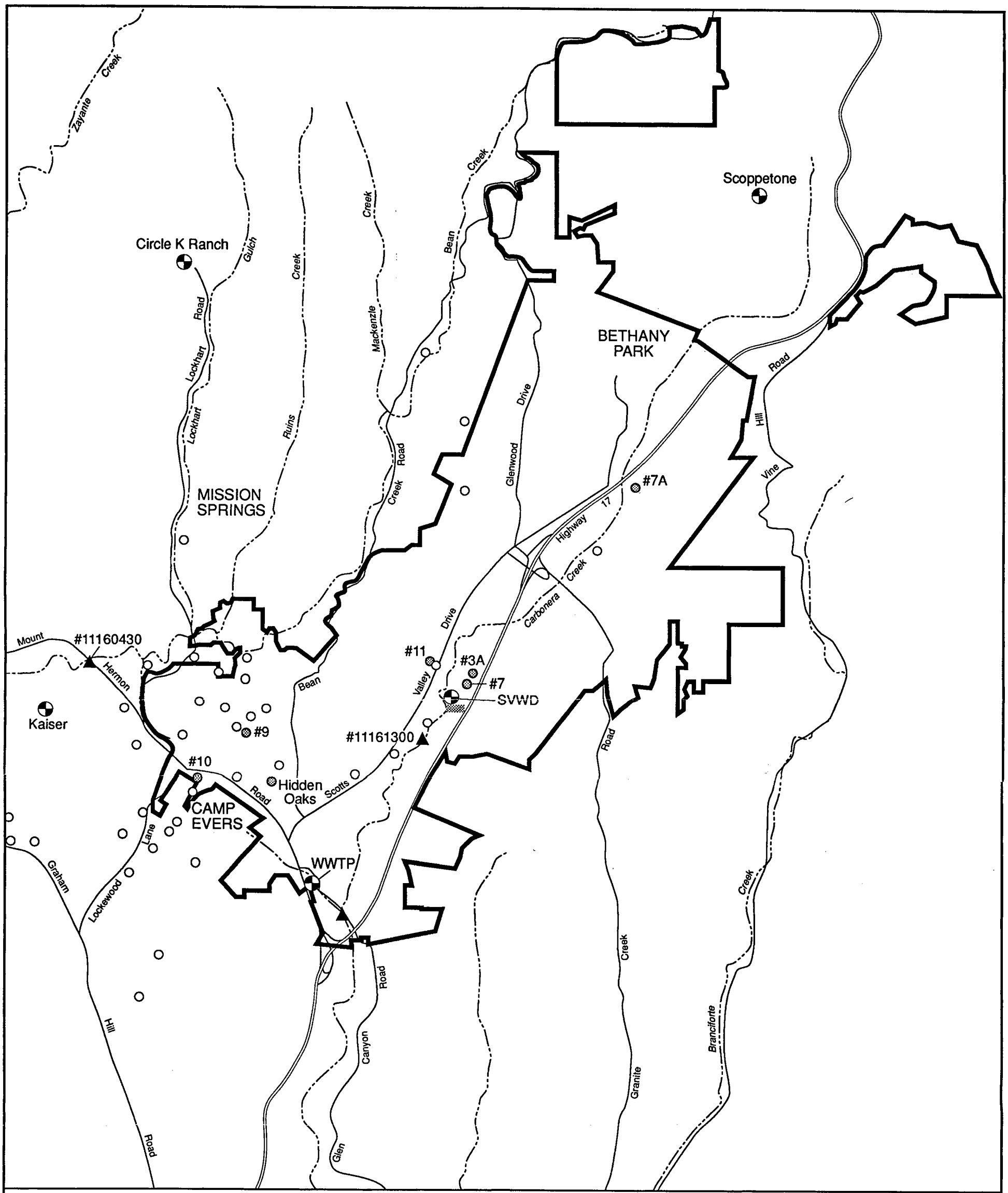
Todd (1980) defines a monitoring program as a scientifically designed surveillance system of continuing measurements, observations, and evaluations. As part of the Scotts Valley Water Resources Management Plan, SVWD maintains a comprehensive monitoring program to protect the long-term supply and quality of groundwater. Results of these monitoring programs are analyzed and presented in annual reports (Todd Engineers, 1984-1994). The current program includes collection of groundwater level data from over 40 wells and collection of water quality and pumpage data from SVWD wells. In addition, there are three streamflow gages, five rainfall gages, and one evaporation measurement station. Drillers logs of wells have been compiled for most of the Scotts Valley and surrounding area with over 400 wells identified and located on a base map. Locations of notable monitoring sites are depicted on Figure 5 while Table 1 is a summary of current Scotts Valley monitoring programs. These programs are described briefly below.

**Precipitation.** Precipitation is recorded automatically at least every 15 minutes at the El Pueblo Yard and at the City of Scotts Valley wastewater treatment plant (WWTP). The El Pueblo Yard gage has been in operation since 1985. Previously, a bucket gage was in operation at the El Pueblo facility between 1981 and

# TABLE 1
# SUMMARY OF SCOTTS VALLEY MONITORING PROGRAMS

| MONITORING TYPE | LOCATION | MEASUREMENT TYPE | DATE STARTED | FREQUENCY/ MAINTAINER | HISTORIC MONITORING |
|---|---|---|---|---|---|
| PRECIPITATION | El Pueblo Yard | 15–minute recording | Feb. 1985 | Daily/District, Monthly/City | OTHER HISTORIC GAGES:<br>1) Blair site on Granite Ck. Rd. (Jan. 1975–Dec. 1980)<br>2) Hacienda Dr. (Jul. 1974–Mar. 1979)<br>3) El Pueblo Yard bucket gage (Jan. 1981–Jan. 1985) |
| | WWTP | 5–minute recording | 1990 | Daily/City | |
| | Kaiser Sand and Gravel Co. | Bucket | Mar. 1985 | Varies/Kaiser | |
| | Carbonera Ck. headwaters @ Scoppetone property | Bucket | Apr. 1985 | Varies/Scoppetone | |
| | Near Lockhart Gulch @ Fabrin's Circle K | Bucket | Mar. 1985 | Varies/G.W. Fabrin | |
| EVAPORATION | El Pueblo Yard | Pan | Jan. 1986 | Daily/District | Evaporation pan raw data not compiled after Jul 1990 |
| STREAMFLOW | Carbonera Ck. at Scotts Valley @ Carbonera Way Bridge (#11161300) | 15–minute recording | Jan. 1985 | Daily/USGS | OTHER HISTORIC GAGES:<br>1) Carbonera Ck. @ Santa Cruz (#11161400) 250 feet upstream from mouth (1974–1976 partial data)<br>2) Bean Ck. near Felton (#11160320) (1973–1978 partial data), low flows at same location (1983–1988) |
| | Carbonera Ck. @ Glen Canyon | 5–minute recording | 1990 | Monthly/City | |
| | Bean Ck. near Scotts Valley @ Mt. Hermon Crossing (#11160430) | 15–minute recording | Dec. 1988 | Daily/USGS | |
| WELL INVENTORY | T10/R01 Sections 6–9, 16–20, 30 and T10/R02 Sections 1, 11–14, 23–26, 36 | Over 400 wells: location, log, type, capacity, etc. | 1950's | Logs from California DWR and others | – |
| GROUNDWATER LEVELS | ~41 Santa Margarita aquifer and ~7 Lompico formation wells | Depth to water | 1968 | At least quarterly/ District and others | Data from over 75 wells, as early as 1968, bi–monthly 1983–1989 |
| PUMPAGE | District wells in production and on standby | Metered, compiled monthly | 1975 | Monthly/District | Additional pumpage from other wells |
| GROUNDWATER QUALITY | District wells in production and on standby | Title 22 constituents | 1963 | At least semi–annually/ District and others | Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program |
| WASTEWATER OUTFLOWS | City of Scotts Valley WWTP @ Lundy Lane | Wastewater outflow volume and effluent quality | 1965 | Daily/City | Plant operational in 1965 (Septic systems pre–1965) |

REF: Todd Engineers (1993)
Todd Engineers (1989)
Todd Engineers (1988)
Handwritten monitoring notes from SVWD on El Pueblo evaporation pan and Kaiser, Scoppetone, and Fabrin rain gages
Water Quality data sheets from various laboratories




**LEGEND**

- Scotts Valley Water District Boundary
- Stream Gage
- Precipitation Gage
- Evaporation Gage
- Groundwater Level Well
- SVWD Production Well

N

0 2000

Scale in Feet

**Figure 5**
**Monitoring Locations**

June 1994

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1985. Before 1981, rainfall was measured at the Blair site on Granite Creek Road and along Hacienda Drive. The WWTP gage has been in operation since 1990. The rain gages at the El Pueblo Yard and WWTP are also read manually once a day by SVWD or City of Scotts Valley staff, respectively. Manually read data are kept on file at the yard or WWTP, while electronic data are sent to the local consulting firm of Linsley, Kraeger Associates. Data have not been compiled since 1993 due to lack of funding.

In addition, three bucket rain gages have been maintained since 1985 at the Kaiser Sand and Gravel site (Kaiser), on the Scoppetone property near the headwaters of Carbonera Creek, and at the Fabrin's Circle K Ranch near Lockhart Gulch.

**Evaporation.** An evaporation pan has been maintained at the El Pueblo Yard since 1986. Current data have not been compiled into useable form because of lack of funding.

**Streamflow.** Two streamgages are monitored in cooperation with the United States Geological Survey (USGS); SVWD provides the funding for gage installation and maintenance. One gage is located on Carbonera Creek at the Carbonera Way Bridge (USGS #11161300) and was installed in early 1985. It has a punch paper tape and records water levels every 15 minutes. The other gage is on Bean Creek at the Mount Hermon crossing (USGS #11160430) and has been in operation since late 1988.

A third gage is located on Carbonera Creek at Glen Canyon. Data for this third gage are recorded every 5 minutes and manually read once a month by City of Scotts Valley staff. Data recorded at this gage has not been compiled because of lack of funding.

**Well Inventory.** Over 400 water well drillers' reports have been compiled from the California Department of Water Resources (DWR) and other sources. These wells are located throughout the Scotts Valley area. Compiled well data include location, well log, well use, capacity, depth, and ground surface elevation. It should be noted that these wells include all those drilled historically, many of which are now unused.

**Groundwater Levels.** The groundwater level monitoring program has included SVWD wells, SLVWD wells, other municipal wells, monitoring wells, and private wells. Between 1983 and 1989 groundwater levels were measured every two months. In 1989 it was determined that static groundwater levels and regional flow patterns did not change significantly over a two-month period, and that measurements of water levels on a quarterly basis would be sufficient. Consequently, water level measurements are taken on or about the first day of January, April, July, and October. Data are compiled into computer databases by Todd Engineers and made available to SVWD.

Water level contour maps are prepared for autumn and spring conditions for the regional Santa Margarita aquifer and for the

Lompico Formation; spring maps are presented in annual reports. Wells used to produce the Santa Margarita aquifer and the Lompico Formation water level contour maps are shown on Figure 5.

**Pumpage.** Pumpage is recorded daily for operating SVWD wells, and compiled on a monthly basis for management purposes. Available pumpage information from SLVWD is also compiled.

**Groundwater Quality.** Currently, groundwater quality samples are collected from SVWD wells in production and on standby as shown on Figure 5. These pumping wells are generally sampled semi-annually or more frequently if constituents of concern are detected.

Historically, analyses from over 80 wells are available in the database. Selected sites were originally sampled bi-monthly and analyzed for nitrate, chloride, and total dissolved solids (TDS). Due to the slow rate of change typical of groundwater quality and lack of significant regional trends, this program was revised in 1989 to focus on SVWD wells. Groundwater is sampled for the constituents required by Title 22, California Administrative Code, Chapter 15. Analyses include: general mineral, physical, inorganic, radiological, bacteriological, and regulated and unregulated organics. Since 1982 groundwater from the SVWD wells has also been analyzed for volatile organic compounds (VOCs).

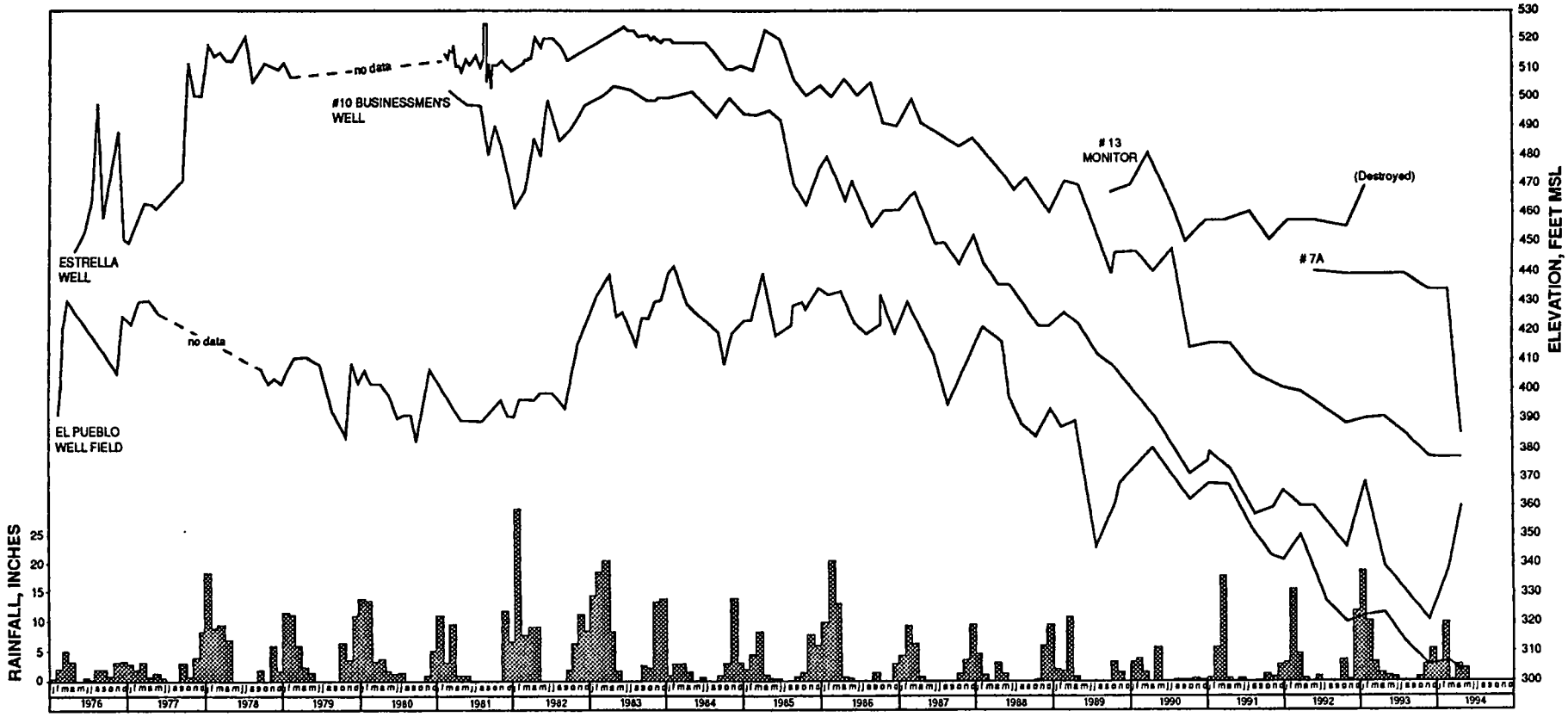
**Wastewater Outflows.** Data are available from the City of Scotts Valley on wastewater outflow volumes and effluent quality; monthly flow data are compiled.

**Recommendations**

- The groundwater level and quality monitoring network is comprehensive and provides good areal coverage of Camp Evers and Scotts Valley. Accordingly it should be continued. Monitoring sites are relatively few and far between in the northern half of the study area and along the eastern margin; however, additional test or monitoring wells are planned for the latter area (see Figure 5).
- The quarterly groundwater level measurements should be coordinated so that they are conducted within a small time period, such as a week.
- Monitoring programs should be flexible and open to supplementary frequency and locations to document or understand site specific occurrences such as recharge rates or potential groundwater contamination.
- Data sharing with other agencies should continue and improve, and the processing of rainfall, evaporation, and streamflow data should be encouraged.

## 3.2 Groundwater Level Trends

Figure 6 depicts water level trends (hydrographs) for select wells in the vicinity of SVWD. The wells depicted on the figure




June 1994

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**Figure 6**
**Water Level Trends in Selected Wells**

are El Pueblo Well 7, Businessmen's Well 10, monitoring Well 13, Well 7A, and the Estrella well which is not within SVWD boundaries. Seasonal fluctuations can be seen in these curves, with higher water levels in late winter and spring and lower levels in summer and fall. It is apparent from the figure that water levels have been steadily declining since the mid-1980's. The sharpest decline has occurred in Businessmen's Well 10 in the Camp Evers area, where levels have dropped over 150 feet between 1985 and 1993. Water levels have been recovering in this well since January 1994 because pumpage has been shifted to other SVWD wells, particularly Well 7A. El Pueblo wellfield and Estrella well water level elevations have both dropped over 100 feet since 1987. These three wells are in developed portions of the basin while monitoring Well 13 (destroyed) and Well 7A are in the less developed northern area. Recent water levels in Well 7A have declined sharply due to a shift of pumpage from the developed areas (Camp Evers area) to Well 7A.

A bar graph on the bottom of Figure 6 indicates the monthly Scotts Valley rainfall measured at the El Pueblo Yard. Comparison of the bar graph with the water level hydrographs demonstrates that periods of high rainfall cause water levels to rise while, conversely, periods of low rainfall or drought result in declining water levels. Clearly, the drought that occurred from the mid-1980's to the early 1990's contributed to the declining water levels due to less recharge and increased pumpage. However, the 1992-1993 rainfall season was marked by rainfall of 50 inches or

125 percent of average. Although this rainfall resulted in seasonal recovery of water levels in wells, the longer term effect was only a moderation of the extent and severity of the area's localized water level declines. This indicates that in the past decade the predominant factor in groundwater levels in the Camp Evers and Scotts Valley Drive areas is groundwater pumpage and not recharge.

As documented in the 1993-1994 Water Resources Management Plan (Todd Engineers, June 1994), baseflows of Bean Creek showed a noticeable response to the increased rainfall of the 1992-1993 season, despite the continued groundwater level declines in the Camp Evers area. This suggests that the baseflow (as measured at the Mount Hermon crossing) is maintained primarily by groundwater inflow from the northern part of the basin. In the short term, the intensive pumpage in the Camp Evers area has resulted primarily in localized groundwater storage depletion and not in depletion of stream baseflows.

Increased pumpage, reduction of recharge, and drought conditions have resulted in groundwater declines since the mid-1980's and the subsequent repercussions listed below.

- Water levels have dropped below well screens causing some shallow wells to dry up.
- Well screens across upper aquifers (i.e. Santa Margarita aquifer) are exposed when the aquifer locally goes dry.
- Well efficiency decreases due to pumping groundwater from deeper and less permeable aquifers.

- Groundwater quality may decline as a result of extracting water from a deeper aquifer of poorer quality.

Previous reports by Todd Engineers have concluded that despite localized groundwater declines, the groundwater basin as a whole is not in overdraft. This was corroborated by an extensive regional groundwater study, Santa Margarita Ground-Water Basin Management Plan (Watkins-Johnson Environmental, Inc., September 1993). This investigation considered an area of 111 square miles in the San Lorenzo River watershed, focusing on Scotts Valley, and entailed development of a computerized groundwater model of the Santa Margarita, Monterey, and Lompico aquifers. The report states that the groundwater basin is not considered to be in overdraft, and concluded that the safe yield of the basin may be defined as maintenance of flow in Bean Creek. Although streamflows are quite low because of the past drought, the long-term safe yield has not been exceeded.

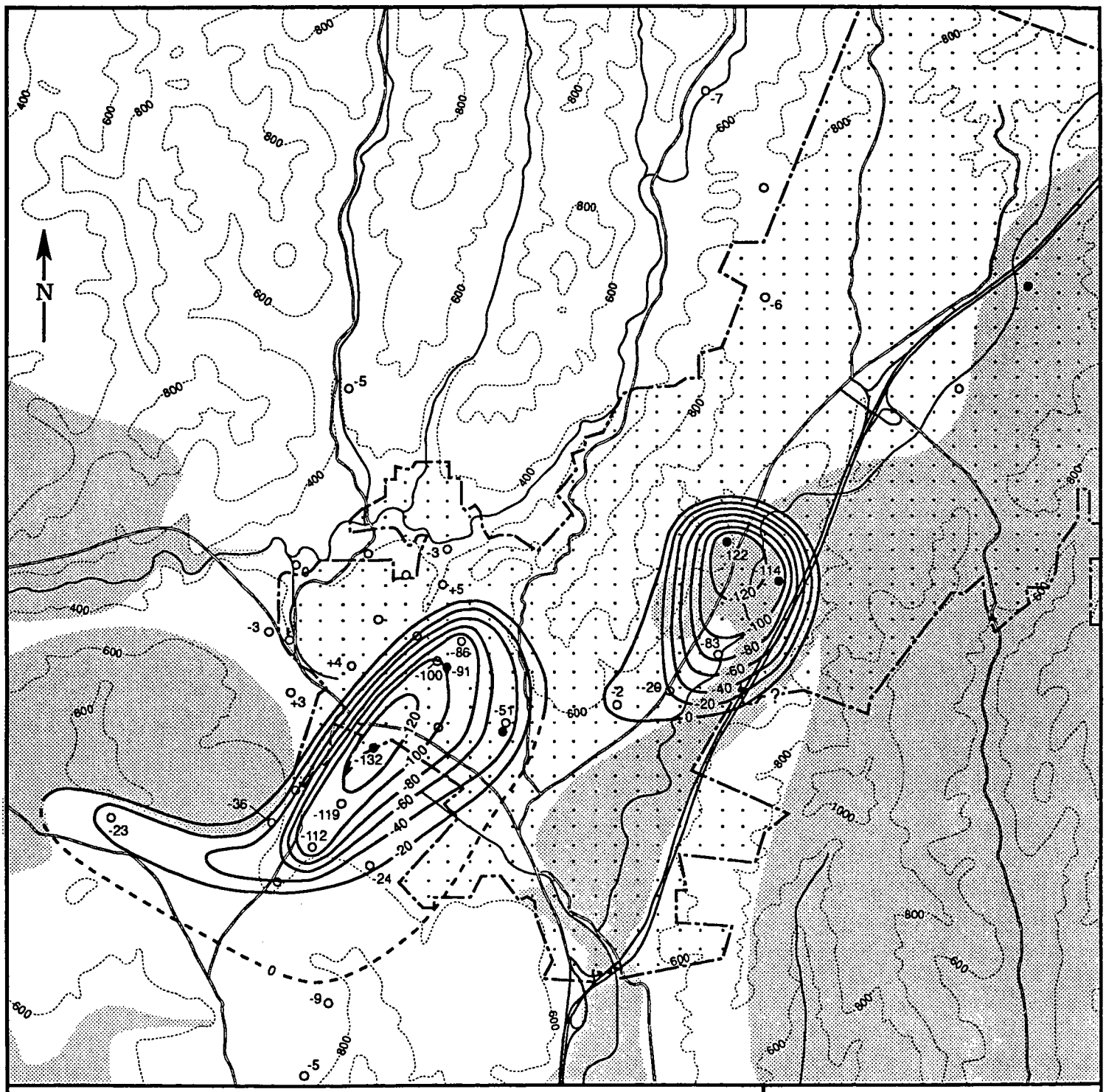
### 3.3 Perennial Yield and Groundwater Storage

The perennial yield is defined as the rate at which water can be withdrawn perennially under specified operating conditions without producing an undesired result (Todd, 1980). Perennial yield was estimated at about 4,200 acre-feet per year (AFY) for the area within the dotted line on Figure 1 (Todd Engineers, 1987). The area used for the 4,200 AFY estimate is approximately three times the area within SVWD boundaries. Note that a constraint on available groundwater is the quality of the water and the presence

of contaminants in groundwater. Persistent contamination can not only limit the usable storage capacity of the aquifer and circumscribe areas of groundwater development, but also can adversely affect significant recharge areas. It should also be noted that perennial yield was estimated as an average annual value, and does not take into account annual or short-term variations in rainfall. Given the variability of rainfall and recharge in recent years, consideration should be given to a more detailed perennial yield study that would evaluate the effect of varied rainfall on groundwater recharge.

Figure 7 documents change in groundwater levels over the seven years between April 1986 and April 1993. Wells used to prepare the contour map are indicated with a solid black dot with a groundwater level change number by the well. The pattern of groundwater level decline is similar to annual water level declines depicted in Todd Engineers yearly management plan reports, although the magnitudes of the declines are greater. Minimal groundwater level changes have occurred throughout most of the area, with localized declines in the areas where flow converges into major pumping wells in the Scotts Valley Drive/El Pueblo area and Camp Evers area. Groundwater levels changes for the seven year period are on the order of 120 feet in the center of these depressions. Several minor isolated groundwater level changes have occurred outside these major depressions and are indicated but not contoured on the figure.

A storage volume change can be calculated by measuring the




**Legend**

- Well
- SVWD Production Well
- -20 Contour in feet (change)
- SVWD Boundary
- Approximate Area of No Saturated Santa Margarita Sandstone

Scale

0 2000 4000 feet

**Figure 7**
**Water Level Change**
**April 1986 - April 1993**

**June 1994**

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volumetric change in groundwater between April 1986 and April 1993. Assuming a storage coefficient of 0.12, the amount of storage depletion was approximately 4,152 acre-feet (AF) or an average of 593 AFY over the seven year period. A loss of 565 AF was calculated for the storage depletion between April 1993 and April 1994 (Todd Engineers, June 1994). Thus, approximately 500 to 600 AF have been lost from groundwater storage each year since the mid-1980's. It should be noted that this change in storage has been computed using a consistent methodology as in previous years. However, estimates of total groundwater storage and change in storage should be revised to take into account increased knowledge of the extent, depth, and storativity of the Lompico aquifer and to take into account the decline in some areas of groundwater levels from the Santa Margarita aquifer into the Lompico aquifer.

Available water stored in the Santa Margarita has been estimated at 43,460 AF (Todd Engineers, 1987). Previously, a slightly larger value was used, but was revised following improved mapping of water levels in the vicinity of the Grace Way monitoring well. Thus, using the groundwater storage depletion number calculated above (4,152 AF), approximately 9.6 percent of the total storage volume has been depleted between April 1986 and April 1993.

### 3.4 AMBAG Model

A proposed management plan for the Santa Margarita groundwater basin was developed by Watkins-Johnson Environmental, Inc. for the Association of Monterey Bay Area Governments (AMBAG) (Watkins-

Johnson Environmental, Inc., September 1993). The purpose of the plan was to coordinate users of the Santa Margarita groundwater basin, establish groundwater and streamflow resource management, and prevent groundwater pollution.

A major accomplishment of the plan was development of a groundwater flow model for the Santa Margarita basin. This model can be used to study the effects of possible future development and environmental stresses on the groundwater basin. The model area of 24.3 square miles encompasses the Santa Margarita aquifer and major portions of the Monterey and Lompico aquifers as depicted on Figure 1 (Watkins-Johnson Environmental, Inc., July 1993). The model is a modified version of MODFLOW, developed by the USGS and simulates groundwater flow in the three aquifers (three layers). The model was calibrated using 1986 water levels and verified with 1991 data.

**Model Simulations.** The model was used to study the four simulations listed below.

- 5 years additional drought (60 percent recharge) and 1992 pumping.
- 5 years normal recharge and 1992 pumping.
- 5 years normal recharge, 1992 pumping quantities with a shift of pumpage to Well 7A.
- 25 years drought (80 percent recharge), increased pumpage of wells in simulation above for the estimated population in 2015 (almost 30 percent increase from 1993).

Results of these simulations indicate that pumping and drought

conditions have resulted in declining water levels and reduction of stream baseflow. Although the basin is not considered to be in overdraft, declining surface water quantities and future groundwater levels are a concern. The above scenarios also indicated that it would be advantageous to extract future groundwater from the Lompico aquifer rather than the Santa Margarita aquifer. The worst case simulation indicated that surface water flow would be substantially reduced and additional wells would need to be dispersed across the basin to support the estimated 2015 population due to a greater area of the Santa Margarita aquifer going dry.

**Limitations.** The MODFLOW program is widely used and accepted, and has been applied to the Santa Margarita basin with diligent regard for the considerable complexity of the groundwater basin. However, a model can only reflect data available at the time it was written. For example, the eastern boundary of the model was simulated as a groundwater divide between the Santa Margarita and Soquel-Aptos groundwater basins. However, the Lompico aquifer extends into the Soquel-Aptos basin in the area of Blackburn Gulch. To properly simulate the pumping of new wells in this area it may be necessary to revise the model by extending it to the east or changing the boundary conditions to reflect the possible influence of the adjoining groundwater basin.

General model limitations are listed in the Santa Margarita Groundwater Basin Management Plan report (Watkins-Johnson

Environmental, Inc., September 1993). These limitations include the problems inherent in the simplification, interpretation, and limited availability of field data. For instance, a single transmissivity value was used for the Lompico aquifer and a few average values of transmissivity were used for the Monterey aquifer. Future, more detailed transmissivity data could be incorporated into the model in the future, although the model would need to be recalibrated at that time.

**Recent Simulations.** Pre- and post-processor programs (MODEDIT and MODPOST) allow some modification of the program data packages, such as model timing for transient simulations, well locations and pumping rates, recharge rates, and solution criteria (i.e. how refined the solution will be). For example, the model can be used to simulate the effect of new wells or changing pumping rates of existing wells, various droughts, and/or changes in recharge.

Todd Engineers modified the program to run the four preliminary scenarios listed below.

- 6 years drought (60 percent recharge) and 1992 pumping.
- Same as above with one additional year of drought at 80 percent recharge.
- 5 years drought (80 percent recharge), drought pumping, 1986 starting heads, and Well 7A pumping at 32,000 cubic feet per day ($ft^3/d$).
- Same as above with estimated Lompico fault location simulated as a barrier.

Preliminary results indicate that the pumping of Well 7A at 32,000 $ft^3/d$ (500 gallons per minute for 8 hours per day) did not appreciably increase drawdowns, although it is near the eastern edge of the model. Insufficient hydrogeologic data exist for this boundary; therefore the accuracy of the model response to pumping in this area is questionable. The simulated Lompico fault caused water levels to deepen on the southeast side of the fault resulting in greater groundwater drawdowns in the El Pueblo area.

In summation, the model can be used to observe effects of proposed well locations and pumping configurations, consequently aiding in optimization of the distribution of pumping. The model also would be useful in regional assessment of proposed replenishment or recharge projects. The AMBAG model is not designed for contaminant transport; nonetheless a program called MT3D, developed by S.S. Papadopulos & Associates, Inc. can be used to model migration of dissolved substances in groundwater. MT3D utilizes MODFLOW groundwater level output and simulates contaminant transport taking into account advection, dispersion, and chemical reactions. Other codes, such as MODPATH and PATH3D, are designed for three dimensional particle tracking and can use groundwater levels from MODFLOW. These model codes can be used to track a contaminant "particle" back to its source or forward in time to a future position. The usefulness of these programs is limited to the availability and reliability of the hydrogeologic and chemical data for the area of interest.

**Recommendations**

- When additional hydrogeologic data become available, modifications to the basic model should be made, such as simulation of the presence of a fault in the Lompico formation northwest of the El Pueblo well field.
- Future model revisions should extend the model eastward to more accurately simulate the effects of pumping wells in that area.
- Current production data should be incorporated into the model.

## 3.5 Pumpage

The localized decline of groundwater levels raises concern about overall groundwater supply and the risk of overdraft. Previous groundwater studies conducted for SVWD have indicated that the groundwater basin is not in overdraft. This conclusion also was reached by the recent Santa Margarita aquifer study sponsored by AMBAG. However, this study rightly noted the need to update the amount of groundwater use. Accordingly, this section summarizes the updated inventory of wells and amount of groundwater production, and discusses groundwater consumption.

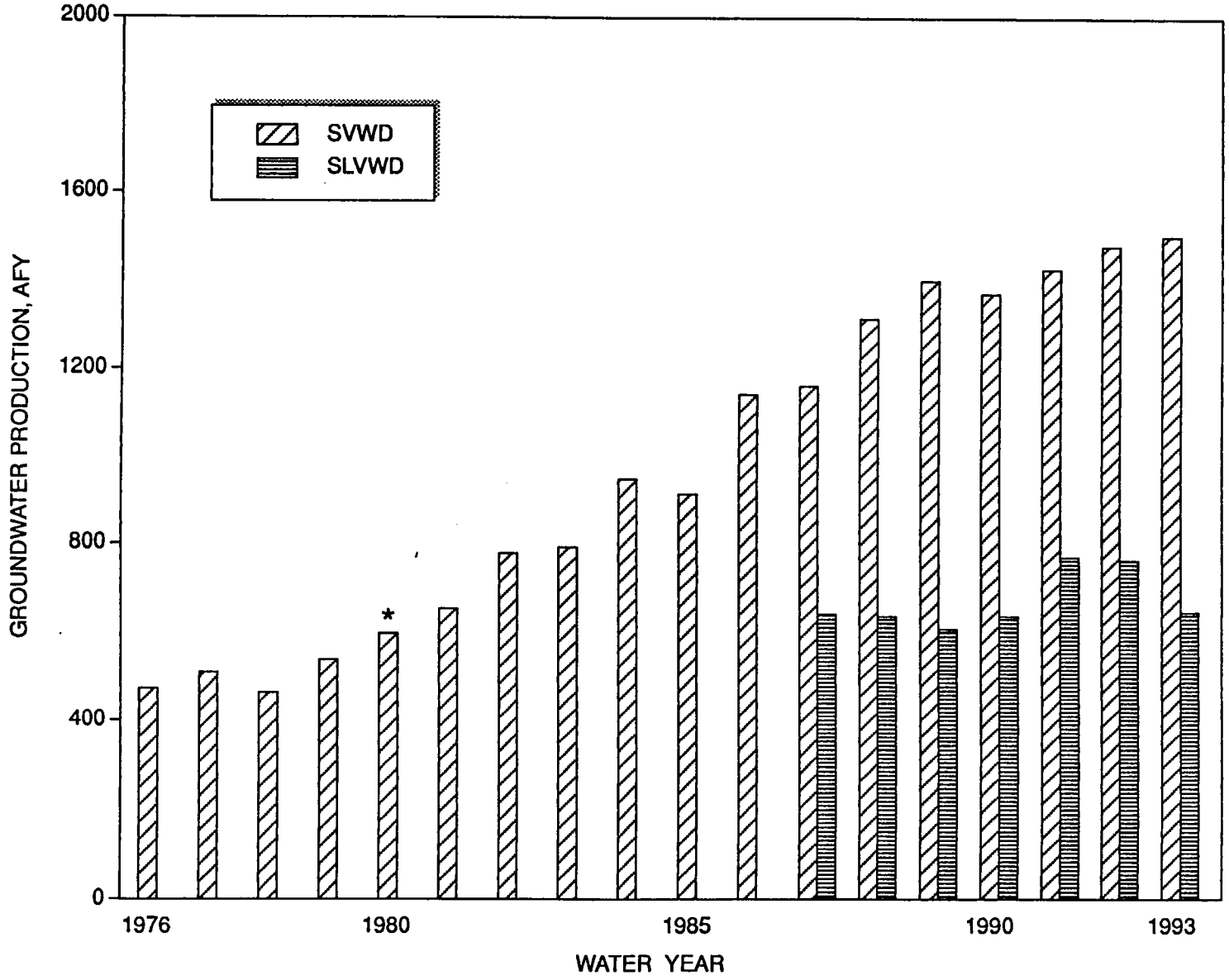
**Well Inventory.** The well inventory has been updated recently, as summarized in the 1994 annual report for the Water Resources Management Plan (Todd Engineers, 1994). This inventory was based largely on water well drillers' reports filed with the DWR. Accordingly, it provides only an approximation of wells currently

in use. The actual number of wells could be greater, because water well drillers' reports may not have been filed for all wells. Conversely, the number of wells in use could be smaller, because information on abandonment of wells is lacking.

Review of the database, which includes wells drilled as early as the 1950's, indicates that well drilling activities peaked in the 1970's and have since declined. In the 1970's, well drillers' reports were filed for production wells at rates exceeding 20 per year. During the 1980's and early 1990's, these rates declined to less than 10 per year.

The inventory indicates that over 400 known wells have been drilled in the Scotts Valley groundwater basin in addition to the numerous (over 70) monitor wells drilled at the Watkins-Johnson site. Of the 400, approximately 260 wells have been drilled for domestic purposes. Other use categories include wells drilled for municipal supply, landscape irrigation, industrial and commercial purposes, and groundwater remediation.

**Groundwater Pumpage.** Actual groundwater production data are available only for SVWD, SLVWD, Mount Hermon water system, and Watkins-Johnson remedial wells. Mount Hermon's groundwater production from both springs and wells amounted to 145 AF in 1993 (R. Jones, personal communication). The remedial pumpage amounts to about 200 AFY (Watkins-Johnson, Environmental, Inc., 1994). Historic groundwater production by the two districts is illustrated on Figure 8.




* Estimated

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**Figure 8**
**Groundwater Production**
**SVWD 1976 - 1993 and**
**SLVWD 1987 - 1993**

Data are available for SVWD from 1976 to present; note that groundwater pumpage in 1980 was estimated because of meter failure in that year. SLVWD data currently are being processed into an easily accessible, computerized form; and are available from 1987 to present. As indicated, SVWD groundwater pumpage increased 2.6 times from 537 AFY in 1979 to 1,400 AFY in 1989. However, in recent years, the rate of increase has slowed. In 1993, SVWD groundwater pumpage amounted to 1,505 AF.

SLVWD operates three well fields, including two in the Scotts Valley groundwater basin--the Olympia well field located near Zayante Creek and the southern wells, notably the Pasatiempo wells near Graham Hill Road. The third well field, Quail Hollow, was not considered here. As shown on Figure 8, groundwater pumpage by SLVWD from the Olympia and Pasatiempo wells during the past seven years has been fairly steady, averaging 675 AFY. In water year 1993, SLVWD pumpage was 645 AF, including about 335 AF from Olympia and 310 AF from Pasatiempo.

The remaining groundwater producers do not meter their wells. Accordingly, their pumpage can only be estimated. Previous estimates of pumpage were made for the AMBAG model (Watkins-Johnson Environmental, Inc., September 1993), and by Jacobvitz (1987), Todd Engineers (1987), and Luhdorff & Scalmanini (April 1984).

A significant amount of groundwater is pumped from the Scotts Valley groundwater basin by private well owners for landscaping purposes, including irrigation and maintenance of decorative ponds. Major landscaped areas include Valley Gardens golf course and the

landscaped commons of the Montevalle, Spring Lakes, and Vista del Lago residential developments. Of these, only Montevalle is located within SVWD boundaries; the others are located along the southern boundary. Other large landscaped areas, notably the new Borland campus, are supplied with SVWD water. As an indication, meters for the Borland site indicate water use of 38 AF from June 24, 1993 to May 5, 1994, or an estimated annual use of about 45 AF. Estimates of landscaping use for each of the other properties have ranged as high as 196 AFY (Todd Engineers, 1987). Accordingly, a rough estimate of 125 AFY for each of the four major landscapers was assumed, for a total of 500 AFY.

The Scotts Valley groundwater basin is also tapped by a number of privately owned water purveyors, listed below in Table 2 along with their number of connections.

**Table 2**
**Private Water Purveyors**

| Water System | Number of Connections |
|---|---|
| Mount Hermon | 462 |
| Spring Lakes | 223 |
| Vista del Lago | 202 |
| Manana Woods | 118 |
| Mission Springs | 100 |
| Fern Grove Club | 69 |
| Hidden Meadows | 11 |
| Spring Brook Park | 11 |
| Fern Brook | 9 |

As noted previously, water production is metered by Mount Hermon for its 462 connections and conference facility, and amounts to 145 AFY. Groundwater production for the remaining water purveyors was estimated by applying groundwater pumpage factors to

the number of connections. Based on the SVWD average groundwater production factor of 0.32 AFY per connection (288 gallons per day per connection), (J. Sansing personal communication), an approximate factor of 0.3 AFY per connection was assumed for most of the private purveyors (Manana Woods, Mission Springs, Fern Grove Club, Hidden Meadows, Spring Brook Park, and Fern Brook). Accordingly, the estimated total groundwater pumpage of these purveyors for their 318 connections is approximately 95 AFY (0.3 AFY per connection x 318 connections).

The Spring Lakes and Vista del Lago developments consist of relatively densely-spaced pre-fabricated homes with minimal individual landscaping. Accordingly, a pumpage factor of 0.15 AFY per connection was assumed, resulting in an estimated groundwater demand of 64 AFY (0.15 AFY per connection x 425 connections). However, in 1993 SLVWD supplied about 47 AF to the two water systems. For simplicity's sake and to avoid double-counting, this amount was assumed to be applied to domestic use. Consequently, groundwater pumpage in 1993 for domestic use by Spring Lakes and Vista del Lago is computed as 17 AF, or about 15 AF. Groundwater pumpage for their landscaped common areas was accounted for in the previous section.

In sum, total groundwater pumpage by the private water purveyors is estimated to be 255 AFY, including 145 AFY for Mount Hermon, 15 AF for Spring Lakes and Vista del Lago (not including landscaping or the SLVWD contribution), and 95 AFY for the remaining purveyors.

The updated well inventory indicates the existence of about 260 domestic wells in the Scotts Valley groundwater basin. It is assumed that most of these wells serve a single household with landscaping. Accordingly, assumption of the groundwater pumpage factor of 0.3 AFY yields a total estimated pumpage of approximately 80 AFY. Little of this pumpage occurs within SVWD boundaries.

Of the local industrial and commercial groundwater users, the largest is Kaiser Sand and Gravel. Previous estimates of Kaiser's groundwater pumpage has ranged from 106 AFY (Jacobvitz, 1987) to 268 AFY (Todd Engineers, 1987), with a more recent estimate of 200 AFY (Watkins-Johnson Environmental, Inc., September 1993). For this study, an approximate pumpage of 200 AFY was assumed for Kaiser.

Other industrial and commercial groundwater pumpers include such disparate businesses as food processing companies, lumber yards, computer-related fabrication plants, and retail stores. With such various activities, groundwater pumpage by each business could range from less than one AFY for a small business using the well for domestic purposes to 40 AFY (Jacobvitz, 1987). Less than 15 current small industrial/commercial well owners are known. Assuming an average groundwater pumpage of 5 AFY, the approximate total pumpage is 75 AFY, most of which occurs within SVWD bounds.

The groundwater pumpage by the Silverking aquaculture enterprise amounts to an additional 66 AFY (Watkins-Johnson, Environmental, Inc., September 1993) However, this pumpage represents essentially a groundwater diversion near the outlet of

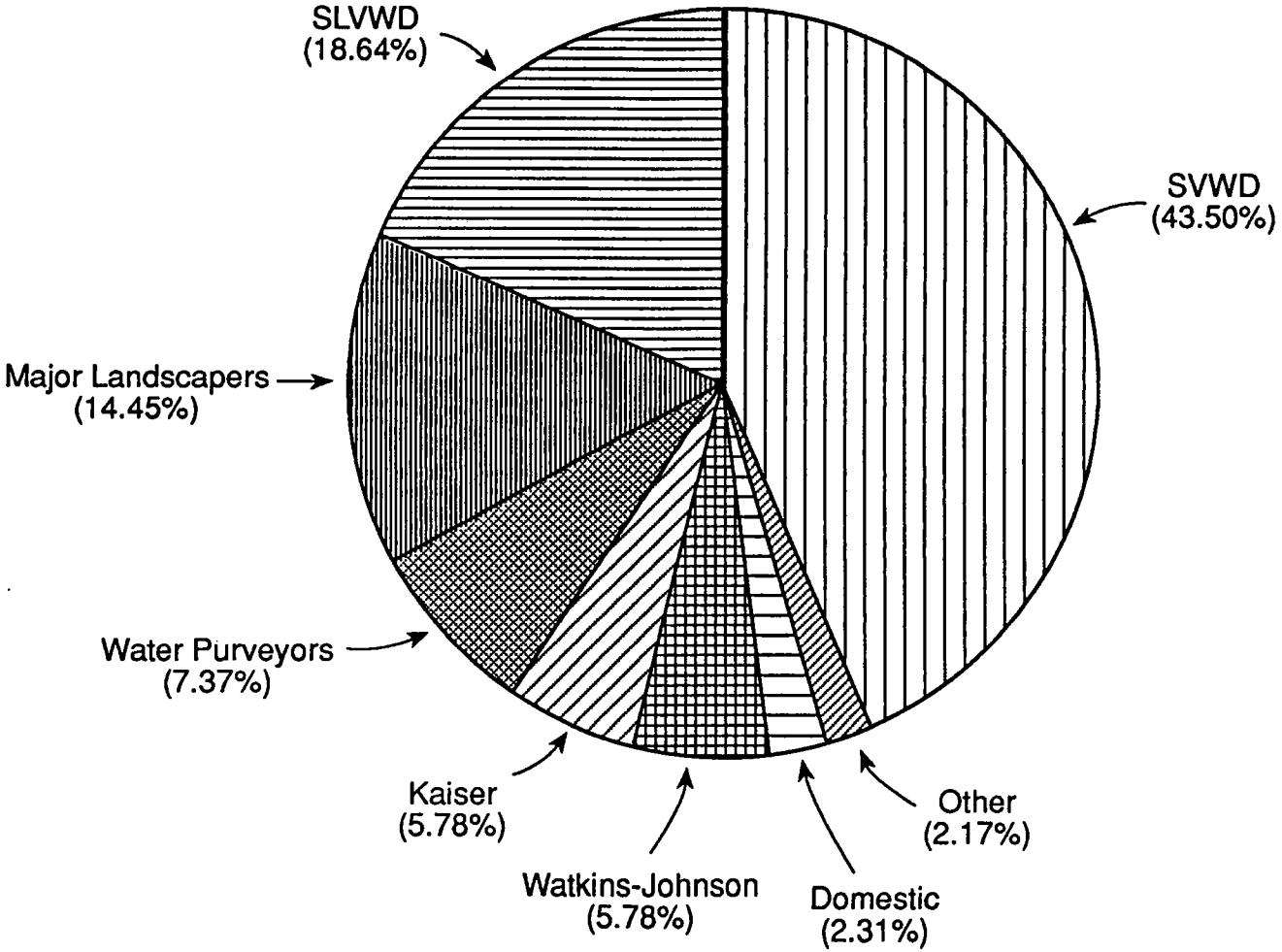
the basin with minimal consumption. Accordingly, it is not included in the sum of groundwater pumpage.

Groundwater production estimates are summarized in Table 3 and on Figure 9, along with the 1993 pumpage totals for SVWD, SLVWD, Mount Hermon, and Watkins-Johnson remediation. It should noted that this pumpage is summarized for the Scotts Valley groundwater basin, as defined for the Scotts Valley Water Resources Management Plan (see Figure 1). Pumpage occurring within SVWD boundaries amounts to about 1,880 AFY and includes pumpage by SVWD itself, Montevalle landscaping use, Watkins-Johnson remedial pumpage, and most of the other commercial/industrial pumpage.

**Table 3**
**Current Groundwater Pumpage, AFY**
**Scotts Valley Groundwater Basin**

| | |
|---|---|
| Municipal | |
| SVWD | 1,505 |
| SLVWD | 645 |
| Major Landscapers | 500 |
| Water Purveyors | 255 |
| Domestic | 80 |
| Watkins-Johnson Remedial | 200 |
| Kaiser Sand & Gravel | 200 |
| Other Industrial/Commercial | 75 |
| Total Estimated Pumpage | 3,460 |

**Summary of Pumpage.** Approximately 3,460 AFY of groundwater are currently being pumped from the Scotts Valley groundwater basin. Of this amount, 2,495 AFY or 72 percent is metered by SVWD, SLVWD, Mount Hermon, and Watkins-Johnson. The remainder is estimated and subject to correction. Measurement of production by only six additional groundwater producers (Montevalle, Valley




**Estimated Total Pumpage: 3460 AFY**

June 1994

DAVID KEITH TODD
Consulting Engineers, Inc.
Berkeley, California

**Figure 9**
**Current Distribution of Groundwater Production**

Gardens, Spring Lakes, Vista del Lago, Manana Woods, and Kaiser) would result in compilation of reliable data for over 90 percent of total pumpage.

This gross pumpage value does not account for return flows. Return flows represent pumped groundwater that is returned to recharge the groundwater basin. They include percolation from landscaping ponds and irrigation, leakage from water supply pipelines, and percolation from septic systems. In addition to return flows, gross pumpage also includes actual groundwater consumption, which results from evaporation and transpiration, wastewater export to the ocean outfall, and possibly through overflow of groundwater-supplied decorative ponds and waterways to streams leaving the groundwater basin. At this time, insufficient data are available to assess return flows and actual groundwater consumption. However, a preliminary review of return flows suggests that consumptive groundwater use probably is on the order of 60 to 70 percent of gross pumpage or 2,000 to 2,800 AFY. Accordingly, groundwater consumption is on the order of 50 to 65 percent of the perennial yield of 4,200 AFY.

The estimated total pumpage of 3,460 AFY amounts to over 80 percent of the estimated perennial yield of 4,200 AFY for the Scotts Valley groundwater basin. Even accounting for return flows, the groundwater pumpage and consumption represents a substantial portion of the perennial yield. As will be discussed in greater detail in later sections, successful maintenance of this groundwater production into the future will require intensive

management of the water resources of the entire groundwater basin.

Groundwater pumpage currently is focused on a small portion of the groundwater basin. Pumpage within SVWD boundaries amounts to about 1,900 AFY, including production by SVWD, Montevalle, Watkins-Johnson, and other industrial/commercial firms. In the contiguous areas bounding SVWD on the southwest, an additional 1,100 AFY is pumped by SLVWD, landscape irrigators, water purveyors, and Kaiser. Thus, 3,000 AFY or about 87 percent of the groundwater pumpage is being produced from the southeast one-quarter of the groundwater basin. Not surprisingly, these areas of focused pumpage coincide with localized groundwater level declines.

It should be acknowledged that SVWD has and is making a considerable effort toward redistribution of its pumpage out of the localized areas of groundwater decline. However, the efforts of a single, albeit major, pumper to redistribute pumpage will not be sufficient to mitigate the groundwater level declines. Current SVWD efforts should be supplemented by additional actions of SVWD and other major local groundwater producers to reduce or redistribute pumpage, to minimize groundwater losses from the basin, or to initiate groundwater replenishment programs.

**Recommendations**

- The well inventory should be maintained and updated periodically.

- Information on pumpage by SVWD and SLVWD should be compiled regularly, with periodic compilation of production data from Mount Hermon and Watkins-Johnson.
- The amount of groundwater production should be measured for the larger groundwater users including Montevalle, Valley Gardens, Spring Lakes, Vista del Lago, Manana Woods, and Kaiser.
- An analysis should be made of return flows and consumptive use of groundwater in the basin.
- SVWD should continue its efforts to redistribute its pumpage throughout its service area to mitigate localized impacts of pumpage.
- Roundtable meetings should be convened by the major groundwater producers in Scotts Valley to discuss various means to analyze and mitigate groundwater level decline problems in the Camp Evers - Lockewood Lane - Mount Hermon area. Such means could include redistribution of pumpage, groundwater replenishment projects, minimization of outflows through the Camp Evers tributary, construction of interties among water systems, determination of operational groundwater levels ("target levels"), and development of joint drought contingency plans.

### 3.6 Replenishment of Groundwater

SVWD has sponsored or participated in a number of studies involving groundwater replenishment. These have included

consideration of treated groundwater, reclaimed wastewater, and local surface water as potential sources for groundwater recharge or irrigation use. No projects have yet been implemented because of regulatory or economic constraints. Nonetheless, groundwater replenishment remains an important management method to mitigate groundwater pumpage impacts and to ensure long-term groundwater supply. Accordingly, this section presents a re-evaluation of previous replenishment studies and an update of the potential for wastewater recycling.

**Review of Previous Studies.** In the early 1970's treated sewage effluent was being recycled in Scotts Valley for various uses. As part of this wastewater reuse effort, a study was conducted to evaluate percolation rates at Skypark Airport (Lowney, 1973). Nine percolation pits were drilled with a bucket auger rig to depths ranging from 28 to 55 feet. Two percolation tests were conducted and measured percolation rates were 0.67 feet/day for a seven foot deep pit with an average head of 1.3 feet and 13.4 feet/day for a 40 foot deep pit with an average head of 35 feet.

A 1974 study completed by Harding Lawson described the disposal of treated effluent to the Kaiser sand pit and Skypark Airport, and its use for irrigation at Valley Gardens golf course and other sites. At the time, the approximate treatment plant capacity was 100,000 gallons per day (gpd) with plans to expand to 400,000 gpd. The increased flow was to be discharged to Kaiser sand pit. Hydraulic conductivity values estimated for the Santa

Margarita sandstone in the vicinity of Kaiser sand pit ranged from 0.0016 to 0.16 feet/day. The estimated groundwater flow direction was northward from the sand pit towards Bean Creek.

A nitrate pollution study conducted in 1984 described the use of treated wastewater for irrigation at Valley Gardens golf course and discharge to Kaiser sand pit and Skypark (Luhdorff & Scalmanini, September 1984). Regulations adopted by the Regional Water Quality Control Board (RWQCB) in 1976 limited the quantity of wastewater disposal to 400,000 gpd at Kaiser and 80,000 gpd at Skypark. In 1978, the RWQCB adopted an order to stop wastewater disposal at Skypark in 1979 and at Kaiser upon completion of the Santa Cruz outfall in 1981. Average wastewater discharge rates were estimated to be 144,000 to 288,000 gpd for Kaiser sand pit for the period 1974 to 1975. Discharge rates at Skypark were unknown and essentially terminated by 1976. Treated wastewater also was sold to Scotts Valley Intermediate School and the California Department of Transportation for landscaping, and to construction companies for dust control. It was estimated that 12 to 95 AFY of treated wastewater were used for landscape irrigation and construction between 1981 and 1983.

In 1988, SVWD retained Todd Engineers to evaluate water reuse options for the Watkins-Johnson remediation system. Watkins-Johnson was pumping 250 gpm on a continuous basis and discharging most of the treated water to Bean Creek. Five alternatives under consideration for this study were artificial recharge, landscape irrigation, an upgradient injection barrier, a perimeter injection

barrier, and reuse at the fish hatchery. Options for artificial recharge included seasonal recharge through SVWD wells, surface recharge in Carbonera Creek channel, and year-round recharge in dedicated wells. Landscape irrigation options included four private organizations in the Camp Evers area, and a planned golf course in the Glenwood area. An evaluation of feasibility, costs, and benefits showed that the best alternative was to combine surface recharge of Carbonera Creek during dry months with recharge through SVWD wells during wet months.

In 1989, SVWD retained Todd Engineers to evaluate water recycling and conservation measures. Artificial recharge was considered from three sources: urban runoff, streamflow, and treated wastewater. The primary concern regarding urban runoff is water quality; therefore, this study proposed to use runoff only from residential and public land uses. It was estimated that 1,160 to 2,150 AFY of runoff was potentially available, although only a portion of this total could realistically be conserved. Streamflow was initially considered from both Bean and Carbonera Creeks. However Bean Creek was subsequently eliminated as a source of water due to high pumping lifts and potential environmental impacts. It was estimated that 4,335 AFY was potentially available from Carbonera Creek, although recharge rates and other factors limit the actual amount that can be retained. The recharge capability of the existing channel was estimated to be 176 AFY, with a potential increase to 312 AFY through construction of check dams. Estimates indicated that off-stream spreading basins could recharge an

additional 616 to 1,267 AFY of Carbonera Creek streamflow.

The quantity of treated wastewater available in 1988 was estimated to be 754 AFY. At that time only 100 AFY were being reused for golf course irrigation. Water quality is the primary concern for utilization of treated wastewater in artificial recharge, and its reuse for artificial recharge could require abandonment of water supply wells adjacent to a proposed recharge facility.

Four specific projects were considered in detail in the 1989 study for artificial recharge of surface water and treated wastewater: Whispering Pines, Valley Gardens golf course, Skypark Airport, and Carbonera Creek channel. Whispering Pines appeared to be the best site, and involved shallow spreading basins to obtain 1,750 AFY of recharge with a net wetted area of nine acres. This site has since been developed for commercial purposes. Skypark Airport also appeared to be a good site, with 590 to 980 AFY of water potentially being recharged over a net wetted area of four acres. This recharge estimate for Skypark was based on diversion of Carbonera Creek flows as the primary source water. The Carbonera Creek channel was suggested as another artificial recharge area with good potential. The evaluation of Valley Gardens golf course indicated poor potential for use in artificial recharge.

Todd Engineers conducted a very brief assessment in 1990 of recharge characteristics for a parcel located adjacent to Well 11 on Scotts Valley Drive at El Pueblo Road. This site encompassed an

abandoned sand quarry and included approximately five acres of level ground. In addition, a small unnamed channel, draining a watershed of approximately 45 acres, crosses the site and flows into Carbonera Creek. The site is underlain by permeable soils and the Santa Margarita sandstone. Potential recharge projects included check dams in the unnamed channel and percolation in the sand pit.

In 1990, SVWD requested that Todd Engineers evaluate potential artificial recharge basins at Skypark in more detail. Three possible conceptual designs were considered: a seasonal recharge basin, a perennial landscaping pond, and a dedicated recharge basin. The source of water would be local runoff diverted from the adjacent Dufours Tributary. A seasonal recharge basin was envisioned near the center of the site with potential to recharge approximately 120 AFY over a net wetted area of two acres. This seasonal recharge basin could serve as a softball field during the dry season. Alternatively, the basin could serve as a perennial landscaping pond if wet season runoff were supplemented by reclaimed wastewater/surface water during the dry season. A perennial pond would be capable of considerably more recharge than a seasonal facility. The third design involved a two-acre dedicated recharge basin along the eastern property line. Local runoff during the wet season would be supplemented by reclaimed wastewater during the dry season. Conclusions of this study indicated that artificial recharge at Skypark would not directly increase potable groundwater supplies to SVWD wells because of

groundwater flow patterns at the time. However, such recharge would mitigate impacts of urbanization on groundwater and Bean Creek streamflow. Furthermore, recharge at this site could help mitigate future increased pumpage in other areas of the basin.

Again in 1991, SVWD retained Todd Engineers to evaluate alternative methods of artificial recharge at Skypark. Other options besides spreading basins included modification of landscaping and infiltration trenches. Preliminary analyses indicated that considerably less recharge would be achieved by landscape modification or infiltration trenches compared to spreading basins. However, spreading basins would require considerably more land for construction.

**Current and Future Status of Wastewater Treatment.** The Scotts Valley wastewater treatment plant (WWTP) currently meets secondary discharge requirements. The treatment process includes organics removal, aeration/oxidation, and disinfection. Effluent from the plant is presently piped to Santa Cruz for discharge to the ocean. The average effluent volume is approximately 0.8 million gallons per day (mgd). The flow process includes an influent pumping station, aeration tank, secondary clarifier, and chlorine contact tank.

Future plans for the wastewater treatment plant would increase capacity to 1.5 mgd. In addition, expansion plans will upgrade the treatment process to meet secondary reclamation requirements. The treatment process would include additional disinfection needed for

wastewater recycling (S. Hamby, personal communication). This water could be reused for construction activities, irrigation, or blended for surface recharge basins (up to 20 percent of total source water). Facilities to be added or expanded upon include a new influent pumping station with mechanical barscreens, a new flow equalization structure, an additional secondary clarifier, modifications to the aeration tank, expansion of the chlorine contact tank, and expansion of the laboratory and buildings.

Additional funding is currently being pursued to add facilities necessary to achieve tertiary treatment standards. AMBAG is considering a feasibility study of costs and benefits for tertiary treatment of wastewater at the WWTP. In addition, an application was filed in 1993 with the State Water Resources Control Board to obtain funding for tertiary treatment. The WWTP was subsequently notified in 1994 that they have been placed on the state priority list for such funding.

**Potential Replenishment Projects.** Potential replenishment projects can be grouped into two categories:

- Indirect or in-lieu replenishment involving use of non-potable water for industrial/dust control or landscaping purposes, or
- Direct artificial recharge.

The indirect or in-lieu replenishment projects result in conservation of groundwater for potable use by satisfying industrial or irrigation water demands with untreated surface water or reclaimed wastewater in lieu of groundwater. Water for

industrial uses could be supplied by secondary reclaimed wastewater, but the quantity conserved in Scotts Valley would likely be small. Water for irrigation and landscaping may also be supplied by secondary reclaimed wastewater in place of groundwater.

Water for direct artificial recharge may be supplied by streamflow or reclaimed wastewater. Direct recharge of wastewater is highly regulated and constrained to protect public health. Current draft regulations for artificial recharge of reclaimed wastewater are shown in Table 4. For example, wastewater must account for less than 50 percent (with tertiary treatment including filtration) or 20 percent (with secondary treatment) of the total recharged water recovered in a well. In addition, nearby production wells within 500 to 2,000 feet of a recharge site may have to be abandoned as drinking water sources.

Specific potential sources of replenishment water include the following:

- Streamflow from Bean Creek,
- Streamflow from Carbonera Creek,
- Reclaimed wastewater,
- Local streamflow, and
- Watkins-Johnson remedial pumpage.

Bean Creek was eliminated as a source due to its sensitivity as a year-round fish and wildlife habitat. Watkins-Johnson was eliminated as a potential source because it is already being reused for other purposes. Therefore, the primary sources of water are Carbonera Creek (only during the wet season), reclaimed wastewater

## TABLE 4
## MINIMUM TREATMENT AND RECHARGE REQUIREMENTS FOR WASTEWATER RECYCLING

| RECHARGE METHOD: | SURFACE SPREADING | | | | DIRECT INJECTION |
|---|---|---|---|---|---|
| PROJECT CATEGORY: | I | II | III | IV | V |
| Maximum % reclaimed water in extracted groundwater | 50 | 20 | 20 | 20 | 50 |
| Depth to groundwater (feet) | | | | | |
| Initial percolation rate: | | | | | |
| <0.20 inches/minute | 10 | 10 | 20 | 50 | NA |
| <0.33 inches/minute | 20 | 20 | 50 | 100 | NA |
| Underground retention time (months) | 6 | 6 | 12 | 12 | 12 |
| Horizontal separation* (feet) | 500 | 500 | 1000 | 1000 | 2000 |
| Level of treatment: | | | | | |
| Oxidation | X | X | X | X | X |
| Filtration | X | X | | | X |
| Organics removal | X | | | | X |
| Disinfection** | X | X | X | | X |

* From edge of recharge/spreading operation to nearest domestic supply well.
** Disinfection level varies.
REF: Proposed Title 22 Groundwater Recharge Regulations

(year-round), and local streamflow (only during the wet season).

Chemical analyses of water from Carbonera Creek evaluated in previous studies indicate that it is probably of satisfactory quality. Evaluation and correlation of streamflow data indicate that the average annual Carbonera Creek streamflow quantity is approximately 4,000 AFY. Reclaimed wastewater is currently discharged at a rate of approximately 900 AFY and meets secondary discharge (water quality) requirements. Local streamflow is derived primarily from residential area runoff. No water quality analyses are available, and thus the quality for recharge is unknown. The initial major storms of the wet season tend to result in the poorest runoff water quality and would not be retained for artificial recharge purposes. However, water from subsequent storms typically is of higher quality and probably would be suitable for recharge. The total quantity of local streamflow is estimated to be 1,200 to 2,200 AFY, although only a fraction could potentially be retained for recharge due to its flashy nature.

Based upon our review of previous studies and an assessment of the current conditions in Scotts Valley, the following potential projects were identified:

(1) Skypark basins,

(2) Carbonera Creek check dams,

(3) El Pueblo recharge wells,

(4) Kaiser sand pit,

(5) Bergstrom Cliffs check dams/El Pueblo sand pit, and

(6) Valley Gardens golf course irrigation.

The preliminary replenishment projects are summarized in Table 5 and described in the paragraphs below.

(1) Skypark basins.

Skypark, slated for residential development in the near future, is one of few large flat parcels that are suitable for artificial recharge. Based upon a review of various options, it is proposed that two recharge basins be built. One basin would be located near the center of the site and dedicated to year-round recharge. The source of water during the rainy season would be local runoff generated within the new development and local streamflow diverted from the adjacent Dufuors tributary. Reclaimed wastewater could be recharged during the dry season. A second seasonal recharge basin would be located along the eastern boundary of the site. The source of water for this basin would be local runoff and streamflow.

Estimates of the quantity of recharge at Skypark were based on the following assumptions: a conservative percolation rate of 1 foot/day, a wetted area of two acres for each basin, a fully wetted basin for 60 days during the rainy season, and 20 percent wastewater usage in the dedicated basin. These assumptions yield estimates of 120 AFY for the seasonal basin and 170 AFY for the dedicated basin, for a total potential recharge of 290 AFY. This estimate of potential recharge is lower than previous estimates, which assumed Carbonera Creek streamflow would serve as a source of recharge water for Skypark.

The estimates of recharge should be compared to the estimated

## TABLE 5
## SUMMARY OF GROUNDWATER REPLENISHMENT ALTERNATIVES

| GROUNDWATER REPLENISHMENT ALTERNATIVE | SOURCE WATER TYPE/ MAXIMUM QUANTITY | QUALITY OF SOURCE WATER | EXPECTED RECHARGE QUANTITY | COMMENTS | POTENTIAL FOR RECOVERY |
|---|---|---|---|---|---|
| Skypark Basins | Local Streamflow/280 to 495 AFY<br>20% Reclaimed Wastewater/56 to 99 AFY | Unknown<br>Secondary Treatment | Less Than 200 AFY | Not compatible with Kaiser, basin siting critical. | Wells 9 and 10 |
| Carbonera Creek Check Dams | Carbonera Streamflow/4,300 AFY | Satisfactory | Less than 100 AFY | Narrowing channel since 1980's. | Well 11 and El Pueblo |
| El Pueblo Recharge Wells | Carbonera Streamflow/4,300 AFY | Treatment Necessary | Unknown | Requires upgrade of treatment facility. | Well 11 or El Pueblo |
| Kaiser Sand Pit | Local Streamflow/280 to 495 AFY<br>20% Reclaimed Wastewater/56 to 99 AFY | Unknown<br>Secondary Treatment | 200 AFY | Not compatible with Skypark, outside SVWD boundaries, large storage capacity. | New recovery well or Well 10 |
| Bergstrom Cliffs/ El Pueblo Sand Pit | Local Streamflow/30 AFY<br>Carbonera Streamflow/4,300 AFY | Unknown<br>Satisfactory | 20 to 30 AFY<br>270 AFY | Check dams may alleviate flooding problems. | Well 11 and El Pueblo |
| Valley Gardens Golf Course Irrigation | Reclaimed Wastewater/up to 900 AFY | Secondary Treatment | 100 AFY | Replaces groundwater pumpage, potential impact on Well 10. | NA |

Notes:
AFY=Acre–feet per year
NA=Not Applicable

quantity of available water. Local streamflow generated from a portion of Camp Evers and central Scotts Valley amount to 280 to 495 AFY, although only a portion of this amount may realistically be retained for recharge. In addition, a portion of local streamflow generated from runoff within the future Skypark development could also be retained. The amount of recharge actually achieved will depend on stream discharge and duration, size of diversion works, and available storage and recharge rate in the basins. Reclaimed wastewater also could be available for recharge, amounting to 20 percent of retained streamflow. Based on the limited quantity of local recharge water that realistically can be diverted, it is estimated that the amount of water that can be percolated at Skypark probably is 200 AFY or less.

A portion of recharged water at Skypark may be recovered with Wells 9 and 10. Some of the recharged water would also flow towards the Watkins-Johnson pumping depression and Bean Creek. Alternately, a new recovery well could be sited northwest of Skypark. Basin siting will be crucial at Skypark to maintain an acceptable distance from recovery wells (due to recharge of reclaimed wastewater), while still allowing for recovery of an acceptable portion of recharged water.

(2) Carbonera Creek check dams.

Carbonera Creek channel consists of alluvium overlying the Santa Margarita sandstone along a 3,700 foot stretch between Highway 17 and Bob Jones Lane. The creek flows generally from October through June with an average annual discharge of approximately 4,300 AFY.

The average annual flow during the past eight water years from October 1, 1985 to September 30, 1993 was approximately 2,750 AFY. These recent flows have been below average due to drought. Average annual recharge in the existing stream channel was previously estimated to be 176 AFY. Previous studies also indicated that modification of the channel with three check dams could increase recharge in the channel by an additional 136 AFY.

Based upon a May 1994 preliminary survey of stream characteristics, suitable locations for check dams exist between Carbonera Way and Bob Jones Lane. However, the morphology of the channel has changed significantly in recent years with a build-up of rather large, vegetated sand/silt bars. This has reduced the wetted channel area and likely has caused a reduction in natural stream recharge. Accordingly, the previous estimates of recharge using check dams also would need to be reduced. It is now estimated that the amount of recharge to be gained by three check dams is less than 100 AFY unless the channel is scraped out. A vacant parcel at the Carbonera Way crossing should be considered as a potential site for an off-stream spreading basin.

Recharged water could be recovered by Well 11 and the El Pueblo well field. However, the impact of contaminants in groundwater locally should be considered.

(3) El Pueblo recharge wells.

Recharge wells inject water directly into the aquifer, and thus require high quality source water, such as treated surface water or tertiary treated wastewater. Wastewater can constitute only up to

50 percent of recharged water, so an additional source of high quality water is needed for blending (see Table 4). A source of high quality recharge water would be available if Carbonera Creek water could be diverted to the water treatment facility at El Pueblo well field. However, the treatment facility would likely have to be upgraded to handle a higher capacity of water and to filter sediment.

Carbonera Creek water could be diverted by imbedding a perforated diversion pipe several feet below the channel bed. This would allow some natural filtration to occur through the sand in the channel bed. The creek water would then flow through the pipeline to the El Pueblo treatment facility. Following treatment, the water could be injected into Well 3A, Well 7 or a new injection well, and subsequently extracted through Well 11. The quantity of recharged water would be dependent upon available flow in Carbonera Creek, the capacity of diversion, transmission, and treatment facilities, and recharge capacity of the injection well.

(4) Kaiser sand pit.

Kaiser sand pit previously served as a recharge/disposal site for treated wastewater in the 1970's and early 1980's. In 1974, the majority of the wastewater treatment plant capacity of 100,000 gpd was disposed of at Kaiser sand pit. A 1974 study (Harding Lawson Associates, 1974) indicated that as much as 400,000 gpd (or 450 AFY) of reclaimed wastewater could be disposed of in the sand pit.

The sources of water are the same as those for Skypark. As with Skypark, the use of reclaimed wastewater would require a

second source of water for blending. It is anticipated that local streamflow (amounting to 280 to 495 AFY) could serve as the other source of water unless it is diverted for other uses (such as Skypark). Based upon the available sources of water, it is estimated that the total quantity of recharge in Kaiser sand pit would potentially be greater than at Skypark because of the greater storage available in the sand pit. It is estimated to be approximately 200 AFY.

Although this site is located outside SVWD boundaries, a significant portion of recharged groundwater could be expected to flow north into SVWD boundaries. A portion of recharged water could potentially be recovered by Well 10 or a new recovery well located northwest of Well 10. Some recharged water would also be expected to flow toward Bean Creek.

(5) Bergstrom Cliffs check dams/El Pueblo sand pit. This site includes a small drainage watershed of about 45 acres and a relatively flat quarried area on Scotts Valley Drive at El Pueblo Road. It is estimated that an annual average runoff of 30 AFY would be available from the watershed. Check dams could be constructed along the drainage to retain water and percolate it into the permeable, underlying Santa Margarita sandstone. It is likely that much of the 30 AFY could be recharged.

A second phase of this project could involve construction of a three acre recharge basin, receiving water diverted from Carbonera Creek. Assuming the basin could remain wetted for 90 days per year with a conservative percolation rate of one foot per

day yields a recharge quantity of 270 AFY. Recovery of the recharged water would be achieved through Wells 11, 3A, or 7. Wastewater recharge was not considered, as it would entail abandonment of Well 11 as a drinking water source.

(6) Valley Gardens golf course irrigation.

Valley Gardens golf course consists of 33 acres including 1.5 acres of ponds and waterways. Groundwater is currently pumped into the ponds, which also serve as storage for irrigation water. A large portion of the irrigation needs of the golf course could be met with reclaimed wastewater. Valley Gardens has previously used on the order of 100 AFY of reclaimed wastewater for irrigation purposes. This conservation measure would indirectly benefit the water table by reducing pumpage in Valley Gardens' well. In addition, nearby residential developments with landscaped commons (i.e. Vista del Lago, Spring Lakes) may offer potential for irrigation with reclaimed wastewater. However, potential impacts on Well 10 would have to be considered.

**Mitigation of Pumpage Impacts.** In summation, groundwater storage declines in recent years have been on the order of 500 to 600 AFY. These declines are localized in the Camp Evers and Scotts Valley Drive areas, and reflect intensive pumpage from major municipal and private wells. Recovery of groundwater levels in these areas probably will require not only redistribution of groundwater production, but also increased conservation of water and active replenishment. Given the complexity of the local

hydrogeologic setting, such active groundwater management will need to be based on a comprehensive, but detailed understanding of the local hydrogeology.

As indicated, alternatives exist for mitigation of the pumpage impacts in the Camp Evers and Scotts Valley Drive areas. It is likely that more than one replenishment project would be needed to offset the groundwater declines of 500 to 600 AFY experienced in recent years. Additional management, conservation, and replenishment efforts would be needed to provide for any additional increase in local water demands.

Replenishment projects can entail significant costs, and for that reason should be planned and implemented in the context of basin-wide water resource management and in coordination with SLVWD, Santa Cruz County, and other major groundwater users. This is particularly true in the Camp Evers area. Replenishment projects also should be supplemented with continued efforts to encourage conservation measures (such as low flow plumbing fixtures and drought resistant vegetation) and efforts to encourage wastewater reclamation and recycling.

**Recommendations**

- More than one project should be considered to mitigate local impacts of groundwater pumpage and to ensure long-term groundwater supply.

- Each project described in this section has been presented in a preliminary and conceptual manner. More detailed investigations would need to be carried out to further evaluate the proposed projects. Additional studies should include:
  1) The discharge of the Camp Evers tributary of Carbonera Creek should be measured periodically to determine this flow out of the basin. The contribution of landscaping ponds and waterways to this outflow should be assessed. If the contribution is significant, SVWD and SLVWD should encourage local landscaping entities to develop a joint landscaping water management plan, including determination and implementation of measures to mitigate this loss of water.
  2) Field work to evaluate subsurface stratigraphy, percolation rates, stream discharge/duration, and water quality.
  3) Computer modeling to evaluate mounding effects, subsurface retention times, and the ultimate destination of water originating from recharge facilities.
  4) Cost/benefit analysis to evaluate the actual cost per acre-foot of recharge water.
  5) Assessment of environmental impacts.
- All projects discussed in this section warrant further consideration, in addition to others that may be proposed.
- Replenishment projects should be planned and implemented in

the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

- SVWD, SLVWD and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.
- SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

## Section 4

## GROUNDWATER QUALITY

The natural quality of groundwater in the Scotts Valley groundwater basin is typically high. However, the occurrence volatile organic compounds in SVWD wells and the Manana Woods well has resulted in increasing concern over groundwater contamination and the lack of timely and effective source identification and remediation. The Santa Margarita aquifer is particularly vulnerable to contamination by leaks and spills at the surface due to the permeable nature of deposits which crop out at the ground surface. In 1982, the Santa Margarita groundwater basin was designated as a sole source aquifer by the USEPA. This means that the City of Scotts Valley and nearby communities use this aquifer as their sole or principal water supply. Therefore, it is deserving of special protection.

The discussion of groundwater quality presented here will focus on human-induced groundwater quality problems. This section will present the regulatory framework for the identification and remediation of contamination problems; areas of contamination identified in the Scotts Valley; and various groundwater contamination prevention programs and activities.

### 4.1 Regulatory Responsibilities

Several local, state, and federal agencies have responsibilities for preventing, identifying, and remediating

groundwater contamination problems in Scotts Valley. These agencies include: the USEPA; the California Environmental Protection Agency, Department of Toxic Substance Control (Cal-EPA); the Regional Water Quality Control Board, Central Coast Region (RWQCB); and the Scotts Valley Fire Protection District (SVFPD). Generally, responsibility for potential contamination sites, suspected contamination sites, and actual contamination sites are distributed between these various agencies. The criteria for distribution of sites between the various agencies is somewhat vague; however, there are some guidelines for the allocation of responsibility.

At the local level, the SVFPD oversees the City of Scotts Valley's hazardous materials management program; implements state regulations for the installation, monitoring, use, and removal of underground storage tanks; and is the first responder in the event of a hazardous material release. The SVFPD also oversees monitoring well and deep soil boring installations and destructions. At the state level, the RWQCB regulates sites where groundwater contamination from underground storage tanks or other sources has occurred. Generally, Cal-EPA oversees sites where groundwater contamination has been detected but the potentially responsible party (PRP) has not been identified or the identified PRP is not financially solvent. At the federal level, the USEPA commonly oversees sites that are on, or proposed for, inclusion on the National Priority List (NPL) of federal Superfund sites.

SVWD is responsible for monitoring of its water supply and

provision of water satisfying state and federal drinking water standards. Although SVWD does not have regulatory authority for the prevention, identification or remediation of contamination sites in Scotts Valley, several groundwater contamination problems have been discovered by SVWD through its regular monitoring of water supply wells. SVWD monitors the groundwater at its active water supply wells at least semi-annually, and monthly if constituents of concern are detected. Groundwater is sampled at the frequency specified and for the constituents required by Title 22, California Administrative Code, Chapter 15. Analyses which have been performed include: general mineral, physical, inorganic, radiological, bacteriological, and regulated and unregulated organics. Water quality data are compiled and analyzed by SVWD and its consultants; water quality concerns are discussed in the annual Scotts Valley Water Resources Management Plan reports (Todd Engineers, 1984 to 1994).

Identification of sources and remediation of groundwater contamination problems is often a slow and difficult process. As a result SVWD has been compelled to provide well head treatment for contaminated groundwater in order to provide water to its costumers which meets regulatory standards. To protect its production wells from the adverse effects of contamination SVWD has previously identified groundwater protection and management zones (Todd Engineers, 1988). Management and protection zones were delineated primarily on the basis of recharge areas, pumpage areas, and risk of contamination. Groundwater management and protection zones were

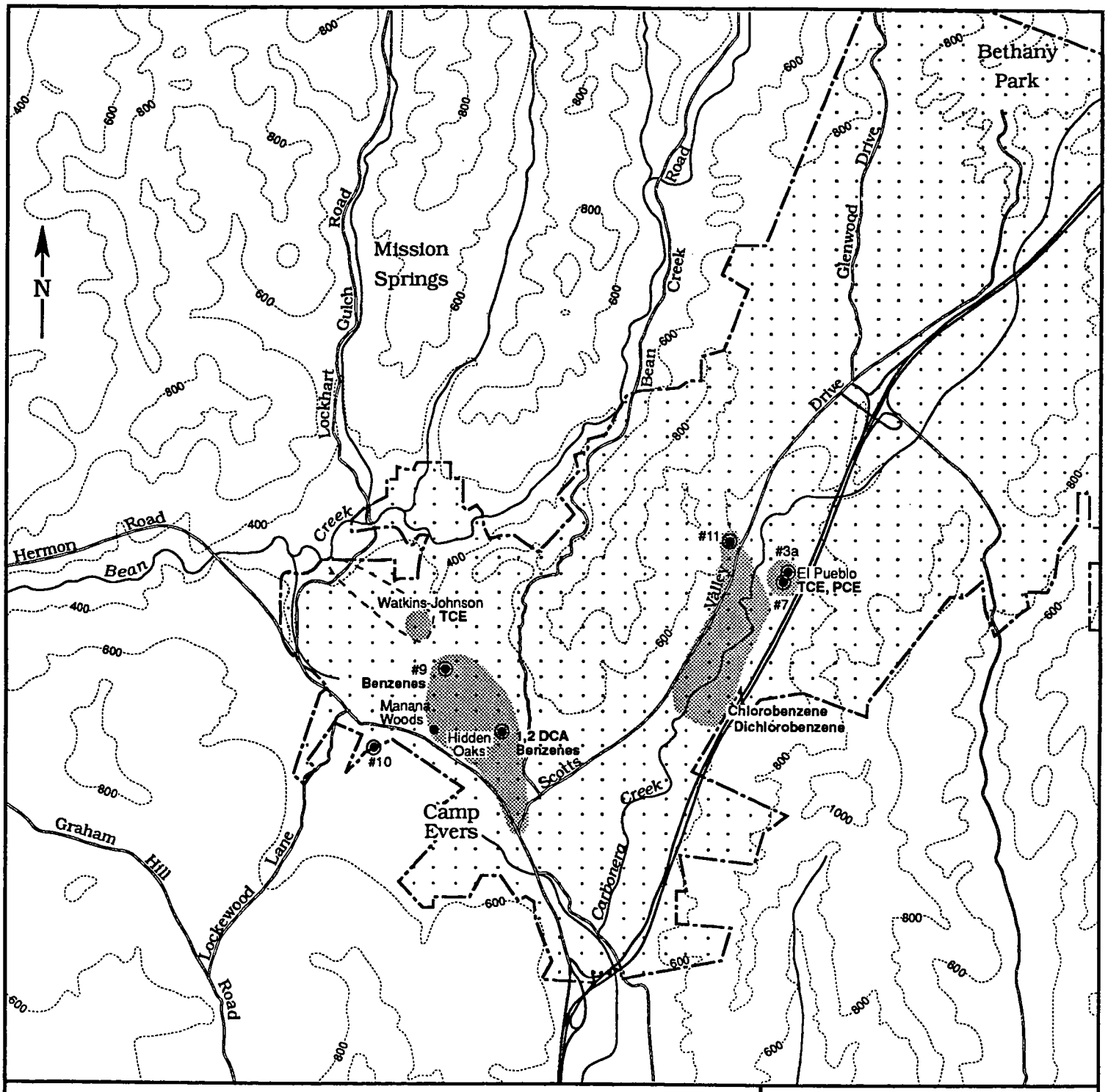
further refined in the AMBAG study (Watkins-Johnson Environmental, Inc., September 1993).

## 4.2 Groundwater Contamination

Several areas of groundwater contamination have been identified in Scotts Valley as shown on Figure 10. Groundwater contamination problems include: benzene and 1,2-dichloroethane (1,2-DCA) identified in the Camp Evers area; chlorobenzene, dichlorobenzene and other solvents found along Scotts Valley Drive; and trichloroethene (TCE) and other solvents under remediation at the Watkins-Johnson site.

**Camp Evers.** Volatile organic compounds (VOCs) have been detected in three water supply wells in the Camp Evers area including the SVWD's Hidden Oaks well and Well 9, and the Manana Woods Mutual Water Company well (Manana Woods well). The Hidden Oaks well has shown detectable concentrations of a variety of VOCs in past sampling events including: benzene, ethylbenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-DCA, and xylenes. Well 9 and the Manana Woods well have shown detections of benzene only, with the exception of a single detection of 0.6 parts per billion (ppb) of 1,2-DCA in Well 9 in March 1994. The highest concentration of benzene detected has been 1,300 ppb, 39 ppb, and 9.4 ppb in the Hidden Oaks well, Well 9, and the Manana Woods well, respectively.

The RWQCB has identified ten possible sources of the




**Legend**

- SVWD Production Wells
- Approximate Plume Area
- Former Plume Area
- SVWD Boundary

Scale

0 2000 4000 feet

**Figure 10**

**Groundwater Quality Problems**

June 1994

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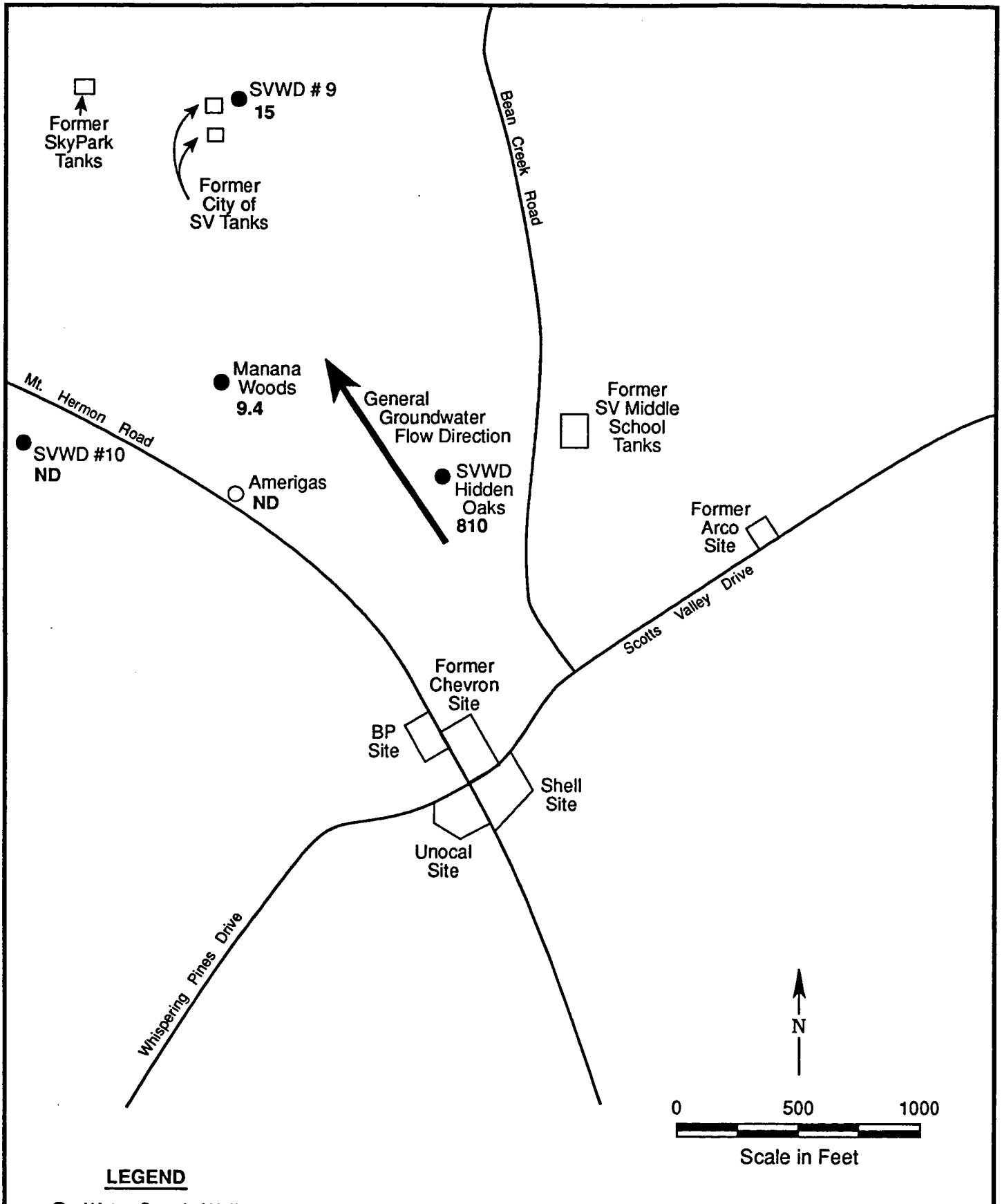
contamination detected in these water supply wells (RWQCB, July 1993, September 1993, and April 1994). Figure 11 shows the wells that are monitored in the Camp Evers area, and the possible contamination source locations that have been investigated by the RWQCB. The highest concentration of benzene detected in wells along with the general groundwater flow direction are also indicated on the figure. The RWQCB has not yet found a definitive link between the contamination detected in water supply wells and any of the potential sources. Each of the potential sources is discussed below.

(1) Scotts Valley Middle School, 8 Bean Creek Road.
Two or three underground diesel tanks were removed from the site in 1988. Analyses performed on samples from a boring in the vicinity of the site showed no detected concentrations of VOCs. The RWQCB does not believe this site is a likely source of water supply well contamination.

(2) City of Scotts Valley, 370 Kings Village Road.
Two underground fuel tanks were removed from the Scotts Valley Old City Hall site. Soil samples taken during tank removal showed minor contamination (approximately 200 ppb total petroleum hydrocarbon). The RWQCB does not believe this site is a likely source of water supply well contamination.

(3) City of Santa Cruz, Skypark, Kings Village Road.
The Skypark Airport was operated in the past by the City of Santa Cruz. The Skypark property was recently annexed to the City of Scotts Valley. Four underground gasoline tanks were removed from




**LEGEND**

- ● Water Supply Well
- ○ Irrigation/Industrial Well
- 15 Highest Concentration of Benzene(ppb)
- ND Not Detected

June 1994

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**Figure 11**
**Possible Sources of Camp Evers Water Supply Well Contamination**

the site in 1984. Petroleum hydrocarbons were identified at elevated concentrations (6,400,000 ppb) in one of four soil borings at a depth of 15 feet. No gasoline hydrocarbons or benzene, toluene, ethylbenzene, or xylene (BTEX) compounds were detected in groundwater sampled from the Skypark Airport supply well. Petroleum hydrocarbons were detected at low levels (64 ppb) in a perched groundwater sample taken from a shallow soil boring (Weber, Hayes & Associates, 1994). The contamination associated with the underground tanks at Skypark appears to be localized. Remediation of soil contamination is being required. The RWQCB does not believe this site is a source of water supply well contamination.

(4) Hidden Oaks.

This site was used as an equipment storage yard in the past, and it is possible that petroleum products were spilled on the ground surface. No investigations have been performed at this site. The RWQCB has no evidence that this site is a source of water supply well contamination.

(5) Manana Woods.

The Manana Woods Mutual Water Company has at least two old wells on their site which could act as conduits to the aquifer. The RWQCB has no evidence that this site is a source of water supply well contamination.

(6) BP Service Station, 201 Mount Hermon Road.

Minor hydrocarbon soil contamination was detected at this site when fuel tanks were replaced with double walled tanks. Groundwater contaminated with petroleum hydrocarbons has been detected at the

site; however, higher levels of contamination have been detected upgradient of the site at the Unocal Service Station. The RWQCB does not consider this site a likely source of water supply well contamination.

(7) Unocal Service Station, 99 Mount Hermon Road. Groundwater and soil contaminated with petroleum hydrocarbons were discovered at this site in October 1986. Remediation at the site has included replacement of four underground storage tanks and a waste oil tank in November 1990 with new double walled tanks, removal of 730 cubic yards of hydrocarbon affected soil around the tanks, installation of 18 monitoring wells, operation of a groundwater extraction and treatment system, and operation of a vapor extraction system. Recent sampling of wells downgradient from the Unocal site indicate that groundwater contamination is localized (RESNA, 1994). The RWQCB will consider the Unocal plume delineated and therefore not a source of water supply well contamination if additional monitoring confirms recent results.

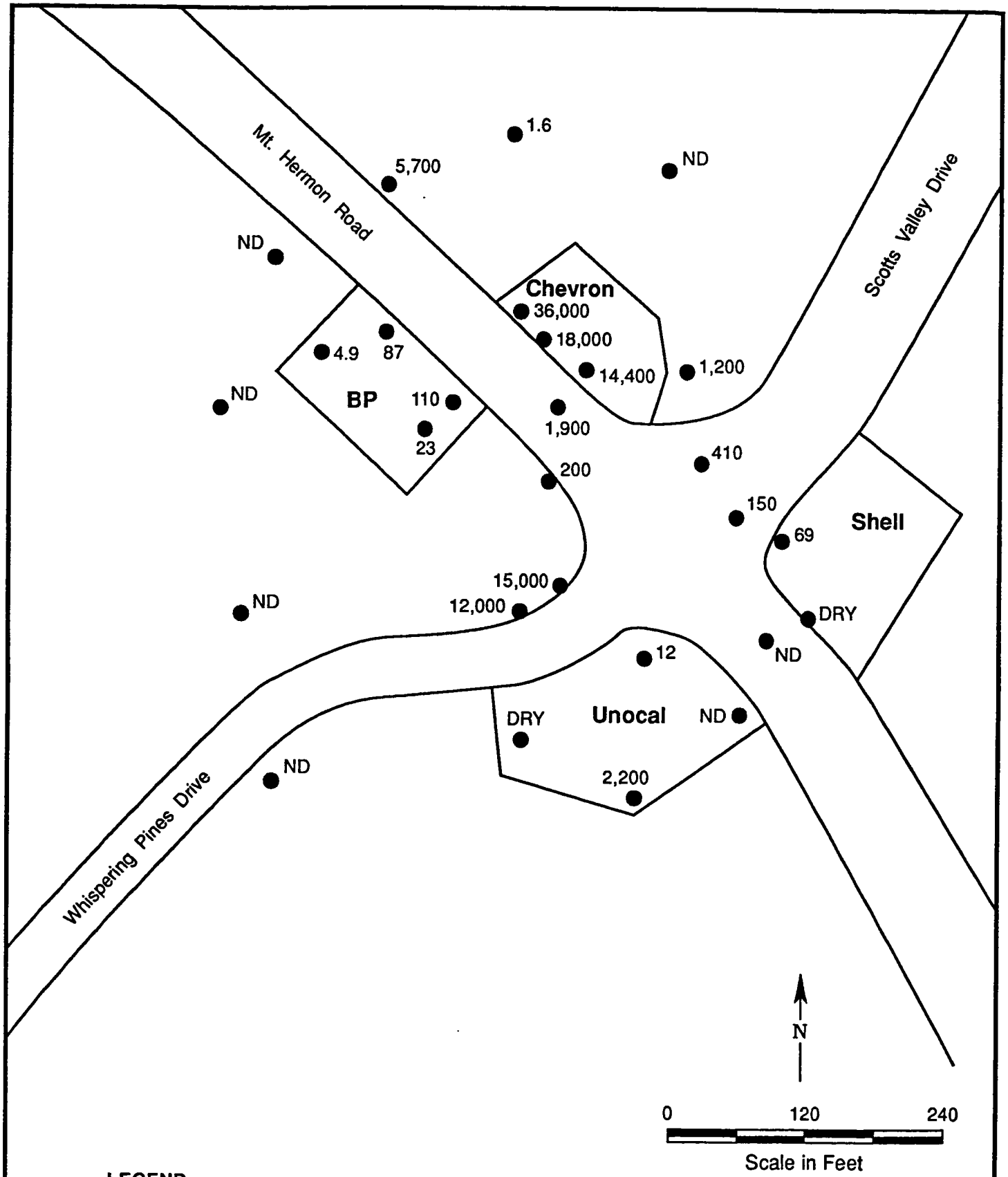
(8) Shell Service Station, 90 Mount Hermon Road. Groundwater and soil contaminated with petroleum hydrocarbons have been discovered at and downgradient of the site (Pacific Environmental Group, 1993). Three underground fuel tanks at the site were replaced with double walled tanks. A soil vapor extraction system has been proposed to remediate soil contamination at the site. A former Chevron Service Station, which shows higher levels of soil and groundwater contamination than the Shell site, is located downgradient. As this site is located upgradient of a

source with higher concentrations of contaminants, this site could be at most a minor contributor to water supply well contamination.

(9) Former Chevron Service Station, 200 Mount Hermon Road. Groundwater contaminated with petroleum hydrocarbons have been discovered at and downgradient of the site. 1,2-DCA has also been detected in onsite monitoring wells. One set of underground tanks located on the east site of the site were probably removed around 1963 when new tanks were installed on the west side of the property (Pacific Environmental Group, January 1994). These three newer underground fuel tanks and one waste oil tank were removed in 1982. Recent groundwater sampling indicated elevated levels of benzene detected downgradient of the site (Pacific Environmental Group, March 1994). The RWQCB considers this site a possible source of water supply well contamination.

(10) Former ARCO Service Station, 4253 Scotts Valley Drive. Preliminary investigations have found two previously unknown underground tanks still in the ground at this site. Soil samples have been taken at the site and the results are pending. Further investigation will be performed to determine if a gasoline release occurred at this site. The RWQCB currently has no evidence that this site is a source of water supply well contamination.

Figure 12 shows the highest concentration of benzene detected in 1993-1994 in monitoring wells located at the intersection of Mount Hermon Road and Scotts Valley Drive. As shown, the highest concentrations of benzene are detected in the vicinity of the former Chevron Station. General groundwater flow is to the west




**LEGEND**

● Monitoring Well

**15** Highest Concentration of Benzene(ppb)

**ND** Not Detected

| June 1994 | **Figure 12** |
|---|---|
| DAVID KEITH TODD<br>Consulting Engineers, Inc.<br>Berkeley, California | **Possible Sources of Camp Evers Water Supply Well Contamination** |

and northwest, or in other words, from the vicinity of the Mount Hermon/Scotts Valley Drive intersection towards the affected wells. Accordingly, the groundwater flow direction and distribution of benzene in the area of the service stations indicate that this area probably is a source of contamination in the water supply wells. Accordingly, the Camp Evers benzene problem probably is a single extensive plume as illustrated on Figure 10.

**El Pueblo Road.** Three separate VOC problems have occurred in the El Pueblo Road area (between Scotts Valley Drive and Highway 17) affecting four SVWD water supply wells. The affected wells include Wells 6, 3A, 7 and 11. Tetrachloroethene (PCE) was detected first in Well 6 in 1984, and was consistently detected at low concentrations (less than 2.2 ppb) from 1984 to 1986. However, sampling performed in late 1986 and 1988 showed no detected concentrations of PCE. Well 6 is no longer in service. Second, TCE was detected in Wells 3A and 7 in 1984. However, VOCs have not been detected in these two wells since September 1991. A third problem was identified when chlorobenzene was detected in 1991 in Well 11. Chlorobenzene and dichlorobenzene were detected in varying concentrations in several other local wells during sampling performed in 1986 and 1988. Chlorobenzene was detected at 2.8 ppb in Well 11 during the most recent sampling event in March 1994. Figure 13 shows the approximate extent of the chlorobenzene plume based on the highest concentrations detected in Well 11 and other wells in the area.

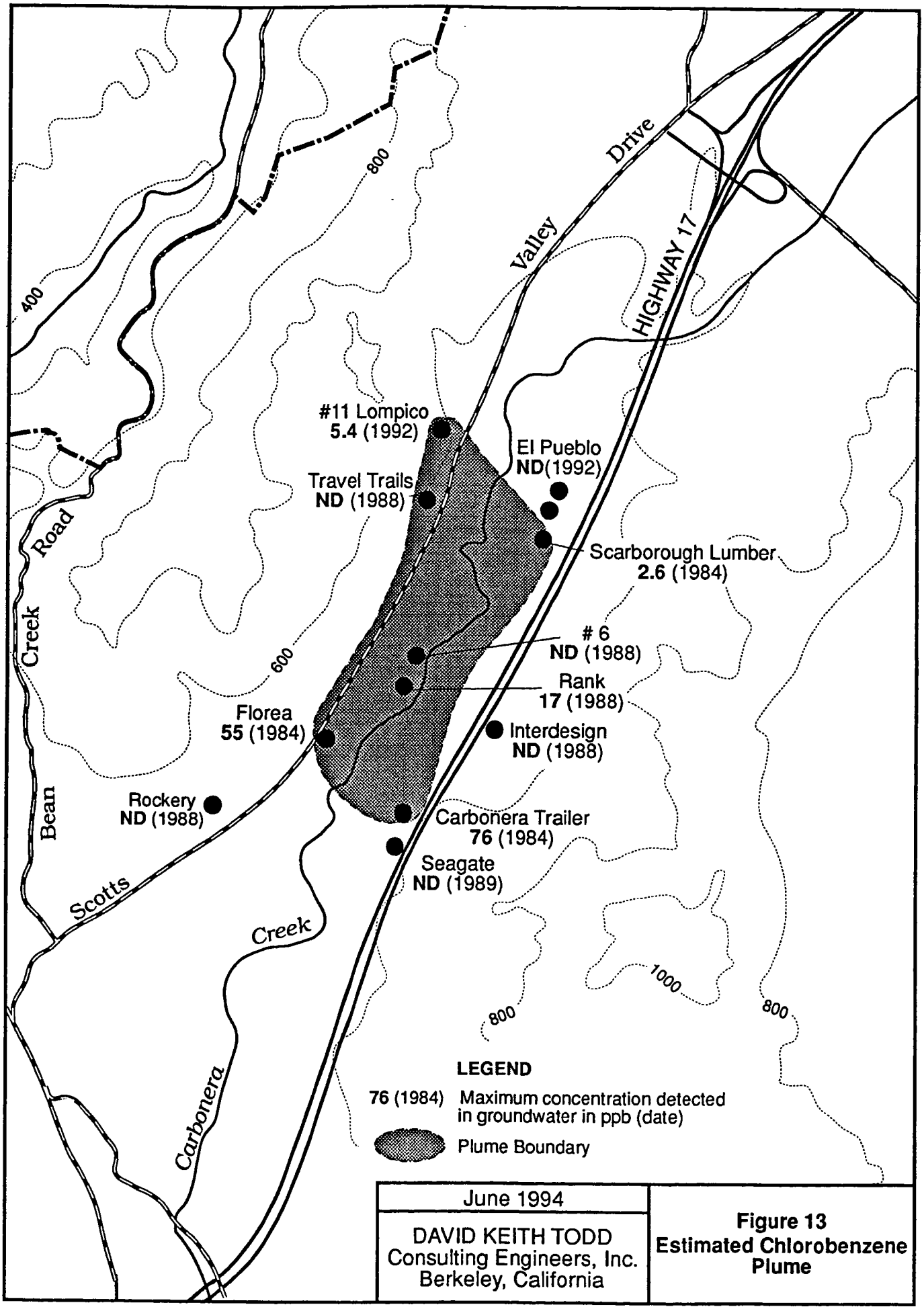



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**Figure 13**
**Estimated Chlorobenzene Plume**

Cal-EPA is the lead agency overseeing characterization and remediation of contamination detected in the El Pueblo Road area. Identification of possible sources of contamination in the El Pueblo Road area has been the focus of investigation for a number of years (California Department of Health Services (DHS), 1987 and 1988). The USEPA funded a study to identify current and past hazardous materials users in the area (Ecology & Environment, Inc., 1986). Priority sites were inspected for use and hazardous materials management practices. Several potential sources of contamination in the area have been identified; however, to date the source or sources of elevated chlorobenzene detected in Well 11 have not been determined (PRC Environmental Management, Inc., 1993). A discussion of potential sources of contamination detected in SVWD water supply wells is presented below.

(1) Scotts Valley Circuits, 66 El Pueblo Road.

VOCs have been detected in soil and groundwater at the Scotts Valley Circuits site. VOCs in soil were first detected at the site in December 1988 in the vicinity of an underground wastewater treatment sump, which is thought to be the primary source of contamination. Chemicals detected in perched groundwater at the site include: PCE, TCE, trichloroethane (TCA), dichloroethene (DCE), dichloroethane (DCA), benzene, toluene, and xylenes. Monitoring wells at the site are screened opposite this perched groundwater zone; however, deeper groundwater monitoring at the site has not been performed. Scotts Valley Circuits has completed a Remedial Investigation (On-Site Technologies, 1992 and 1993), and

a Feasibility Study (Cypress Environmental, 1993). The preferred remedial alternative is soil excavation, vapor extraction, and perched groundwater extraction and treatment. A final remedial action plan remains to be drafted and approved by the Cal-EPA following the results of a treatability study. The Scotts Valley Circuits site is a possible source of the contamination detected in Wells 3A and 7.

(2) Former Technical Plastics (Currently Seagate Technology and Si-Fab Corporation), 19 and 27 Janis Way.

Hazardous materials may have been disposed onsite. Soil sampling conducted in 1990 found various chemicals in the soil including: toluene (less than 6 ppb), PCE (2 ppb), ethylbenzene (less than 450 ppb), xylene (less than 100 ppb), 4-methyl,2-pentanone (3 ppb), hexanone (14 ppb), and styrene (less than 980 ppb). This site has moderate potential for release of contaminants to groundwater.

(3) J&E Machine (Currently Ashland Machines), 5998 Butler Lane.

The site was operated by J&E Machine from 1980 to 1986 and was cited by the RWQCB in 1984 for illegal discharge of TCE to Carbonera Creek and illegal hazardous waste storage. The site reportedly contained a 5,000 gallon underground storage tank. This site was given a high priority for further sampling by the Ecology and Environment, Inc. study; however, it appears that no further sampling has been performed at this site.

(4) Tate Western, 340-F El Pueblo Road.

Soil contamination with toluene (less than 6,300 ppb) was detected on an adjacent property due to Tate Western chemical handling activities. Approximately 36 cubic yards of affected soil and 3,000 gallons of contaminated rain water were removed from the site. No further sampling was recommended in the Ecology & Environment, Inc. study.

(5) Pettibone Signs, 17 Janis Way.

Small quantities of wastes may have been disposed onsite. This site was given a medium priority for further sampling in the Ecology & Environment, Inc. study. It does not appear that any additional sampling has been performed at this site.

(6) Carbonera Trailer Park, Disc Drive.

Chlorobenzene (76 ppb) and dichlorobenzene (1,100 ppb) have been detected in two groundwater wells located at this site. These concentrations are the highest detections of chlorobenzene and dichlorobenzene in groundwater in the El Pueblo Road area. No soil sampling has been done at this site. Due to the relatively high detections in wells on the site, a possible source may be located nearby.

(7) Septic Systems, regional.

All facilities in the El Pueblo Road area used septic systems and leach fields until 1970 to dispose of sanitary wastewater. Between 1970 and 1975, sewers were installed. Discussions with the Scotts Valley Department of Public Works indicates that a small percentage of businesses scattered around the city could still be on septic

systems. Improper disposal of chemicals into septic systems and leach fields could result in groundwater contamination. Septic system cleaners have in the past contained hazardous chemicals including orthochlorobenzene. There is a potential for inactive and active septic and leach field systems in the area to contribute to groundwater contamination.

**Watkins-Johnson.** Watkins-Johnson is located at 440 Kings Village Road adjacent to the Skypark Airport on the western perimeter of the City of Scotts Valley. Investigations initiated in 1984 found a number of organic compounds in soil and groundwater at the site. Site characterization and remedial activities were originally overseen by the RWQCB; currently the USEPA provides regulatory guidance because Watkins-Johnson is a proposed NPL site. A dilution tank located on the site and removed in 1987 is the major suspected source of site contamination. In the vicinity of the Watkins-Johnson site, the Santa Margarita aquifer is comprised of a perched and regional zone. TCE is the key constituent detected in perched and regional groundwater (Watkins-Johnson Environmental, Inc., April 1989). In 1987, a program of aquifer restoration was initiated (Watkins-Johnson Environmental, Inc., November 1989). Operation of remedial facilities at the site has reduced the extent of groundwater contamination at the site to within site boundaries. The Watkins-Johnson site is not a suspected source of contamination to water supply wells.

**Other Identified Contamination Sites.** Several other leaking underground storage tanks sites have been identified in Scotts Valley. These sites include:

- Jeff Mora Property, 5276 Scotts Valley Drive,
- Exxon Station, 5620 Scotts Valley Drive,
- Chevron Station, 6012 Scotts Valley Drive,
- Shell Station, 1 Hacienda, and
- Fast Gas, 5451 Scotts Valley Drive.

These sites show minor contamination which is either confined onsite or has been remediated to low levels. These sites are not likely sources of water supply well contamination.

### 4.3 Groundwater Contamination Prevention

Groundwater contamination prevention programs are the best strategy for minimizing future groundwater contamination problems. This is particularly true in Scotts Valley because of the permeability and susceptibility of local aquifers to contamination, difficulty in determining the sources of groundwater contamination, extended periods of time and high costs required to remediate known contamination problems, and added cost of wellhead treatment by water purveyors.

There are a number of groundwater contamination prevention activities which have been or could be implemented in Scotts Valley. The topics related to groundwater protection discussed in the following sections include well construction, abandonment, and destruction; hazardous material management; underground storage

tanks; septic tank disposal systems; and city planning and zoning. These activities are performed by various state and local agencies. While SVWD has some responsibility for the construction and destruction of supply wells, the prevention of groundwater contamination requires the cooperation of a number of local and state agencies. The regulatory framework for the implementation of groundwater prevention programs is discussed at the end of this section. Recommendations to improve groundwater protection are presented at the end of each section.

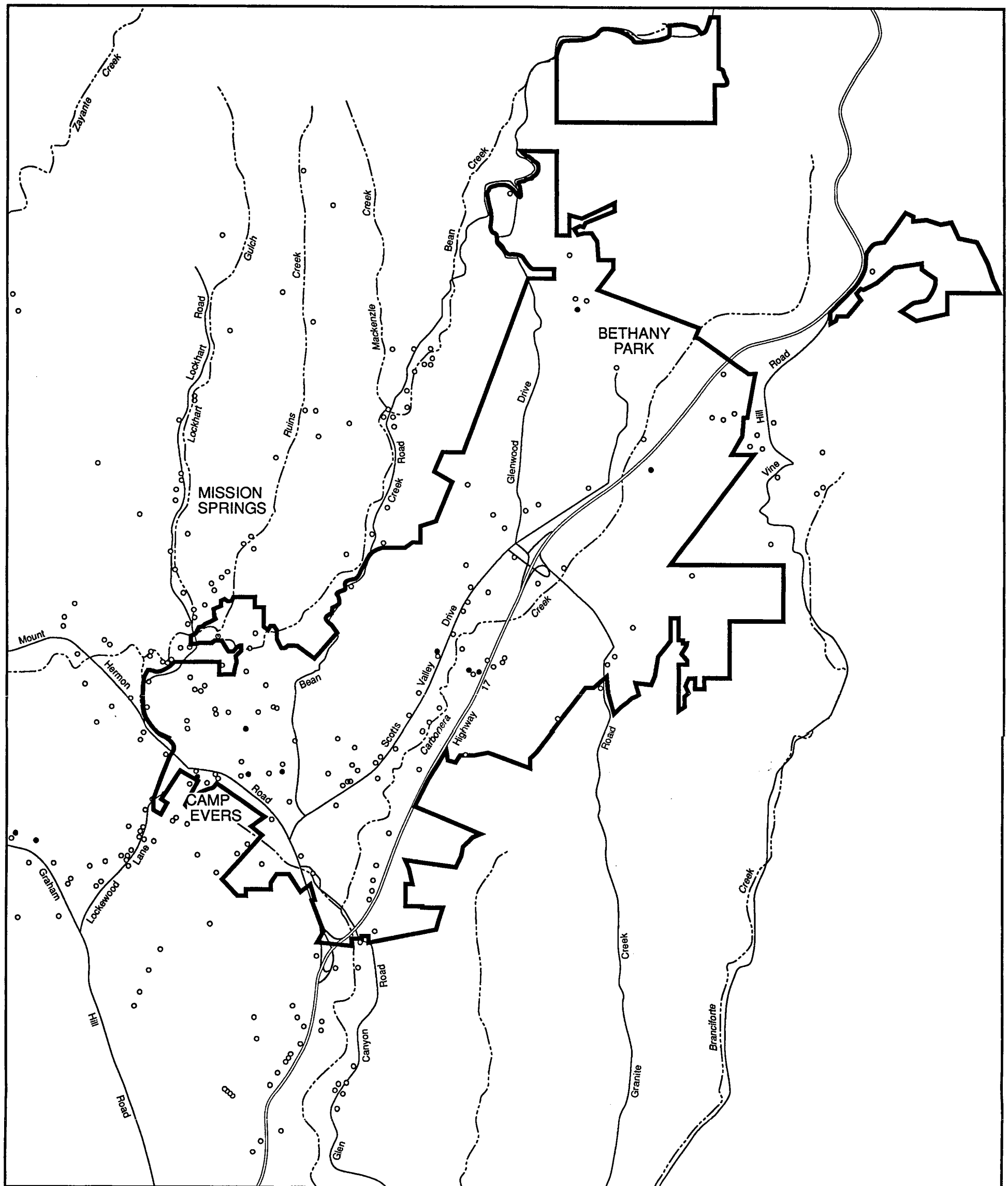
**Well Construction, Abandonment, and Destruction.** Water wells connect the ground surface to the aquifer, and can connect one aquifer to another; consequently they can act as conduits for the transmission of pollutants from the land surface to the aquifer or from a shallower aquifer to a deeper aquifer. However, properly constructed and destroyed wells are engineered to minimize such mechanisms of transmission.

Responsibility for regulation of the construction, abandonment, and destruction of water wells is divided between the DWR, SVWD, Santa Cruz County, SVFPD, and the USEPA. The California Water Code Section 231 requires the DWR to develop well standards to protect California's water quality. DWR Bulletin 74-81 (1981) and supplemental Bulletin 74-90 (1991) contain the minimum requirements for constructing, altering, maintaining, and destroying wells. Local governments may have more stringent standards than those of the DWR. In Scotts Valley, DWR standards

for the permitting, construction, abandonment, and destruction of water supply wells are enforced by SVWD and Santa Cruz County; while the permitting, construction, abandonment and destruction of monitoring wells and soil borings are enforced by the SVFPD.

A database of domestic, industrial, and municipal water supply wells and around the SVWD boundaries has been compiled by Todd Engineers. The database documents the well owner, location, uses, and construction and hydrogeologic information. Figure 14 shows the locations of known private, irrigation, industrial and municipal water supply wells in and around Scotts Valley. As can be seen on the figure, many wells have been constructed, with at least 100 wells drilled within the district boundaries. A review of the water well drillers reports show that many of these wells are old and screened at relatively shallow depths. It is likely that many of these wells are no longer in use and have been destroyed; however, documentation of well destructions is scarce and in many cases does not exist. It is likely that some of these wells have been lost or covered over at the surface and have not been properly destroyed. These lost and abandoned wells provide a potential conduit for the migration of contaminants from the ground surface to the depth penetrated.

In addition, since small private groundwater users in Scotts Valley are not well documented, it is not clear whether some private well users may be consuming groundwater that is contaminated with low levels of VOCs. There is no mechanism currently in place, other than newspaper articles, to inform small




**LEGEND**

- Scotts Valley Water District boundary
- Private domestic, irrigation or industrial well
- Municipal water supply well

N

0 2000

Scale in Feet

**Figure 14**
**Water Well Locations in the Scotts Valley Area**

June 1994

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private well owners of contamination problems.

The SVFPD implements DWR standards and the more strict standards for monitoring wells that were developed by the Santa Clara Valley Water District (SCVWD, 1989). The SVFPD keeps records of all monitoring well installations in Scotts Valley with the exception of monitoring wells installed at the Watkins-Johnson site, which are regulated by the USEPA. There are 87 groundwater monitoring, vadose zone monitoring, groundwater recovery, and vapor extraction wells documented in SVWPD records. An additional 51 monitoring wells are located on and around the Watkins-Johnson facility.

To date, Scotts Valley has had no documented problems associated with old wells acting as conduits for the migration of contaminants. Nonetheless, prevention of future problems can be facilitated by better documentation of existing wells and stricter enforcement of DWR guidelines.

**Recommendations**

- Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.
- Document the status of wells within the SVWD boundaries and update well inventory database (i.e. identify and inventory active and destroyed wells).
- Establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

- Given the existence of multiple aquifer systems within SVWD, implement well construction standards to prevent cross-contamination of aquifers (i.e. installation of conductor casings and minimum seal depths).
- Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.
- Establish a program to identify (e.g. during real estate property transfers) and encourage the proper destruction of abandoned wells within the SVWD boundaries.

**Hazardous Materials Management.** Hazardous materials users pose a threat to groundwater quality through accidental or intentional surface spills, leaking underground storage tanks, and improper handling, storage, and disposal. It should be noted that the general public also handles hazardous wastes in the form of paints, fertilizers, pesticides, household cleaners, and waste oil.

The SVFPD is the local agency which oversees hazardous materials management for the City of Scotts Valley, while hazardous wastes are regulated by the Santa Cruz County Health Services Agency, Environmental Health Service (Santa Cruz County). Santa Cruz County also oversees the household hazardous waste programs in Scotts Valley. The hazardous materials management program as implemented by the SVFPD is intended to insure that hazardous materials are properly stored and monitored, that leaks and spills are detected in a timely manner, and that proper

reporting and corrective actions are taken in the event of a leak or spill. A Hazardous Materials Management/Business Plan (HMMP) must be submitted by businesses or individuals who use or store toxic chemicals or hazardous materials over certain volumes, as part of the application for a Hazardous Materials Permit. The HMMP contains information on types and volumes of hazardous materials used, storage, and safety procedures.

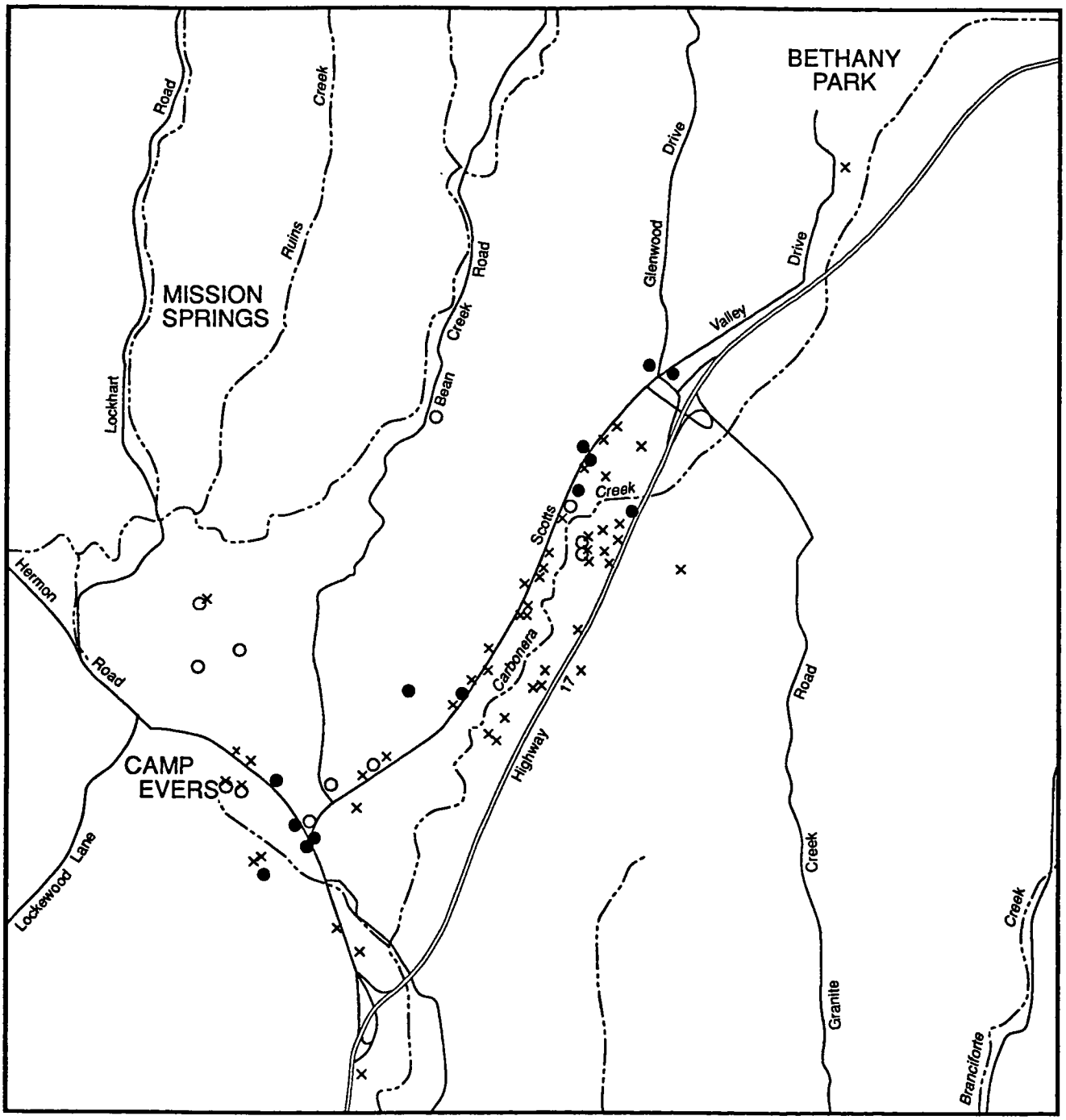
A risk management and prevention program (RMPP) is required if a location stores or uses extremely or acutely hazardous material. No business in Scotts Valley has been required to file a RMPP.

Figure 15 shows the locations of hazardous materials users in Scotts Valley on file at the SVFPD. Sixty-four facilities have been identified as hazardous materials users in Scotts Valley. As shown, hazardous materials users are clustered along Scotts Valley Drive and between Scotts Valley Drive and Highway 17. There are no hazardous waste transfer, treatment, storage, and disposal facilities (TSDF) in Scotts Valley.

**Recommendations**

It is recommended that SVWD cooperate with the city and other agencies to:

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Consider stricter regulations for hazardous material users.




**LEGEND**

- ● Underground Storage Tanks, Active
- O Underground Storage Tanks, Inactive, Removed or Closed in Place
- × Hazardous Materials Use

N

0 2000
Scale in Feet

**Figure 15**
**Underground Storage Tank and Hazardous Material Locations**

June 1994

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**Underground Storage Tanks.** The SVFPD implements state regulations for the installation, monitoring, use, and removal of underground storage tanks (USTs) in Scotts Valley. The SVFPD keeps a database that documents the locations, status, capacity, construction, and contents of USTs in Scotts Valley. The UST information is reported to State Water Resources Control Board (SWRCB).

Review of SVFPD records show that there are 37 active USTs located at 13 sites in Scotts Valley. Of the 37 active USTs, 15 are single-walled, and 22 are double-walled and meet new tank requirements for UST construction and monitoring standards. At least 50 USTs within Scotts Valley have been removed, while one tank was identified as closed in place and two previously unknown tanks are scheduled for removal. Figure 15 shows the locations of active, inactive, removed, and closed-in-place USTs in Scotts Valley, most of which are located along Scotts Valley Drive. Because of the density of USTs and other hazardous material use, this area has a high potential for release of pollutants to groundwater and surface water. It should be noted that it is likely that USTs may exist which have not been documented. Two recently discovered tanks on Scotts Valley Drive attest to this possibility. Other USTs may have been removed prior to institution of inspection programs without proper testing to determine if the tanks had leaked.

Chapter 6.7, Division 20 of the Health and Safety Code and the California Underground Storage Tank Regulations (Subchapter 16 of

Title 23 CCR), established a program for regulation of USTs that requires local implementing agencies to permit, inspect, and oversee monitoring programs to detect leakage of hazardous materials from USTs. The following requirements for new and old USTs are among those described in the California Underground Storage Tank Regulations.

New tank construction standards require that all new USTs (including associated piping) used for the storage of hazardous substances shall be required to have primary and secondary levels of containment. New tank monitoring standards require that all exterior surfaces of the USTs and the surface of the floor directly beneath the USTs shall be capable of being monitored by direct viewing. The liquid level in the USTs shall be recorded at the time of each inspection. The secondary containment system shall be equipped with a continuous monitoring system that is connected to an audible and visual alarm system.

The observation of any liquid around or beneath a UST shall require the owner/operator to undertake the following action or actions:

1) Conduct an appropriate laboratory or field analysis of the observed liquid. If the liquid is a hazardous substance, proceed with actions 2 and 3 below.
2) Conduct an appropriate tank integrity test.
3) If a leak is confirmed, immediately remove all hazardous substances from the UST and the secondary containment system.

Old tank monitoring standards apply to owners of existing USTs that do not meet new tank construction requirements. These standards require implementation of a monitoring program that is capable of detecting any unauthorized release from any portion of the UST system at the earliest possible opportunity. The monitoring program shall include visual and non-visual monitoring.

The owner or operator shall undertake all of the following activities if any liquid around or beneath an old UST is observed:

1) Any and all action necessary shall be taken to promptly determine if the observed liquid constitutes an unauthorized release.
2) Observed liquid shall be analyzed in the field or laboratory to determine if an unauthorized release has occurred.
3) The UST shall be tested utilizing a quantitative release detection method.
4) If the above steps indicate that an unauthorized release has occurred, the owner or operator shall replace, repair or close the UST.

The California Trade and Commerce Agency, Office of Small Business offers low interest loans for repairing underground petroleum storage tank projects (RUST). Qualified businesses have total resources not exceeding 21 million dollars over a three year period. Eligible projects include the upgrade, repair, or removal of underground storage petroleum products. Measures can also include minor cleanup. Loan amounts are from $10,000 to $350,000

with low, fixed-rate financing, and up to 20 years to repay.

The California State Legislature created the UST Cleanup Fund (SB 2004) to provide funding to eligible UST owners and operators for the cleanup of contaminated soil and groundwater caused by leaking petroleum USTs. Owners/operators of petroleum USTs are eligible for funding if they meet the following requirements:

1) There has been an unauthorized release of petroleum from the UST reported to and confirmed by the regulatory agency.
2) As a result of this unauthorized release, the owner/operator must take corrective action as required by a regulatory agency.
3) The owner/operator must be in compliance with any applicable financial responsibility requirements and by UST requirements.

The maximum amount available from the UST Cleanup Fund per occurrence is $990,000. Claimants are responsible for the first $10,000 of eligible corrective costs.

It is clear that leaking USTs have been a serious groundwater contamination source in Scotts Valley. Several sites have been identified where leaking USTs have impacted groundwater. The high cost and extended time required to identify and remediate these sites makes the prevention of leaks a desirable alternative. Single walled tanks pose a particular hazard because leakage is often not detected until a release has occurred. The current application of state standards to the use, monitoring, and removal of USTs may not provide adequate protection to the groundwater

resources of Scotts Valley. Although SVWD has no regulatory authority over USTs, SVWD should encourage stricter regulation.

**Recommendations**

SVWD should cooperate with the City of Scotts Valley and other agencies to:

- Develop more stringent local standards for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

**Septic Tank Disposal Systems.** Septic tanks and cesspools are one of the most frequently reported sources of groundwater contamination in the United States. Prior to 1964, all of Scotts Valley used septic systems, leach fields and cesspools for the disposal of wastewater. The first sewage treatment plant in Scotts Valley was built in 1965 and sewer lines were extended to various areas over a period of years. For example, homes and facilities in the El Pueblo Road area used septic systems and leach fields until 1970, while some residential neighborhoods located along Lockewood Lane south of Mount Hermon Road were not sewered until the mid-

1980s. Four major outlying residential areas still rely upon septic systems for waste disposal (Figure 16). Currently, all businesses and private residences within 200 feet of sewer lines are required to hook into the sanitary sewer system. Discussions with the Scotts Valley Department of Public Works indicate that a small percentage of businesses and private residences (less than 5 percent) scattered around the city could still be on septic systems.

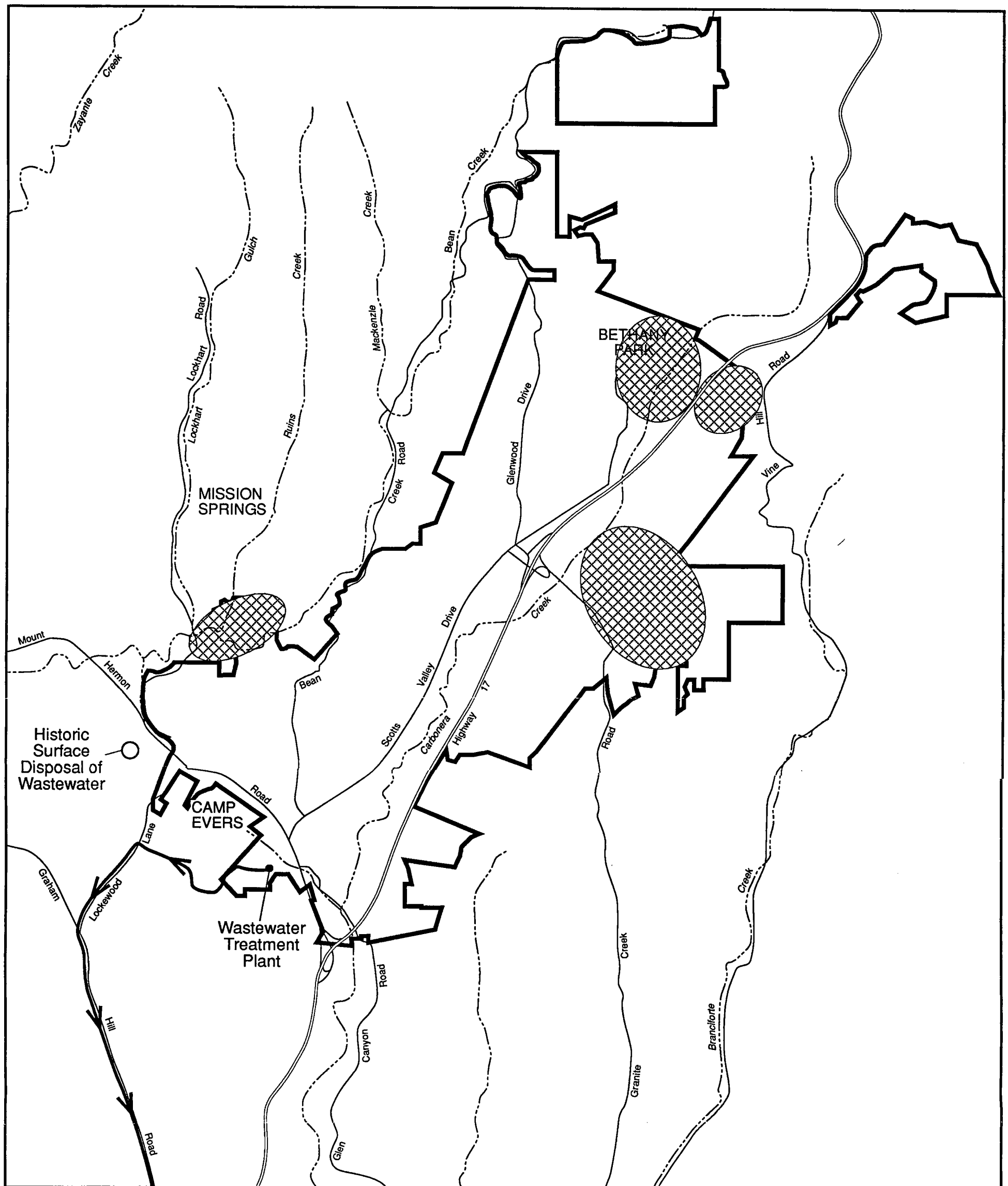
In the past, problems with elevated nitrate concentrations in groundwater have been attributed in part to use of residential septic systems. In addition, improper disposal of chemicals into septic systems and leach fields can result in the release of metals and organic constituents to groundwater. Septic system cleaners and drain cleaners contain hydrocarbons and chlorinated hydrocarbons which can leach into groundwater.

**Recommendations**

SVWD should cooperate with the City of Scotts Valley to:

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system; and
- Encourage all businesses and residences not currently hooked to the sanitary sewer system to connect to system.

**City Planning and Zoning.** A city zoning map, Figure 17, shows the distribution of land use in the City of Scotts Valley. Light




**LEGEND**

- Scotts Valley Water District Boundary
- Approximate Major Residential Areas on Septic Systems
- Treated Wastewater Disposal to Ocean

N

0 2000
Scale in Feet

**Figure 16**
**Wastewater Treatment and Disposal Facilities**

June 1994

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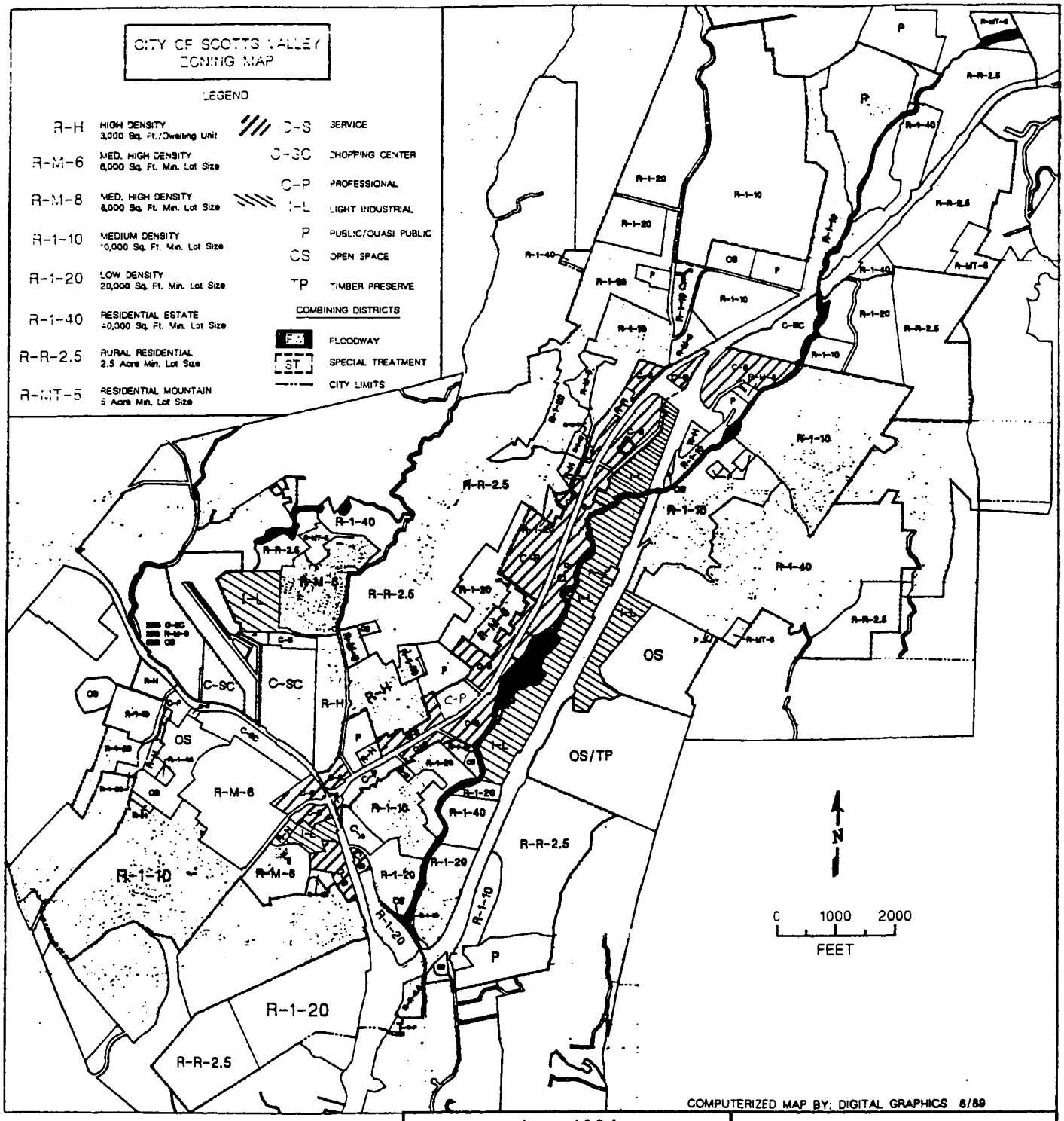
Consulting Engineers, Inc.
Berkeley, California




June 1994

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**Figure 17**
**City of Scotts Valley Zoning**

industrial and commercial service zones are shown to be concentrated along Scotts Valley Drive and Highway 17 and along Mount Hermon Road. These zones represent the areas of greatest risk to groundwater quality because they are current and potential locations of hazardous materials users, USTs, and potential sources of contaminant release. These areas have been recognized as "high risk" (Todd Engineers, 1988), and as needing greater management. Accordingly, groundwater prevention programs by the City and other agencies should focus on these areas as a first priority. On its part, SVWD should continue its policy of limiting groundwater supply development in shallow aquifers in these areas. In addition, SVWD should consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

**Recommendations**

SVWD should encourage the City to:

- Limit future industrial and commercial service development to existing areas.
- Encourage greater consideration by City planners of groundwater protection issues in land use planning.

**Summary.** In summation, the Scotts Valley groundwater basin is locally susceptible to groundwater contamination, and has experienced serious local groundwater contamination problems.

Several local, state, and federal agencies share responsibility for groundwater protection and remediation in Scotts Valley. However, no single regulatory agency has a regional outlook or authority on groundwater contamination problems.

SVWD does not have authority for the prevention, identification, or remediation of contamination sites. It does have some authority over the construction, abandonment, and destruction of water wells, and specific recommendations are provided to aid groundwater contamination prevention through this limited authority. However, SVWD is responsible for monitoring its groundwater supply and providing water satisfying state and federal drinking water standards. Given this responsibility, SVWD has delineated zones of groundwater contamination risk and has pursued a policy of developing groundwater supplies in areas and aquifers of low contamination risk. In addition, SVWD provides wellhead treatment for contaminated groundwater affecting some of its wells.

SVWD also monitors the status of groundwater contamination sites that pose a potential threat to groundwater resources, and to SVWD wells. Generally, key reports are sent to the SVWD; however, no official policy or agreement exists whereby SVWD is automatically and fully informed of groundwater contamination problems. Given SVWD's existing role and proven record in monitoring local water resources, and its critical responsibility in providing safe drinking water, SVWD should be automatically and fully informed of groundwater contamination situations. This information will become increasingly important if artificial

recharge or other local groundwater supply management efforts are implemented in the Camp Evers or Scotts Valley Drive areas. In turn, SVWD could help to provide a regional overview and aid in information sharing among agencies.

## Section 5

## CONCLUSIONS

Conclusions of each of the major sections of the report are summarized below.

### HYDROGEOLOGY

1. The areal extent, thickness, and depth of the local aquifers are strongly affected by erosion and geologic folding and faulting, resulting in a complex and varied setting for groundwater storage and flow. As a consequence, groundwater and storage available to a given well could be limited.

2. Much valuable information is available on the hydrogeology of the margins of the Scotts Valley groundwater basin. However, geologic data are relatively lacking for the central portion of the basin.

### GROUNDWATER SUPPLY

#### Monitoring

3. The water resource monitoring program is comprehensive, with an appropriate focus on the developed portions of the basin.

#### Groundwater Level Trends

4. Although the basin is not in overdraft, localized groundwater level declines have resulted in adverse effects, including drying up of shallow private wells, loss of production and efficiency in wells, and a somewhat lower groundwater quality.

5. The wet 1992-1993 season resulted only in a moderation of the extent and severity of localized groundwater level declines.

6. Although affected by recent drought, Bean Creek responded to the wet 1992-1993 season with increased baseflow during the summer of 1993.

**Perennial Yield and Groundwater Storage**

7. Perennial yield for the Scotts Valley groundwater basin has been estimated to be 4200 acre-feet/year. This is an average annual value and is relevant to the area of the Scotts Valley groundwater basin.

8. Groundwater storage in the developed portion of the basin has declined between April 1986 and April 1994 by an estimated 500 to 600 acre-feet/year, or about 10 percent of estimated total groundwater storage.

**AMBAG Model**

9. The model can be used to observe effects of proposed well locations and pumping configurations and potential recharge projects, consequently aiding in groundwater management.

10. The model can be supplemented by other computer programs for use in simulating migration of dissolved contaminants in groundwater.

**Pumpage**

11. About 70 percent of the total estimated groundwater production is metered by SVWD, SLVWD, Watkins-Johnson, and the Mount Hermon Association. Groundwater production was estimated for other groundwater users, including landscape irrigators, private water

purveyors, commercial and industrial firms, and domestic users.

12. Total estimated groundwater production is 3,460 AFY, not accounting for return flows to the groundwater basin via percolation from irrigation and landscaping ponds, leakage from pipelines, and percolation from septic tanks.

13. The estimated total groundwater pumpage amounts to over 80 percent of the estimated 4,200 AFY of perennial yield for the Scotts Valley groundwater basin, and is concentrated in the southeast one-quarter of the groundwater basin.

14. The efforts of SVWD to redistribute its pumpage have not been sufficient to mitigate localized groundwater declines. SVWD efforts should be supplemented by additional actions of SVWD and others to redistribute pumpage, minimize groundwater losses, and to initiate groundwater replenishment programs.

**Replenishment**

15. More than one replenishment program will be needed to mitigate localized groundwater level declines and to ensure long-term groundwater supply.

16. Six conceptual projects for direct artificial recharge or wastewater irrigation are presented with possible yields ranging from 20 to 200 AFY each.

## GROUNDWATER QUALITY

**Regulatory Responsibilities**

17. The Scotts Valley Fire Protection District oversees the City of Scotts Valley's hazardous materials management program,

implements state regulations of underground storage tanks, oversees monitoring and soil boring installation and destruction, and responds first to a hazardous material release.

18. The California Regional Water Quality Control Board (RWQCB) regulates sites where groundwater contamination occurs from underground tanks or other sources.

19. The California Environmental Protection Agency (Cal-EPA) oversees groundwater contamination sites where the potentially responsible party is not known or is not financially solvent.

20. The United States EPA oversees sites that are on or proposed for the Superfund list.

21. The Scotts Valley Water District does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. SVWD is responsible for monitoring of its water supply and provision of water satisfying state and federal drinking water standards.

**Groundwater Contamination**

22. Ten possible sources of the benzene contamination in Camp Evers have been investigated by the RWQCB. Of these, three service stations along Mount Hermon Road have been identified as possible sources.

23. Cal-EPA is the lead agency overseeing the characterization and remediation of contamination in the El Pueblo Road area, and is in the process of identifying possible sources of the TCE and chlorobenzene problems. Of seven possible sources, Scotts Valley Circuits has been identified as a possible source of TCE

contamination. A Remedial Investigation and Feasibility Study for the site have been prepared; a remedial action plan remains to be drafted and approved.

24. The United States EPA is overseeing remediation at the Watkins-Johnson site, which has reduced groundwater contamination to within site boundaries.

**Groundwater Contamination Prevention**

25. Prevention of groundwater contamination in Scotts Valley is important because of the susceptibility of aquifers to contamination, difficulty in determining sources of contamination, extended time and high costs to remediate contamination, and added costs of wellhead treatment by water purveyors.

26. Improperly constructed or abandoned wells can provide conduits for downward migration of contaminants from the ground surface.

27. SVWD and Santa Cruz County share responsibility for enforcing standards for permitting, construction, abandonment, and destruction of water supply wells.

28. Sixty-four facilities using hazardous materials exist in Scotts Valley, located mostly along Scotts Valley Drive.

29. Thirty-seven active underground storage tanks have been identified in Scott Valley, of which 22 are double-walled and meet new tank standards.

30. Septic tanks represent other potential sources of contamination.

## Section 6

## RECOMMENDATIONS

### HYDROGEOLOGY

1. Groundwater exploration efforts and hydrogeologic studies should be undertaken in cooperation with SLVWD and Santa Cruz County to more fully evaluate the Scotts Valley groundwater basin as a whole.

### GROUNDWATER SUPPLY

#### Monitoring

2. Continue data compilation on wells and geology and the program of climatic, surface water, and groundwater monitoring with annual reporting.

3. Encourage coordination of groundwater level monitoring by all agencies so that the quarterly measurements occur within a small time period, such as one week.

4. Expand data compilation and monitoring as groundwater exploration and production are extended into new areas, or as needed for groundwater replenishment projects or for groundwater contamination investigations or remediation.

#### Perennial Yield and Groundwater Storage

5. The perennial yield and groundwater storage of the Scotts Valley groundwater basin should be reevaluated in greater detail.

**AMBAG Model**

6. The model should be maintained, but revised as additional hydrogeologic and groundwater production data become available.

**Pumpage**

7. Information on wells and metered groundwater production should be compiled and updated regularly. Groundwater production by large groundwater users should be measured.

8. Following metering of major groundwater producers, consumptive use of groundwater should be analyzed.

9. SVWD should continue its efforts to redistribute its pumpage throughout its service area.

10. Roundtable meetings should be convened by the major groundwater producers to discuss means to analyze and mitigate groundwater level declines.

**Replenishment**

11. Replenishment projects should be planned and implemented in the context of basin-wide groundwater resource management, and coordinated when appropriate with SLVWD, Santa Cruz County, and major groundwater producers.

12. The conceptual replenishment projects, in addition to others that may be suggested, should be considered in greater depth. Additional investigations would include field work, computer modeling, cost/benefit analysis, and assessment of environmental impacts.

13. SVWD, SLVWD and other groundwater producers should continue efforts to encourage conservation measures such as low flow plumbing fixtures and drought resistant vegetation.

14. SVWD should continue to work with the City of Scotts Valley to encourage appropriate recycling and reuse of wastewater.

**GROUNDWATER QUALITY**

SVWD does not have regulatory authority for the prevention, identification, or remediation of groundwater contamination. However, SVWD and Santa Cruz County share responsibility for enforcing standards for construction, abandonment, and destruction of water supply wells. Accordingly, specific recommendations for SVWD are as follows:

**Well Construction, Abandonment, and Destruction**

15. Continue to update and maintain the well inventory database to include all wells within SVWD boundaries.

16. Conduct a survey to document the status of wells within SVWD boundaries, and to identify both active and destroyed wells.

17. Once the well survey is complete, establish a notification system to alert private groundwater users of contamination problems within the SVWD boundaries.

18. Given the existence of multiple aquifer systems within SVWD implement well construction standards to prevent cross-contamination of aquifers (i.e. installation of conductor casings and minimum seal depths).

19. Establish and enforce a permitting system for well destructions within the SVWD boundaries and track well destruction in the well database.

20. Establish a program to identify (e.g. during real estate property transfers) and encourage the proper destruction of abandoned wells within SVWD.

21. In addition, SVWD is responsible for provision of water satisfying state and federal drinking water standards. Accordingly, SVWD should continue its policy of siting new wells in areas and aquifers that are less susceptible to contamination. SVWD should also consider installation of monitor wells sited between possible contamination source areas and major municipal well fields to allow early identification of groundwater contamination problems.

The remaining recommendations, grouped according to the specific areas of groundwater contamination prevention, are long-term and require cooperations between agencies.

**Hazardous Materials Management**

- Establish a public/business education program emphasizing the importance of the proper disposal of hazardous materials.
- Institute programs encouraging reduced hazardous material use and waste minimization programs.
- Consider stricter regulations for sites which use hazardous materials.

**Underground Storage Tanks**

- Develop more stringent local standard for the use, monitoring, removal, and replacement of USTs.
- Eliminate exemptions to UST requirements such as residential tanks, farm tanks, and elevator vaults.
- Require replacement of single walled tanks or upgrade monitoring requirements.
- Evaluate feasibility of local regulation of UST cleanups to speed the process of source identification and remediation.
- Discourage additional installations of USTs in Scotts Valley.

**Septic Tank Disposal Systems**

- Review records of Scotts Valley City Finance Department to identify businesses and residences not currently connected to sanitary sewer system.
- Encourage hookup of all businesses and residences not currently connected to the sanitary sewer system.

**City Planning and Zoning**

- Limit future industrial and commercial service development to existing areas.
- Encourage greater consideration by City planners of groundwater protection issues in land use planning.

Overall SVWD should encourage and cooperate fully with responsible agencies in the investigation and remediation of contamination sites, and in the identification of potentially responsible parties. SVWD also can provide a regional groundwater management overview and aid in information sharing among agencies.

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# Technical Memorandum 4-Regional Water Demand for Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project:

November 2010

Prepared for

County of Santa Cruz
Environmental Health Services
701 Ocean Street
Room 312
Santa Cruz, CA 95060-4011

K/J Project No. 0864005

**Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.**

November 2010

# Technical Memorandum 4 – Regional Water Demand

To: Mike Cloud and John Ricker, Santa Cruz County Health Services Agency

From: Sevim Onsoy and Sachi Itagaki, Kennedy/Jenks Consultants, Mary Stallard, Montclair Environmental

Subject: **Regional Water Demand**
Santa Cruz County Conjunctive Water Use and Enhanced Aquifer Recharge Study
K/J 0864005

## 1. Introduction

Kennedy/Jenks Consultants (Kennedy/Jenks) is pleased to provide the Santa Cruz County Health Services Agency (County) with Technical Memorandum 4 (TM4) in support of the Conjunctive Use and Enhanced Aquifer Recharge Project (Conjunctive Use Project). The Conjunctive Use Project is one of sixteen projects funded by a Proposition 50 Water Bond grant from the State Water Resources Control Board to the Regional Water Management Foundation, a subsidiary of the Community Foundation of Santa Cruz County. The Conjunctive Use Project is Project 3 of the grant and is being administered by the County.

### 1.1 Purpose

The objective of the Conjunctive Use Project is to assess the most the appropriate approaches for coordinating water projects in the Santa Margarita Groundwater Basin for increasing the volume of groundwater storage in order to improve the drinking water supply reliability, mitigate declines in groundwater levels, and increase stream baseflow (Figure 1). The Conjunctive Use Project will investigate the opportunities to use water exchanges, winter streamflow diversion, and/or reclaimed wastewater to replenish groundwater storage (Figure 1).

Understanding of the regional water supply is an important component for the Conjunctive Use Project. TM4 provides a brief summary of the overall regional water supply and demand in the Santa Margarita Groundwater Basin and provides a framework and boundary in which to evaluate potential projects. Additional refinements to this work will be useful, particularly after the 2010 UWMP update and resolution of instream flow requirements to further evaluate water needs and availability. This work corresponds to Task 4 of the County's Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project general scope of work (SOW). Task 4 consists of an inventory of current and future water supply and demand, and identification of other potential water sources and issues.

TM4 provides a regional evaluation to look for potential partners in the vicinity of the specific project area. The regional area includes the northern portion of Santa Cruz County and the specific project area is the southwestern portion of the Santa Margarita Groundwater Basin, and


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includes parts of Scotts Valley District (SVWD), San Lorenzo Valley Water District (SLVWD) and the City of Santa Cruz Water Department (SCWD) as shown on Figure 1.

# 2. Scotts Valley Water District

The SVWD provides water to the majority of customers in the City of Scotts Valley and to some customers outside the city limits. In 1994, SVWD formally adopted its Groundwater Management Plan (Todd Engineers, 1994), and has been managing groundwater resources through a comprehensive monitoring program of groundwater conditions in the Scotts Valley area for over 20 years. Results, analysis and interpretation of the monitoring program are reported each year in the Annual Groundwater Management Report. The most recent was issued in May 2009 (Kennedy/Jenks, 2009a). Below is a brief summary of the information provided in the Annual Report and other sources.

## 2.1 Current Water Supply and Demand

The following subsections provide information on current water supply and demand. This information comes from the SVWD Groundwater Management Program WY2007 and WY2008 Annual Report (Kennedy/Jenks, 2008, 2009a), the SVWD Urban Water Management Plan (SVWD, 2005), and the Groundwater Modeling Study of the Santa Margarita Groundwater Basin (ETIC, 2006).

### 2.1.1 Groundwater Supply Sources

Groundwater production currently provides 100% of the SVWD's potable water supply from seven production wells: Groundwater production by SVWD in water year 2008 (WY2008) was 1,664 acre-feet per year (AFY). The water year represents the period from October to the following September, and is used because if more closely approximates the climatic conditions in the area which control water usage. Precipitation, in the form of rainfall, is the primary source of groundwater recharge in the basin. Groundwater recharge occurs from both the direct percolation of rainfall through the soil and the infiltration of runoff through streambeds (Kennedy/Jenks, 2009a).

The WY2008 groundwater production represents a decline of about 94 acre-feet from WY2007, and a 400 acre-feet decline over the five-year interval from WY2003 to WY2008. The WY2008 groundwater production is about 20% lower than during WY2003. Prior to 2003, groundwater production grew accordingly with the increase in population in Scotts Valley (Figure 2). From WY1977 through WY2003, groundwater production rose steadily from about 500 acre-feet to over 2,000 acre-feet (Figure 2). Groundwater production from WY2005 through WY2008 has averaged approximately 1,720 AFY (Kennedy/Jenks, 2009a).


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Figure 3 shows SVWD monthly production on average from WY1997 through WY2004, as well as specifically in WY2006 and WY2007. As shown, monthly water production is typically between 100 and 150 acre-feet/month during the wetter months of November through April and between 175 and 250 acre-feet/month during the drier months of May through October. The lower summer demand in WY2007 as compared with WY2006 and the longer-term average is attributed to increased water recycling and conservation during WY2007 (Kennedy/Jenks, 2008).

### 2.1.2. Other Water Supply Sources

Since WY2004, SVWD has actively worked to control growth of water supply demand primarily through implementing the Water Conservation and the Recycled Water Programs. The observed decline in groundwater production is considered to primarily represent the effects of these programs. In the past five years groundwater production has steadily declined by about 75 AFY, even though the number of service connections has continued to grow (Kennedy/Jenks, 2009a).

Water Conservation: In areas where groundwater is the primary source such as SVWD, water conservation can be considered as an in-lieu groundwater recharge source as it helps to sustain groundwater levels and long-term groundwater production by reducing groundwater pumping. In recent years, SVWD has implemented several water conservation policies and practices to encourage water conservation among customers through coordinating public outreach activities, issuing monetary rebates to customers, and implementing conservation best management practices (BMPs). Among these activities, SVWD added a water conservation section to its website to promote rebate program and indoor/outdoor water conservation ideas (http://www.svwd.org/index/Water Conservation).

SVWD adopted the California Urban Water Conservation Council s (CUWCC) Memorandum of Understanding (MOU) in 2005. As a signatory to the MOU, SVWD reports to the CUWCC on the implementation status of conservation BMPs as requested by the CUWCC. The Water Conservation Program was credited with reducing groundwater production by 250 to 450 acre-feet during WY2008 (Kennedy/Jenks, 2009a).

Water Recycling: SVWD s Water Recycling Program augments the water supply and offsets groundwater pumping for non-potable uses, especially for landscape irrigation. The source of recycled water is the tertiary water treatment plant operated by the City of Scotts Valley in conjunction with the SVWD.

Recycled water deliveries have been increasing steadily since they began in 2002, reaching nearly 159 acre-feet serving 26 sites in WY2008 (Figure 4). Through WY2008, all of the recycled water use sites were located within the Santa Margarita Groundwater Basin. Therefore, all of the approximately 159 AFY of recycled water usage is considered to represent


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an equivalent decrease in groundwater pumping in the basin. This reduced pumping is considered to be left in storage in the groundwater basin and available for future beneficial use. Currently, SVWD estimates that approximately 80 acre-feet of this decrease in groundwater pumping is realized directly by the SVWD while the remainder is realized by the other purveyors in the area (Kennedy/Jenks, 2009a).

Therefore, the SVWD Water Conservation and Water Recycling Programs combined have been credited with successfully decreasing the SVWD groundwater demand between 2505 and 450 AFY, which represents a 14 to 22 reduction over existing demand (Kennedy/Jenks, 2009a). It should be noted that to continue to maintain these water savings, conservation programs should account for decay of device effectiveness and maintain funding for replacement of devices over time.

### 2.1.3 Water Use by Customer Type

SVWD serves primarily residential customers with some commercial development. Computer software development and disk drive assembly are the major industries in the area. Currently, there is no commercial agriculture in the service area. Based on the information from the SVWD s 2005 UWMP (SVWD, 2005), SVWD had 3,773 active water service connections that served an estimated population of 11,195 in 2005 (Table 1). Single family residential is the largest customer type in terms of both the number of accounts and total amount of water consumed. Approximately 1,250 AFY of water delivered by SVWD was used by the 3,054 single-family customers in 2005. This represents about 62 of total water delivered. Except for the commercial sector and parks/landscape customers, water used by other customer types is relatively small (SVWD, 2005).

## 2.2 Future Water Supply and Demand

The population in the SVWD service area is projected to increase by 9 from 2005 to 2025, reaching 12,288 (SVWD, 2005). Although the UWMP does not predict when build-out is likely to occur in Scotts Valley, it notes that since the terrain in the Scotts Valley area reduces the available land for development; most new connections after 2005 will most likely be created by zoning changes to a higher density, infill projects, and redevelopment.

Accordingly, residential growth within the SVWD service area is expected to occur with the addition of more multi-family units and condensed housing. The number of metered service connections is projected to reach 4,110 by 2025, which is an 8 increase from the 2005 conditions (SVWD, 2005). This anticipated increase in growth and development will continue to put pressure on SVWD s groundwater supply; however, production volumes for the past several years (Figure 2) indicate that this pressure will be alleviated to some extent through water conservation, water recycling, and possibly other water sources, as described further in Section 2.2.1 below.


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**Table 1 - SVWD Current Number of Customers and Water Use**

| Customer Class | No. of Accounts (8/31/05) | 2005 Usage (AFY) | Percent of Total Water Use |
|---|---|---|---|
| Single Residential | 3,054 | 1,249 | 62 |
| Residential - Duplex | 68 | 35 | 1.7 |
| Residential - Triplex | 12 | 6 | 0.3 |
| Residential 4-Plex | 21 | 18 | 0.9 |
| Residential - Multi Unit | 26 | 40 | 2 |
| Landscape | 66 | 80 | 4 |
| Parks | 16 | 2 | 0.1 |
| *Landscape/Parks – Recycled* | *21* | *122* | *6.1* |
| School | 22 | 56 | 2.8 |
| Public Buildings | N/A[(a)] | 12 | 0.6 |
| Fire Service | 202 | 2 | 0.1 |
| Commercial | 209 | 277 | 13.8 |
| Industrial | 58 | 110 | 5.5 |
| **Total** | **3,775** | **2,009** | **100** |

Source: Compiled from data in Tables 2-3 and 4-2 of the 2005 UWMP (SVWD, 2005).
(a) N/A indicates no specific information given.

### 2.2.1 Future Water Supply

The SVWD 2005 UWMP presents estimates of sustainable yield for the entire Santa Margarita Basin, which includes the area tapped by SVWD production wells in addition to the SLVWD well fields and several other water purveyors and private users. As reported in the UWMP, the groundwater sustainable yield for the Santa Margarita Basin is estimated to be 4,200 AFY (Table 2) (SVWD, 2005). This volume was originally approximated in 1995, and was reevaluated and deemed reasonable in 1998 using the basic water balance equation: inflow minus outflow equals change in storage (SVWD, 2005).

In 2006, the basin-wide Santa Margarita Basin Groundwater Model was completed. Based on this analysis, the sustainable yield for the entire Santa Margarita Basin was estimated at 3,320 AFY (ETIC 2006) which is significantly less than the earlier estimates using the overall water balance approach. Further analysis estimated the sustainable yield in the Scotts Valley portion of the Santa Margarita Basin at 2,600 AFY (ETIC 2006).

The 3,300 AFY estimate represents the groundwater volume that is available under the current production well pumping configuration without causing any overall change in storage, while the


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4,200 AFY estimate represents the groundwater volume that can be removed from the Basin given an optimal spatial distribution of wells and average aquifer conditions. In addition to the assumption of optimal well locations, there are other assumptions and uncertainties inherent in defining inflows and outflow for the basin that contribute to the overall uncertainty in the 4,200 AFY estimate. To be conservative, 3,320 AFY is used as the best current estimate of available groundwater volume in the Santa Margarita Basin and that is the volume included in Table 2 below and in this section. Using 3,300 AFY as the Santa Margarita Basin sustainable groundwater yield, the total supply available from the various sources will increase from 3,450 AFY in 2005 to 3,855 AFY in 2025/

The projected increase in supply is a result of a projected increase in recycled water from the SVWD (Table 2). As presented in Section 2.1.2, 133 acre-feet of recycled water were supplied by SVWD in WY2007. This is just 12 of the maximum 1.0 million gallon per day (MGD) tertiary wastewater treatment plant capacity for generating recycled water (SVWD, 2005). As shown on Table 2, projections in the UWMP are that recycled water supply will increase in response to demand to 535 AFY by 2015 and remain at that level through 2025.

**Table 2 - Santa Margarita Basin Current and Projected Future Water Supply**

| Water Supply (AFY)[(a)] | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|
| Groundwater (sustainable yield) | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 |
| Recycled Water | 130 | 350 | 535 | 535 | 535 |
| **Total Supply** | **3,450** | **3,670** | **3,855** | **3,855** | **3,855** |

Source: SVWD s 2005 UWMP for Recycled Water and ETIC 2006 for Groundwater
(a) Estimated for normal year hydrologic conditions.

Estimates of recycled water demand (and supply) are based on potential new customers identified by the SVWD (SVWD, 2005). The SVWD Groundwater Management Plan 2007 Annual Report (Kennedy/Jenks, 2009a) indicates that several efforts are underway to expand the SVWD Water Recycling Program through the development of a Facilities Planning Report that is being completed in 2009 (Kennedy/Jenks, 2009b).

In addition, the City of Scotts Valley has passed an ordinance mandating use of recycled water for new construction where economically feasible (Kennedy/Jenks, 2009a). As a participant in the Santa Cruz County Conjunctive Use Study, Phase 1 currently in progress, the feasibility of injecting/recharging excess wet season recycled water into groundwater during the winter is being evaluated. Draft groundwater recharge reuse regulation was issued by the Department of Public Health in August 2008 for allowing recharge of aquifers with recycled water. Some of the constraints on groundwater recharge reuse discussed in the draft regulation include the requirement for dilution water prior to recharge, minimum retention time in the aquifer of 6


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months before entering a drinking water well as documented by a tracer study, total organic carbon limitations, and extensive monitoring of both wastewater treatment and groundwater during operation. As a result of the extensive requirements, which may be difficult to physically meet within Scotts Valley, and because recycled water demand for irrigation in excess of supply on a year-round basis has been identified, it is unlikely that recharge of recycled water will be recommended at this time.

Another potential source of groundwater supply is increased recharge by storm water. Rainfall that is captured by storm drains that discharge directly to creeks is essentially lost as a source of groundwater recharge. The topic of surface water availability and the consequence of direct discharge of stormwater to creeks are described in greater detail in the technical memorandum for Task 2. Recent groundwater model analysis by the SVWD suggests groundwater recharge lost due to precipitation runoff in the Scotts Valley Groundwater Subarea in the range of 500 and 1,000 AFY (Kennedy/Jenks, 2009a).

Increased urbanization and direct piping of stormwater to Carbonera Creek has increased runoff and reduced groundwater recharge. The City of Scott s Valley Storm Water Management Plan (SWMP) that was approved, with modifications, by the Central Coast Regional Water Quality Control Board in March 2009, includes interim hydromodification control criteria for new and redevelopment projects. Hydromodification are changes to the storm water runoff characteristics of a watershed caused by changes in land use that result in increased downcutting and erosion in creeks. The SWMP and hydromodification control criteria will likely result in measures to reduce runoff that will, in turn, increase recharge. The hydromodification criteria will eventually be enforced through a new city ordinance (City of Scotts Valley, 2008).

SVWD s long-term goal for evaluating potentially viable new water supplies is to actively investigate and ultimately implement groundwater augmentation measures that would increase long-term groundwater supplies and provide for future water supply reliability and security. In addition to significantly increasing recycled water supply and increasing storm water recharge, SVWD plans to diversify its water portfolio through other potential long-term options for groundwater augmentation, including increased water conservation and in-lieu recharge (Kennedy/Jenks, 2008). SVWD anticipates groundwater augmentation in the range of 500 to 1,000 AFY in the long-term in an effort to significantly increase groundwater levels in the Scotts Valley area (Kennedy/Jenks, 2008).

### 2.2.2 Future Water Demand

Based on the 2005 UWMP, total SVWD demand is also projected to increase gradually from 2,011 AFY in 2005 to 2,346 AFY in 2025 (Table 3). Considering other groundwater users in the Santa Margarita Groundwater Basin (primarily SLVWD), total demand in the Scotts Valley area in 2025 is projected to reach 4,548 AFY, which is about a 12 increase from total demand in 2005 (SVWD, 2005).


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As discussed in Section 2.1.3, SVWD groundwater production in recent years declined from its peak in WY2003 to an average of 1,740 AFY for WY2005 through WY2007 (Figure 2). Based on the 2005 UWMP projections (SVWD, 2005), SVWD groundwater pumping is anticipated to increase to 1,891 AFY by 2010, then decrease to 1,746 AFY by 2015, and then slowly increase to 1,811 AFY by 2025 (Table 3). Although these projections show groundwater pumping not changing significantly, the 2005 UWMD indicated that demand is projected to continue to increase. However, recent economic downturn, additional efforts in water conservation, and future measures to meet California's goals to reduce statewide per capita water consumption 20% by the year 2020 (20x2020) will likely result in minimal increases to groundwater pumping rates in the near term.

In addition, the SVWD's Recycled Water Program continues to expand, and much of the increased demand in the SVWD service area is projected to be met primarily with recycled water. Future demand projections for SLVWD and other water users in the Santa Margarita Basin are also included in Table 3. Future demand for SLVWD is discussed further in Section 3.2 and for other water users is discussed in Section 5. In aggregate, Table 3 indicates that there will likely be a continued deficit which could be met with groundwater pumping in the future. As the 2010 UWMP are prepared and demand projections revised to reflect water conservation efforts, it is likely that the deficit will be further minimized. It may be prudent in future phases of this project to revisit the overall supply and demand as well as Scotts Valley specific supply and demand.

**Table 3 - Santa Margarita Basin Current and Projected Future Water Supply and Demand**

| Water Supply and Demand (AFY) | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|
| **Total Supply[(a)]** | **3,450** | **3,670** | **3,855** | **3,855** | **3,855** |
| SVWD Potable Demand | 1,881 | 1,891 | 1,746 | 1,785 | 1,811 |
| SVWD Recycled Water Demand | 130 | 350 | 535 | 535 | 535 |
| **Total SVWD Demand** | **2,011** | **2,241** | **2,281** | **2,320** | **2,346** |
| Other Demand[(b)] | 1,993 | 2,046 | 2,100 | 2,153 | 2,202 |
| **Total Demand** | **4,004** | **4,287** | **4,381** | **4,473** | **4,548** |
| Estimated Consumption (93% of Total Demand) | 3,724 | 3,987 | 4,074 | 4,160 | 4,230 |
| **Total Supply Minus Estimated Consumption** | **-274** | **-317** | **-219** | **-305** | **-375** |

Source: UWMP (SVWD, 2005) and Annual Report (ETIC, 2006).
(a) See Table 2 above for detail.
(b) Includes SLVWD well fields and other production in the Santa Margarita Groundwater Basin.


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Table 4 presents the SVWD□s current and anticipated water demand by each customer type as presented in the UWMP (SVWD, 2005). The total water demand is estimated to reach approximately 2,242 AFY in 2010, an increase of approximately 230 AFY or about 10□ from the 2005 demand. By 2025, estimated demand would reach approximately 2,347 AFY, about 14□ higher than the 2005 demand.

**Table 4 - SVWD Projected Future Water Demand by Customer Class**

| Customer Class | 2005 | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|
| Single Residential | 1249 | 1378 | 1401 | 1431 | 1437 |
| Residential □Duplex | 35 | 41 | 42 | 43 | 43 |
| Residential □Triplex | 6 | 8 | 8 | 8 | 8 |
| Residential 4-Plex | 18 | 24 | 24 | 26 | 26 |
| Residential □Multi Unit | 40 | 52 | 57 | 58 | 58 |
| Commercial □Retail | 184 | 205 | 209 | 213 | 215 |
| Commercial □Offices | 93 | 104 | 106 | 107 | 109 |
| Landscape □Domestic | 202 | 225 | 229 | 233 | 236 |
| Industrial | 110 | 123 | 125 | 127 | 129 |
| School | 56 | 63 | 64 | 65 | 66 |
| Parks | 2 | 3 | 3 | 3 | 3 |
| Public Buildings | 12 | 13 | 14 | 14 | 14 |
| Fire Services | 2 | 3 | 3 | 3 | 3 |
| **Total[(a)]** | **2009** | **2242** | **2285** | **2331** | **2347** |
| **□ Increase from 2005** | **0** | **10.4** | **12.0** | **13.8** | **14.4** |

Source: UWMP (SVWD, 2005)
(a) Totals in this table differ slightly from those shown in Table 3, also from the UWMP.

## 3. San Lorenzo Valley Water District

Based on information on their website (www.slvwd.com), the SLVWD serves more than 7,300 metered connections. Established in 1941, the District supplies water to the southwestern portion of the City of Scotts Valley and the communities of Boulder Creek, Brookdale, Ben Lomond, Zayante, Ma□ana Woods and Felton. In 2007, the Ma□ana Woods Mutual Water Company formally joined SLVWD, and SLVWD took over the operation of the two Ma□ana Woods production wells. The Ma□ana Woods Mutual Water Company was previously a private water supplier that delivered water to its residences near Scotts Valley. In 2008, SLVWD took over as water supplier for the City of Felton, when the SLVWD completed the purchase of the system from German-owned Rheinisch-Westf□lisches Elektrizit□tswerk (RWE).


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## 3.1 Current Water Supply and Demand

SLVWD has recently completed a Watershed Master Plan (SLVWD, 2009) and a Water Master Plan (Johnson, 2009). A brief summary is provided below based on information from these reports and other sources.

### 3.1.1 Water Supply Sources

SLVWD relies entirely on local water supplies of groundwater and of surface water from five tributaries to the San Lorenzo River, all with pre-1914 water rights. SLVWD does not import water from state or federal agencies (SLVWD, 2009, Johnson, 2009).

SLVWD's surface water supply flows primarily from creeks on the western side of the watershed. Together, these creeks, which are tributaries to the San Lorenzo River, provide approximately half of the total water supply (SLVWD, 2009). SLVWD currently operates four standalone water systems with separate water supplies: The Northern System, the Southern System, the Manana Woods System and the Felton System. Together, these four water systems serve approximately 7,400 connections for 22,500 people (Johnson, 2009, SLVWD, 2009). The Southern System and the Manana Woods System each serve a portion of the Scotts Valley area. The Southern System and the Manana Woods system rely solely on groundwater.

SLVWD produces groundwater using four well fields: the Pasatiempo, the Olympia, the Quail Hollow, and the recently-acquired Manana Woods fields. The Pasatiempo and Manana Woods well fields are in the Pasatiempo Groundwater Subarea in the southwest portion of the Santa Margarita Groundwater Basin, and are within the specific project area for this conjunctive use evaluation (Figure 5). These well fields are southwest of the SVWD boundary. The Olympia and Quail Hollow wells produce water from the central portion of the Santa Margarita Groundwater Basin, outside of the conjunctive use project area. There are currently two active Pasatiempo production wells, one Manana Woods well, two Olympia wells, and two Quail Hollow wells (Johnson, 2009).

In addition to groundwater, SLWVD seasonally supplements the water supplied by the Olympia wells with surface water from several creeks in the northern portion of the basin. SLWVD also has water rights to Loch Lomond Reservoir, but has not exercised those rights to date (Johnson, 2009) The recently acquired Felton supply consists of surface water diversions from tributaries to San Lorenzo River located downstream of the other SLVWD surface water diversions.

### 3.1.2 Other Water Supply Sources

Currently, water conservation is the only other source of water supply for the SLVWD. SLVWD has been active in promoting public awareness and education about the need to conserve


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water. SLVWD has a website (http://www.slvwd.com/conservation.html) dedicated to water conservation that provides information to its customers about conservation practices and technologies. SLVWD also offers rebate programs for replacement of traditional toilets with ultra low flow toilets and installation of high efficiency clothes washers (http://www.slvwd.com/water credit program3.htm).

In response to the lack of rainfall in recent years, water conservation has become an imperative component of SLVWD's long-term water planning in order to sustain water supplies through the summer and to avoid shortfalls. Since SLVWD depends on local surface water and groundwater, its water supply is highly vulnerable to shortage in drought years. During summer 2007, SLVWD implemented Phase 2 of its Drought Contingency Plan, asking all customers to reduce water use by 20%. Due to continuing dry conditions in 2008 and 2009, SLVWD continued enforcement of the Phase 2 water restrictions described in the Drought Contingency Plan, urging customers to continue to implement water conservation measures to avoid shortfalls later in 2008 and 2009. During the implementation of the mandatory water conservation program, SLVWD intensifies public information and media campaign actions and activities, initiates neighborhood education programs, and engages in an aggressive leak detection program (SLVWD, 2008).

### 3.1.3 Historical and Current Groundwater and Surface Water Production

Table 5, compiled from production data provided by SLVWD, shows how water production has changed over the years. As shown, total production increased from approximately 1,650 acre-feet in 1988 to 2,060 acre-feet in 1997. For the past ten years, growth in production has been modest (less than 1% per year) but steady, reaching approximately 2,220 acre-feet in 2007.

**Table 5 - Historical SLVWD Water Production**

| SLVWD Water Production (AFY)[a] | 1988 | 1997 | 2001 | 2003 | 2007 |
|---|---|---|---|---|---|
| **Total Production** | **1,650** | **2,060** | **2,100** | **2,130** | **2,220** |
| South Well Field[b] | 240 | 430 | 440 | 440 | 440 |
| Olympia Well Field | 410 | 410 | 550 | 430 | 550 |
| Quail Hollow Well Field | 510 | 230 | 220 | 320 | 460 |
| Surface Water Production[c] | 490 | 990 | 890 | 940 | 770 |

(a) from SLVWD database
(b) currently includes Pasatiempo and Mañana Woods wells
(c) Without Felton surface water source

As shown in Table 6, groundwater supplied approximately 57% and surface water sources supplied approximately 43% of SLVWD's water during WY2006 and WY2007. An average of 417 AFY, or 19% of the total supply, was pumped from the Pasatiempo and Mañana Woods wells, which are in the specific area of interest for this conjunctive use project.


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Based on the monthly data provided by SLVWD and shown on Figure 5, SLVWD water production in WY2007 during the wetter months of November through April ranged from approximately 120 to 170 acre-feet per month, while the range for October and May through September was approximately 180 to 250 acre-feet per month. Pumping from the Pasatiempo and Ma□ana Woods well fields ranged from 20 to 35 acre-feet during the wetter months and 37 to 52 acre-feet during the dry months. Pumping from the other well fields (Olympia and Quail Hollow) shows much more significant seasonal variation because surface water replaces much of the Olympia well field pumping during the wet months. These other wells pumped a minimum of less than 11 acre-feet during March of WY2007 and a maximum of over 148 acre-feet in July.

**Table 6 - Recent SLVWD Water Production**

| SLVWD Water Production (AFY) | WY2006 | WY2007 | 2-Year Average □ |
|---|---|---|---|
| Pasatiempo Well Field | 387 | 423 | 17.2 |
| Ma□ana Woods Well Field | 7 | 17 | 1.6 |
| Olympia Well Field | 357 | 554 | 20.6 |
| Quail Hollow Well Field | 329 | 461 | 17.9 |
| Surface Water Sources[(a)] | 1,114 | 768 | 42.6 |
| **Total Production** | **2,193** | **2,223** | **100** |

Source: Data provided by SLVWD
[(a)] Without Felton surface water source

### 3.1.4 Water Use by Customer Type

Similar to SVWD, the area served by SLVWD is primarily residential, with some commercial and industrial customers. Specific information on the types and numbers of SLVWD customers was not available.

## 3.2 Future Water Supply and Demand

Although the SLVWD has not prepared its own UWMP or GWMP, the supply and demand information and projections presented in the SVWD 2005 UWMP (SVWD, 2005) also include the SLVWD well fields. Based on the □Total Supply□projections shown on Table 3 above (from the SVWD 2005 UWMP), groundwater supply for the SLVWD service areas are projected to remain unchanged through 2025.

On the demand side, as calculated from the projections shown on Table 3, the SVWD 2005 UWMP predicts that □Other Demand□for groundwater will increase by approximately 5.3□ between 2005 and 2015, and by another 4.8□ between 2015 and 2025. Although specific projections for SLVWD groundwater production are not broken out, production from SLVWD


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wells makes up over half of this Other Demand for potable water. Based on the data in Table 5, SLVWD water production increased approximately 7.8 during the ten-year period from 1997 through 2007, so these projections for future SLVWD demand appear to be reasonable.

## 4. City of Santa Cruz

In addition to the limits of the City of Santa Cruz, the SCWD service area includes unincorporated areas to the north and east of city limits and a small portion of the City of Capitola. An estimated population of 90,000 is served by the SCWD. The governing body for the Water Department is the Santa Cruz City Council, which is advised by a seven member Water Commission.

Unless otherwise noted, the information provided in this section is from the City of Santa Cruz s 2005 UWMP (SCWD, 2006) or it s Integrated Water Plan (SCWD, 2005). Water volumes are presented in units of million gallons (MG) in the SCWD UWMP, but have been converted to AF in this document, where appropriate, for ease of comparison with the information for other water suppliers.

### 4.1 Current Water Supply and Demand

The SCWD relies on both surface water and groundwater. Surface water is the primary source of water and is supplemented by groundwater when the SCWD s surface water becomes inadequate to meet the peak demand. The SCWD s water supply relies entirely on rainfall, surface runoff, and groundwater infiltration occurring within watersheds located in Santa Cruz County. The SCWD does not purchase water from state or federal agencies and does not import water from outside the Santa Cruz area.

#### 4.1.1 Surface Water Supply

On average, about 75 of the SCWD s annual water supply needs are met by surface water diversions from the San Lorenzo River and the North Coast streams. In general, the North Coast sources are tapped to the greatest extent possible because of their excellent water quality and lowest production cost. North Coast sources consist of surface diversions from three coastal streams and a natural spring, including Liddell Spring, Laguna Creek, Reggiardo Creek, and Majors Creek. Diversions are limited primarily by flows and are least affected by water right limitations, as the use of these sources by the SCWD dates back as far as 1890. Daily production from the North Coast sources varies seasonally from 5 MGD in spring to 2 MGD in fall.

San Lorenzo River is the SCWD s largest source of water supply. Water needed to meet daily demand is diverted from the San Lorenzo River at two surface water diversion points: Tait


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Street Diversion and Felton Diversion Station. The Tait Street Diversion is the main surface water diversion and dates back to the 1920s. Under normal operations, about 7.5 MGD can be produced at the Tait Street Diversion. The Tait Street Diversion is supplemented by two auxiliary wells that are hydraulically connected to the river. The Felton Diversion is operated intermittently as needed during the winter months of dry years.

Withdrawals from the Loch Lomond Reservoir are made mainly in the summer and fall months when the North Coast and San Lorenzo River sources become untreatable due to excessive turbidity from storm runoff or when flows drop off and additional supply is needed to meet higher daily demands in the peak season. Some withdrawals from Loch Lomond can also occur during the winter as well. Constructed in 1960, the Loch Lomond Reservoir has a maximum capacity of 2,810 MG (8,620 AF) and accounts for about 20% of the SCWD's annual supply. Raw water is conveyed from Loch Lomond in the Newell Creek Pipeline for treatment at the Graham Hill Water Treatment Plant. In addition to the SCWD, SLVWD is entitled to receive a portion of the water stored in this reservoir.

### 4.1.2 Groundwater Supply

The Live Oak Wells are pumped during summer and fall as supplemental water when the SCWD's other sources are inadequate to meet peak season daily demands. The Live Oak Well system consists of three production wells located in the southeast portion of the SCWD water service area. Groundwater production from these wells falls outside of the Santa Margarita Groundwater Basin, which is the major groundwater basin that SVWD and SLVWD depend on. The entire production of the SCWD's Live Oak Well field is derived from the Purisima Formation, which is the primary source of groundwater in the mid-Santa Cruz County region. Recharge to the Purisima Formation is thought to occur from deep percolation of rainfall in the upper watersheds and along the existing streambeds.

Even though groundwater constitutes only 4 to 5% of the entire SCWD water supply on an annual basis, it has been a crucial component of the water system for meeting peak season demands and during periods of drought. The three currently active SCWD production wells are normally operated 150 to 200 days of the year during the dry season at a combined rated of about 1.0 MGD. Details on the SCWD's historical groundwater pumping can be found in the 2005 UWMP (SCWD, 2006).

### 4.1.3 Other Water Supply Sources

The SCWD actively promotes water conservation and water efficiency practices as a means to protect natural resources, to stretch existing water supplies, to minimize the need for costly water supply projects, and to maximize sustainability in meeting future water needs. In June 2001, the SCWD became a signatory to the CUWCC MOU and joined the CUWCC in promoting water conservation. The City of Santa Cruz's General Plan calls for a strong emphasis on water


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conservation and elimination of water waste to stretch existing sources, minimize the need for new water sources, and protect the environment. The SCWD has adopted an ordinance prohibiting water waste and is continuing to implement a broad set of conservation programs which are projected to result in long-term water savings of approximately 920 AFY. The SCWD's estimated water savings target through the implementation of water conservation programs is approximately 860 AFY for 2010. Between 2000 and 2005, the SCWD achieved water savings through conservation of about 470 AFY on average (SCWD, 2006).

### 4.1.4 Historical and Current Water Production

Figure 6 illustrates total annual gross water production by the SCWD over the 20-year period between 1985 and 2004 from each of the main production sources (SCWD, 2006). During this period, total water production varied from a low of 3,300 MG per year (or approximately 10,000 AFY) in 1990 to over 4,400 MG per year (or over 13,500 AFY) in 2000, depending on hydrologic conditions, operations and maintenance, customer demand, and other factors. As shown on Figure 6, production decreased from 2000 to 2002 and remained steady at approximately 4,000 MG per year (or approximately 12,300 AFY) from 2002 to 2004.

As shown on Figure 6, gross production from 2000 to 2004 for the North Coast sources averaged 1,348 MG, or 32%, while the San Lorenzo River supplies (including Tait wells) averaged 1,990 MG, or about 47% of the total annual supply. Together, North Coast and San Lorenzo River provided nearly 80% of the SCWD's yearly water needs for this time period. Water supplied from Loch Lomond reservoir averaged 716 MG or 17% of the SCWD's total annual supply. Groundwater pumping from the Live Oak Wells provided only an average of 151 MG or about 4% of the total supply annually.

Historically, net water production averages about 6% less than gross production. The difference between gross and net production is due to raw water sales, turnouts, maintenance, and losses from leakage on the North Coast transmission main. From 2000 to 2004, net water production averaged 3.9 billion gallons per year, which is about 7% less than the gross production of 4.2 billion gallons annually.

Treated net water production varies seasonally from a low of mid-200s MG (approximately 800 AF per month) in winter to a high of mid-400s MG (approximately 1,400 AF per month) in summer (SCWD, 2006). A monthly production graph for 1996 through 2002 presented in a report prepared by the SCWD Water Conservation Office (SCWD, 2004), shows production in the range of approximately 750 AF per month to over 900 AF per month during the period from November to March, and peak production in July up to approximately 1,500 AF per month. Average daily water demand ranges from about 8.5 MGD during the winter season to 14.5 MGD in summer months, with peak days reaching up to 16 MGD (SCWD, 2006). Based on information on the production section of the SCWD website (http://www.ci.santa-


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cruz.ca.us/wt/production/production.html), daily SCWD water production can be as high as 18 MGD during the summer months.

### 4.1.5 Water Use by Customer Type

According to the SCWD's 2005 UWMP, the SCWD has 23,799 customers in the service area (SCWD, 2006). Similar to SVWD and SLVWD, single family residential class is the largest customer category in terms of both the number of accounts and total amount of water consumed (Table 7). Single residential customers use approximately 1.5 billion gallons annually (approximately 4,630 AFY), representing 42% of total water use. Multi-family residential and business sectors also consume significant amount of water, approximately 2,520 and 2,090 AFY, which represents 23 and 19% of total water use, respectively.

**Table 7 - City of Santa Cruz Current Water Use by Customer Class**

| Customer Class | No. of Accounts | Average Annual Usage (AF) | Percent of Total Water Use |
|---|---|---|---|
| Single Residential | 18,352 | 4,630 | 42 |
| Multiple Residential | 2,636 | 2,520 | 23 |
| Business | 1,886 | 2,090 | 19 |
| Industrial | 56 | 750 | 7 |
| Municipal | 230 | 190 | 2 |
| Irrigation | 412 | 410 | 4 |
| Golf Irrigation | 6 | 340 | 3 |
| Coast Irrigation | 36 | 190 | 2 |
| Other | 185 | 12 | - |
| **Total** | **23,799** | **11,130** | **100** |

Source: SCWD, 2006

## 4.2 Future Water Supply and Demand

According to the SCWD's 2005 UWMP, the number of SCWD's customer accounts is anticipated to increase by approximately 3,000, or 10%, between 2005 and 2030 (Table 8), which will increase water demand. Supply from existing sources is expected to remain relatively constant for this time period; therefore new supplies are needed to meet this projected increase in demand.


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**Table 8 - City of Santa Cruz Projected Number of Service Connections by Customer Class**

| Customer Class | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Single Residential | 17,926 | 18,182 | 18,494 | 18,823 | 19,087 | 19,352 |
| Multi-Family Residential | 2,719 | 2,791 | 2,865 | 2,942 | 3,017 | 3,092 |
| Business | 2,314 | 2,469 | 2,593 | 2,693 | 2,820 | 2,947 |
| Industrial | 50 | 52 | 54 | 56 | 58 | 60 |
| Municipal | 21 | 224 | 232 | 238 | 248 | 258 |
| Irrigation | 356 | 373 | 387 | 400 | 415 | 430 |
| Golf Irrigation | 6 | 6 | 6 | 6 | 6 | 6 |
| Coast Irrigation | 29 | 29 | 29 | 29 | 29 | 29 |
| Other | 263 | 293 | 304 | 310 | 320 | 330 |
| **Total Connections** | **25,689** | **26,429** | **26,979** | **27,517** | **28,025** | **28,534** |
| **Increase from 2005** | **0** | **2.8** | **4.8** | **6.6** | **8.3** | **10.0** |
| **Total System Demand (Table 10)** | **14,930** | **15,440** | **15,630** | **15,830** | **16,080** | **16,340** |
| **Increase in demand from 2005 (Table 10)** | **0** | **3.4** | **4.7** | **6.0** | **7.7** | **9.4** |

Source: City of Santa Cruz 2005 UWMP, estimated based on demographic data and land use information.

The increase in service connections can then be compared to the total estimated demand found in Table 10. The percent increase in demands found in Table 10 are slightly lower in the later years reflecting the impacts of water conservation on per unit demand.

### 4.2.1 Future Water Supply

Table 9 presents projections of water supply and water production for each of the SCWD's current major sources. Estimates are based on normal water conditions in future years with no change to current operations or water rights. Based on these projections, the SCWD supply would remain constant at approximately 4.3 billion gallons per year (approximately 13,200 AY) into the foreseeable future. However, even for single dry water years, estimated water supply from these sources is estimated to be reduced significantly to approximately 11,700 AFY (SCWD, 2006). During multiple dry years, further reductions would be expected, with the estimated water supply ranging from 8,300 AFY to 10,740 AFY (SCWD, 2006). Regardless, based on projected demand, the SCWD needs additional water sources to meet demand in the future.

As discussed above, SCWD has an active water conservation program that is projected to provide 300 MG per year (approximately 920 AFY) water savings in the future (SCWD, 2006). The implementation of the other water augmentation options described below is anticipated to require a regional approach to planning and capital investment. The success of these programs is dependent upon coordinated planning, design and implementation. These and other alternatives for water augmentation considered by the SCWD, SVWD, and SLVWD will be


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identified and evaluated for effectiveness in addressing regional water supply and demand issues as part of Task 5 of this project.

**Table 9 - City of Santa Cruz Current and Future Planned Water Supply Sources**

| Water Supply Sources (AF) [(a)] | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Groundwater Production | 570 | 570 | 570 | 570 | 570 | 570 |
| **Surface Water Diversions** | | | | | | |
| North Coast Sources | 3,310 | 3,310 | 3,310 | 3,310 | 3,310 | 3,310 |
| San Lorenzo River | 6,160 | 6,160 | 6,160 | 6,160 | 6,160 | 6,160 |
| Loch Lomond Reservoir | 3,200 | 3,200 | 3,200 | 3,200 | 3,200 | 3,200 |
| Transfer in or out | Potential transfer of up to 1,400 AFY out to Soquel Creek Water District. | | | | | |
| Desalination | Potential production of 1,400 AFY in normal water years for transfer to Soquel Creek Water District. | | | | | |
| Other | - | - | - | - | - | - |
| **Total (Average Year)** | **13,240** | **13,240** | **13,240** | **13,240** | **13,240** | **13,240** |
| **Total (Single Dry Year)** | **11,660** | **11,660** | **11,660** | **11,660** | **11,660** | **11,660** |
| **Total (Multiple Dry Years)** | **8,290** | **8,290** | **8,290** | **8,290** | **8,290** | **8,290** |

Source: City of Santa Cruz 2005 UWMP, data converted from MGY to AFY and rounded to nearest 10 AFY
(a) Volumes are estimated for average water year.

It should be noted that the total average annual runoff in the San Lorenzo River is 93,000 AFY, which should be compared to the UWMP average year San Lorenzo River availability of 6,160 AFY. In hydrologically wet years, the annual runoff can range from about 120,000 AFY up to a peak of 280,000 AFY in 1993. However, it should be noted that even in hydrologically wet years, diversion of more water may not be feasible as there is insufficient storage in Loch Lomond and water demands are lower in the diversion periods so the water, unless it can be stored elsewhere, will naturally flow out to the ocean.

Water Recycling: The City of Santa Cruz owns and operates a regional wastewater treatment facility providing service to a population of approximately 130,000 in the cities of Santa Cruz and Capitola and parts of unincorporated Santa Cruz County. The SCWD has conducted a conceptual level evaluation of water supply alternatives which identified wastewater reclamation as a potentially viable new water source for the SCWD (Black and Veatch Engineers, 2002). Reclaimed water exchange with the North Coast farmers is considered viable for the SCWD. The general concept is that reclaimed water would be delivered to farmers for irrigation supply in exchange for groundwater that farmers currently use. A rough estimate of groundwater pumping that could potentially be exchanged with reclaimed water is 400 to 500 MG per year (Black and Veatch Engineers, 2002).


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Desalination: The SCWD has recently completed a conceptual evaluation of water supply alternatives which identified ocean-water desalination as a potentially viable new water source for the SCWD (Black and Veatch Engineers, 2002). In response to projected shortfalls in future water supplies during drought conditions, the SCWD is evaluating the feasibility of securing a supplemental source of water through seawater desalination. Objectives of this effort are two-fold: to reduce reliance on well water and prevent the threat of seawater intrusion in local groundwater aquifers. The SCWD's Integrated Water Plan envisions building and operating a new seawater desalination plant with a 2.5 MGD capacity in a cooperative arrangement with the Soquel Creek Water District (SCWD, 2006).

The general concept for a regional desalination facility is to provide water to the SCWD during drought years and to the Soquel Creek Water District during non-drought, normal rainfall years. This supply is projected to become available beginning around the year 2010. In the near term, the plant would be operated only in drought conditions. After 2015, up to 1.25 MGD of water from the desalination plant may be needed on a regular basis as a supplemental water supply for the SCWD, depending on the actual water demands at that time stemming from the physical expansion and the amount of growth in the City and County of Santa Cruz and the City of Capitola under future General Plans (SCWD, 2006).

SCWD's proposed water portfolio for the future under both "normal" and "drought" conditions is summarized in Figure 7 from the Fall 2008 Integrated Water Plan Update (SCWD and Soquel Creek Water District, 2008). As shown, SCWD plans to supplement current supply primarily through conservation with limited water recycling during normal rainfall periods, and to add rationing, desalination, and banked water to the supply during drought periods.

### 4.2.2 Future Water Demand

Forecasts for the SCWD service area suggest that the total annual water demand would increase to 4.8 billion gallons (approximately 14,700 AFY) in 2030 (Table 10). Including the expected system losses, the total demand would actually be 5.3 billion gallons (approximately 16,300 AFY) in 2030 (SCWD, 2006).


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**Table 10 - City of Santa Cruz Water Demand Projections (AF)**

| Customer Class | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Single Residential | 4,890 | 4,850 | 4,850 | 4,860 | 4,870 | 4,890 |
| Multi-Family Residential | 2,920 | 2,950 | 2,980 | 3,020 | 3,060 | 3,110 |
| Business | 2,700 | 2,850 | 2,980 | 3,070 | 3,200 | 3,340 |
| Industrial | 1,760 | 2,030 | 2,030 | 2,040 | 2,040 | 2,050 |
| Municipal | 170 | 170 | 180 | 180 | 190 | 200 |
| Wastewater Plant | 70 | 70 | 70 | 70 | 70 | 80 |
| Irrigation | 440 | 460 | 480 | 490 | 510 | 530 |
| Golf irrigation | 360 | 360 | 360 | 360 | 360 | 360 |
| Coast irrigation | 100 | 100 | 100 | 100 | 100 | 100 |
| Other | 50 | 50 | 60 | 60 | 60 | 60 |
| **Metered Water Consumption** | **13,440** | **13,900** | **14,070** | **14,250** | **14,470** | **14,710** |
| Water Losses | 1,490 | 1,540 | 1,560 | 1,580 | 1,610 | 1,640 |
| **Total System Demand** | **14,930** | **15,440** | **15,630** | **15,830** | **16,080** | **16,340** |
| **Increase from 2005** | **0** | **3.4** | **4.7** | **6.0** | **7.7** | **9.4** |

Source: SCWD, 2006

# 5. Area wide Supply and Demand

This Section provides information on other water suppliers and users in the project area, as well as an overall summary of significant water supply and demand factors for the area of interest.

## 5.1 Other Water Demands in the Area

Currently, several other water users, in addition to SVWD and SLVWD, depend on groundwater in the Scotts Valley area. These users were accounted for in the SVWD 2005 UWMP (SVWD, 2005), under Other Demand, although no breakdown for specific users were provided. This Other Demand was shown as 1,993 AFY in 2005, with a projection to reach 2,202 by 2025. Based on data provided by SLVWD, approximately 1,000 AFY was pumped from SLVWD wells in 2005, leaving approximately 1,000 AFY in additional demand from other groundwater users. Historical and current users are briefly described below.

**Mount Hermon Association** As a private water purveyor, Mount Hermon Association supplies water to a nearby area outside of the Scotts Valley city limits. Based on data provided by the Mount Hermon Association, groundwater pumping by this purveyor has steadily increased from 90 acre-feet in WY1984 to 215 acre-feet in WY2007.

**Environmental Remediation Activities** - Historically, environmental remediation activities in the basin have accounted for significant groundwater production in the basin, primarily for the Watkins-Johnson Superfund Site and the Camp Evers MTBE plume. However, based on data provided by Watkins-Johnson, groundwater production for environmental remediation has


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steadily declined from 464 acre-feet in WY1986 to 144 acre-feet in WY2007. Communication with the regulators is underway to monitor the potential shut-down of remedial activities at the Watkins-Johnson Superfund Site.

**Hanson Quarry** A significant amount of groundwater was used for gravel mining operations, gravel washing and dust control until the quarry was closed in 2004. Groundwater use ranged from 96 acre-feet to 470 acre-feet between WY1976 and WY2004, but no pumping has been reported since 2004.

**Other Private Users** Based on the Other Demand volume presented in the UWMP and the volumes reported for Mount Hermon and the Watkins-Johnson site above, groundwater pumping by other private users is Santa Margarita Basin is estimated to be approximately 600 acre-feet for WY2005. The Groundwater Modeling Study of the Santa Margarita Groundwater Basin (ETIC, 2006) provided WY2004 pumping data for other private users that accounted for a little over half of this volume. The largest other users shown in this report include the Valley Gardens Golf Course (113 acre-feet), Montevalle Mobile Park (60 acre-feet), Spring Lakes (46 acre-feet), Vista del Lago (38 acre-feet), and Mission Springs (30 acre-feet).

## 5.2 Water Supply and Demand Summary

Table 11 that follows summarizes the key information on current and future water supply and demand that is presented in Sections 2 through 5. This table focuses on information for the areas of most interest for this conjunctive use project, i.e., the southern portion of the Santa Margarita Basin (Scotts Valley area) and the area served by SCWD. As shown, this table indicates a significant and increasing deficit in available supply in the future based on current groundwater and surface water supplies.

The actual deficit may be adjusted because it is based on supply and demand in an average year and does not account for prolonged drought. An estimate of supply that accounts for SCWD s single dry year supply would increase the deficit to approximately 4,400 AFY in 2005 up to 5,700 AFY in 2025. On the other hand, since the estimated supply of 3,320 AFY shown for the Santa Margarita Basin is a more conservative estimate of sustainable yield than the earlier higher estimate, the estimated deficit is likely to be fairly conservative. In addition, the estimated deficit shown on Table 11 does not account for measures already taken to reduce demand on groundwater and surface water sources, including water conservation by SCWD and SVWD and use of recycled water by SVWD. As shown, these measures have already reduced demand significantly and will likely reduce demand further in the future. However, it is clear from these projections that other water sources and approaches to regional water management must be identified and utilized to meet projected future demand and to improve the overall reliability of water supply to the Scotts Valley and Santa Cruz area. As noted earlier, the demand estimates should be reviewed once the 2010 UWMP are completed by SCWD and SVWD.


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**Table 11 - Project Area Water Supply and Demand Summary**

| | 2005 | 2015 | 2025 |
|---|---|---|---|
| | ----------AFY---------- | | |
| **ESTIMATED SUPPLY** | | | |
| Santa Margarita Basin[1] | 3,320 | 3,320 | 3,320 |
| SCWD[2] | 13,240 | 13,240 | 13,240 |
| **Total** | **16,560** | **16,560** | **16,560** |
| **ESTIMATED DEMAND** | | | |
| Santa Margarita Basin[3] | 4,004 | 4,381 | 4,548 |
| SCWD[4] | 15,000 | 15,600 | 16,100 |
| **Total** | **19,004** | **19,981** | **20,648** |
| **ESTIMATED DEFICIT** | **2,444** | **3,421** | **4,088** |
| **IDENTIFIED POTENTIAL ADDITIONAL SOURCES** | | | |
| SVWD Recycled Water[5] | 130 | 535 | 535 |
| SVWD Conservation[6] | 170 to 320 | ---------- 320 | ---------- |
| SCWD Recycled Water[7] | 0 | ----------up to 1,500---------- | |
| SCWD Conservation[8] | 470 | 920 | 920 |
| SCWD Desalination[9] | 0 | ----------1,400---------- | |

## 6. Opportunities for Water Exchange or Transfer

### 6.1 Intertie System

The Santa Cruz County water agencies and Santa Cruz County are cooperating to develop an intertie system to help manage water resources on a regional basis. Currently, only emergency interties exist between the SCWD system and the SVWD and Soquel Creek Water District. These connections, however, were set up to feed water from the SCWD system to the adjacent Districts for short-term emergency purposes. The interties are not intended for, nor are the adjacent systems currently capable of, transferring or exchanging non-emergency water with the SCWD.

The project to develop a new intertie system is an effort to develop water markets between the water agencies in Santa Cruz County that would allow for banking excess water when transfers and conservation meet the needs of the region and conserving the groundwater and surface water resources when alternative supplies are available for transfer. The ability to share water efficiently would allow the water agencies to work collaboratively towards a variety of goals, including sustainable water supply, drought preparedness, reducing dependence on


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groundwater, reducing stream diversions during critical habitat periods, increased use of recycled water, and development of alternative water sources through water market exchanges.

Towards this goal of regional interties, SVWD submitted two grant applications in January 2009 on behalf of five agencies (SVWD, SLVWD, and SCWD, along with the Soquel Creek Water District and Santa Cruz County) to the U.S. Bureau of Reclamation under its "Water for America: Water Marketing and Efficiency Grant" and "Water for America: Expand, Protect, and Conserve Our Nation's Water Resources-System Optimization Reviews" opportunities.

The primary goal of the project proposed in these grant applications is to optimize water resource management and exchanges amongst the agencies. The implementation of the proposed program is subdivided into two main tasks: 1) hydraulic modeling, and 2) conjunctive use through water markets, banking and conservation. The grant proposal specifies that current demands, projected future demands and shortages for each agency would be taken into consideration as interties between the agencies are developed. Water rights, in-stream flows, and possible storm water for recharge would also be considered as part of the project. After completion of all the tasks, integration of the systems through the hydraulic model and water agreements, the agencies anticipate a conceptual plan would be designed and preliminary costs assessed for the intertie system.

In addition to these proposed and existing interties between water districts, there are also existing interties within the agencies that might be of use for regional water management. These include an intertie between the northern and southern portions of the SLVWD, an intertie to allow SLVWD to tap into the Loch Lomond reservoir, and an emergency intertie between SLVWD and its newly-acquired Felton supply.

## 6.2 Potential Alternative Supply Sources

The interties described above would provide a system for better management of the regional groundwater resources by allowing for in-lieu recharge of the groundwater resources. In-lieu recharge consists of replacing a groundwater supply with a supply of another type that has excess water during part or all of the year. This alternative source would most likely be available in the winter months. In this type of arrangement, the in-lieu water would substitute for the groundwater as the water supply. By not pumping, the groundwater stays in storage allowing groundwater levels to recover. This saved groundwater storage provides for more water supply during times of greater need, such as an extended drought period. In addition to the surface water supply in rivers and creeks, potential water sources for in-lieu exchanges include storm water, recycled water, and desalinated water. Water quality and other considerations associated with in-lieu use of storm water and recycled water, as well as for potential direct recharge to groundwater, are discussed briefly in Section 7.


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# 7. Regulatory and Water Quality Considerations

This section presents an overview of the potential regulatory and water quality requirements and issues that should be evaluated when contemplating the reuse of storm water or recycled water. In addition to these general concerns, each specific water source and application may have additional specific considerations related to the water quality and/or proposed reuse location and/or type.

## 7.1 General Water Quality Considerations

The potential water quality impacts of each project alternative must be considered, using the Regional Water Quality Control Board (RWQCB) Central Coast Basin Plan and associated amendments as a starting point. These documents can be accessed at: http://www.waterboards.ca.gov/centralcoast/publications forms/publications/basin plan/index.shtml. The Basin Plan specifies the beneficial uses associated with each surface water body and the water quality objectives (WQOs) associated with each beneficial use. In some cases, total maximum daily loads (TMDLs) have been established for the amount of a particular material that can be discharged to a water body on a regular basis and be assimilated such that levels remain protective for the beneficial uses designated for that water body.

It appears that the only TMDLs that have been approved to date for the project area are a nitrate TMDL and a sediment TMDL for San Lorenzo River, including Carbonera Creek, Lompico Creek, and Shingle Mill Creek. Reduction of peak stormwater flows as could occur through implementation of Low Impact Development (LID) measures, especially to Carbonera Creek, will likely have benefits in reducing erosion, and thereby sediments to the creek and assist in meeting the sediment TMDL.

In addition, the Central Coast RWQCB adopted a TMDL for pathogens in San Lorenzo River Estuary, San Lorenzo River, Branciforte Creek, Camp Evers Creek, Carbonera Creek, and Lompico Creek in March 2008, but this does not appear to have been formally approved by the state yet. Similarly, LID could improve water quality so that pathogens would also be reduced and assist in meeting the sediment TMDL.

Progress on the development, approval, and implementation of these and other TMDLs can be tracked at the basin plan website listed above in this paragraph. In addition to these Basin Plan water quality considerations, the Endangered Species Act and potential impacts on salmon and steelhead must be considered.


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## 7.2 Storm Water

Regulatory and water quality considerations specific to the use of storm water from the Scotts Valley area are described below.

### 7.2.1 Regulatory Considerations

In general, the discharge of storm water to surface waters in California is regulated by the State Water Resources Control Board (SWRCB) and its nine RWQCBs through National Pollutant Discharge Elimination System (NPDES) permits. Currently, the discharge of storm water to surface waters in the Scotts Valley area is regulated primarily through City efforts and requirements. In addition, many industrial/other facilities and construction projects over one acre fall under general NPDES permits for storm water management and must prepare and implement Storm Water Management Plans (SWMPs) that address the specific storm water runoff concerns that apply to their facility/project. Small (less than 100,000 people) municipalities such as Scotts Valley fall under a General Permit for the Discharge of Storm Water from Small Municipal Separate Storm Sewer Systems (MS4s), which the SWRCB has just been in the process of implementing and enforcing in the past few years. The Small MS4 permit requires the discharger to develop and implement a Storm Water Management Plan (SWMP) with the goal of reducing the discharge of pollutants to the maximum extent practicable. The management programs specify what stormwater BMPs will be used to address certain program areas. The program areas include public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations.

The City of Scotts Valley has submitted a draft SWMP to the Central Coast RWQCB (City of Scotts Valley, 2008) addressing these required Small MS4 program elements. The RWQCB has recently approved the City's SWMP (City of Scotts Valley, 2008). Following SWMP approval, the City of Scotts Valley will implement the specified monitoring program and prepare annual reports demonstrating that the community has implemented the plan and complied with the measurable goals. This program will enhance the efforts the City of Scotts Valley has already made towards improving storm water quality, maintaining pre-development runoff rates, limiting erosion, etc.

Santa Cruz County, with the City of Capitola has also prepared a SWMP for the areas within the County except for Scotts Valley, Santa Cruz and Watsonville which have their own SWMP programs. The County's SWMP program was originally approved in 2003 and was recently updated in 2010.

The use of storm water to recharge groundwater has a set of requirements different from those for surface water discharge. Recharge of storm water through grassy swales, "filter strips" and similar impoundments is generally unregulated in California. More "engineered" storm water


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recharge facilities generally fall under the category of a Class V well under the federal Underground Injection Control (UIC) regulations. Per EPA, a Class V well is by definition any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system (an infiltration system with piping to enhance infiltration capabilities).

To comply with UIC in California for storm water injection, one must: 1) submit an Inventory Form to EPA describing the planned injection; once this form is submitted the submitter is then authorized by rule to operate; 2) respond to any request from EPA for additional information or investigations; 3) apply for a permit if EPA requires it (no record of this being required in California has been identified) and, 4) make sure the injection facilities are not adversely affecting drinking water sources. In addition, the RWQCBs have the authority to issue Waste Discharge Requirements (WDRs) for any discharges that may impair beneficial use, but they have not issued these for storm water recharge to date.

The Scotts Valley draft SWMP contains BMPs for storm water management that would apply to infiltration as well as surface discharge (i.e., measures to make sure the water is as clean as possible). Already existing measures to increase/improve storm water infiltration in Scotts Valley include: 1) construction measures to allow more infiltration have been required since the mid-1990s at least; and, 2) new hydromodification standards have been recently established for new/redevelopment projects. Similar measures are found in the County's SWMP.

### 7.2.2 Water Quality Considerations

The primary concerns for discharge of storm water into surface waters in the project area are the TMDLs described in Section 7.1 (i.e., sediment and pathogens). Other contaminants of concern in municipal systems are total suspended solids (TSS), total organic compounds (TOC), and pH. In general, municipalities under the Small MS4 permit are not required to perform chemical monitoring. However, a wide variety of chemical contaminants may be present in storm water. Fuel hydrocarbons, heavy metals and other chemicals may be monitored as part of site-specific industrial permits. Pesticides, PCBs, dioxins and other persistent synthetic organic compounds may also be present in storm water from some areas.

These water quality issues will also be of concern if direct injection of storm water is considered for ground water recharge. On the other hand, these water quality issues will be less of a concern with surface or near-surface storm water infiltration because of the subsurface materials the water must pass through provide filtration and treatment before reaching the groundwater. In general, the farther the infiltration point is located both laterally and vertically from a water supply well the more water quality is protected. In addition, common sense dictates that storm water from industrial/commercial sites with significant outdoor chemical use or storage should not be used for infiltration projects.


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## 7.3 Recycled Water

Regulatory and water quality considerations specific to the use of recycled water are described below.

### 7.3.1 Regulatory Considerations

Permits for the use of recycled water in California are granted by the SWRCB and its nine RWQCBs. The California Department of Public Health (CDPH) reviews and establishes water recycling criteria and regulations. For each water-recycling project, CDPH makes recommendations to the appropriate RWQCB, and the RWQCB issues the permit and provides ongoing oversight of the project. To establish uniform requirements for the use of recycled water, the SWRCB adopted a statewide Recycled Water Policy on February 3, 2009 (http://www.waterboards.ca.gov/water issues/programs/water recycling policy/ ). The regulatory provisions of this policy will not go into effect until approval by the Office of Administrative Law. The primary purpose of the policy is to increase the use of recycled water.

Reuse of recycled water at the surface (e.g. for irrigation) is relatively straightforward and is already significantly implemented by SVWD under its permit Order No. 01-067. In general, the water must be disinfected tertiary recycled water to be used for most applications, including irrigation, recreational impoundments, cooling systems, and toilet flushing, among others. In addition to meeting water quality criteria (see Section 7.3.2), there are specific requirements for conveyance systems, use area evaluations and postingsRegulations related to recycled water in California can be found at:
http://www.waterboards.ca.gov/water issues/programs/grants loans/water recycling/statutes regulations.shtml .

For groundwater recharge using recycled water, only surface infiltration has generally been allowed. However, in Southern California, the injection or recharge of highly treated recycled water directly to groundwater has been allowed in Orange County and at the Montebello Forebay in Los Angeles County for many years. The Orange County project provides additional treatment of the recycled water with reverse osmosis, while the Montebello Forebay project recharges tertiary treated recycled water.

For a new recharge project, CDPH holds a public hearing before implementation, and provides recommendations to the RWQCB, which then prepares and issues the permit. CDPH is currently developing regulations as described in section 2.2.1, for the use of recycled water for recharge projects, and has a website dedicated to information on this (http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/Waterrecycling.aspx).


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### 7.3.2 Water Quality Concerns

Wastewater undergoes primary, secondary and tertiary treatment at water reclamation plants. During primary treatment, large solids are removed. Secondary treatment uses bacteria to remove approximately 90 to 95 of the remaining solids and uses a disinfectant, such as chlorine, to destroy bacteria, viruses, and other pathogens. For some recycled water uses (e.g., some industrial and irrigation uses where access is controlled), secondary treatment is sufficient. For many reuse applications, advanced tertiary treatment processes, such as filtration are required. The Scotts Valley treatment plant includes a Tertiary Treatment Facility with sand filters and ultraviolet lights for water disinfection, and the treated water generated by this facility meets unrestricted use criteria for recycled water in Scotts Valley (http://www.scottsvalley.org/wastewater recycling/wastewaterhistory.html).

Water quality standards for recycled water use in California are incorporated in Title 22, Chapter 3, Division 4 of the California Code of Regulations, with stipulations applying to the various types of reuse and levels of required treatment. Periodic monitoring is required to ensure standards are met. Recycled water for groundwater recharge and many other uses must meet the State of California drinking water standards. Even so, concerns remain with recycled water application, especially for groundwater recharge, primarily related to unregulated/emerging constituents such as pharmaceuticals and endocrine disrupters (http://www.cdph.ca.gov/CERTLIC/DRINKINGWATER/Pages/EmergingContaminants.aspx). Currently, the CDPH provides guidance on monitoring for such constituents on a project-by-project basis

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# FIGURES


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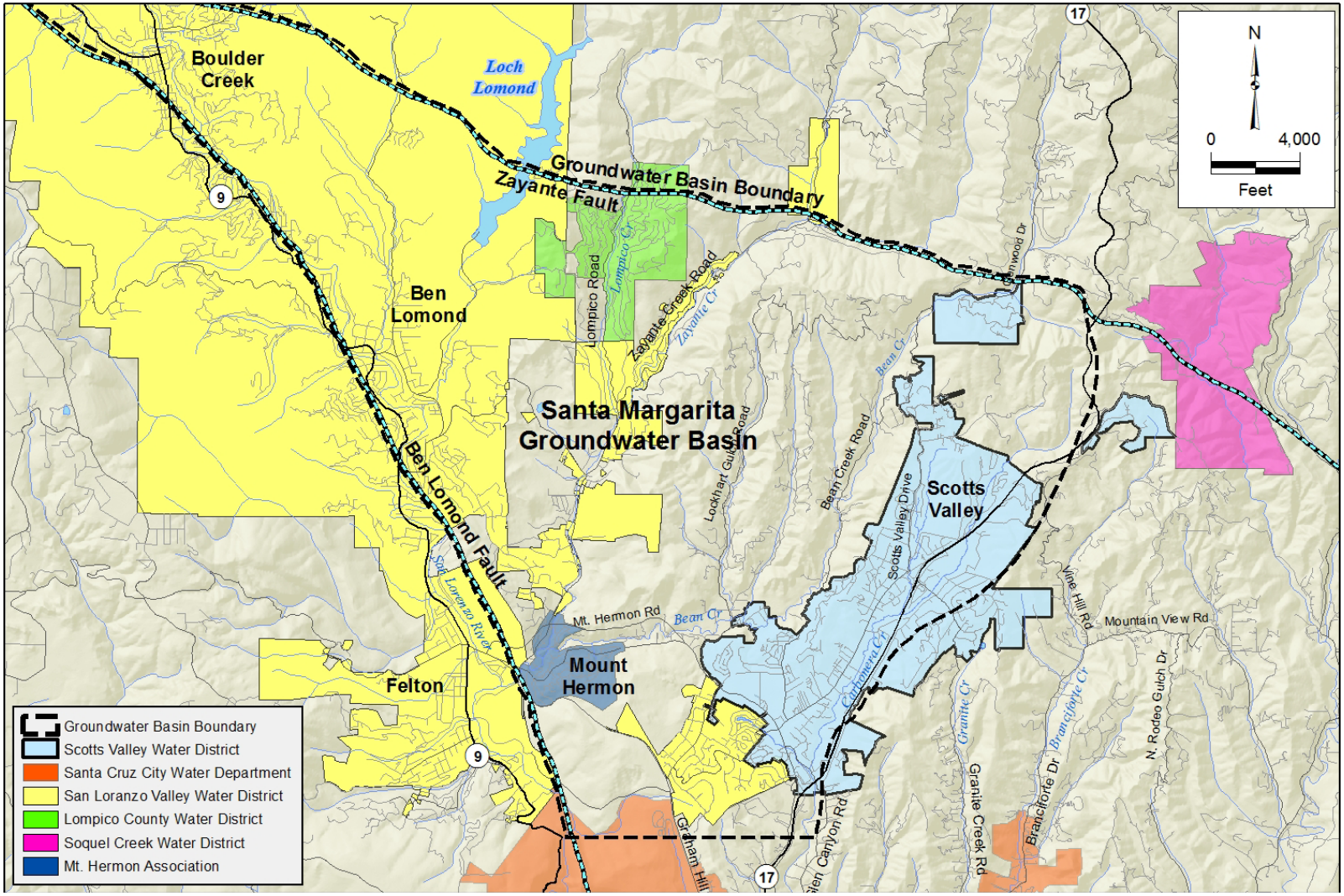


Source: Kennedy/Jenks 2009a

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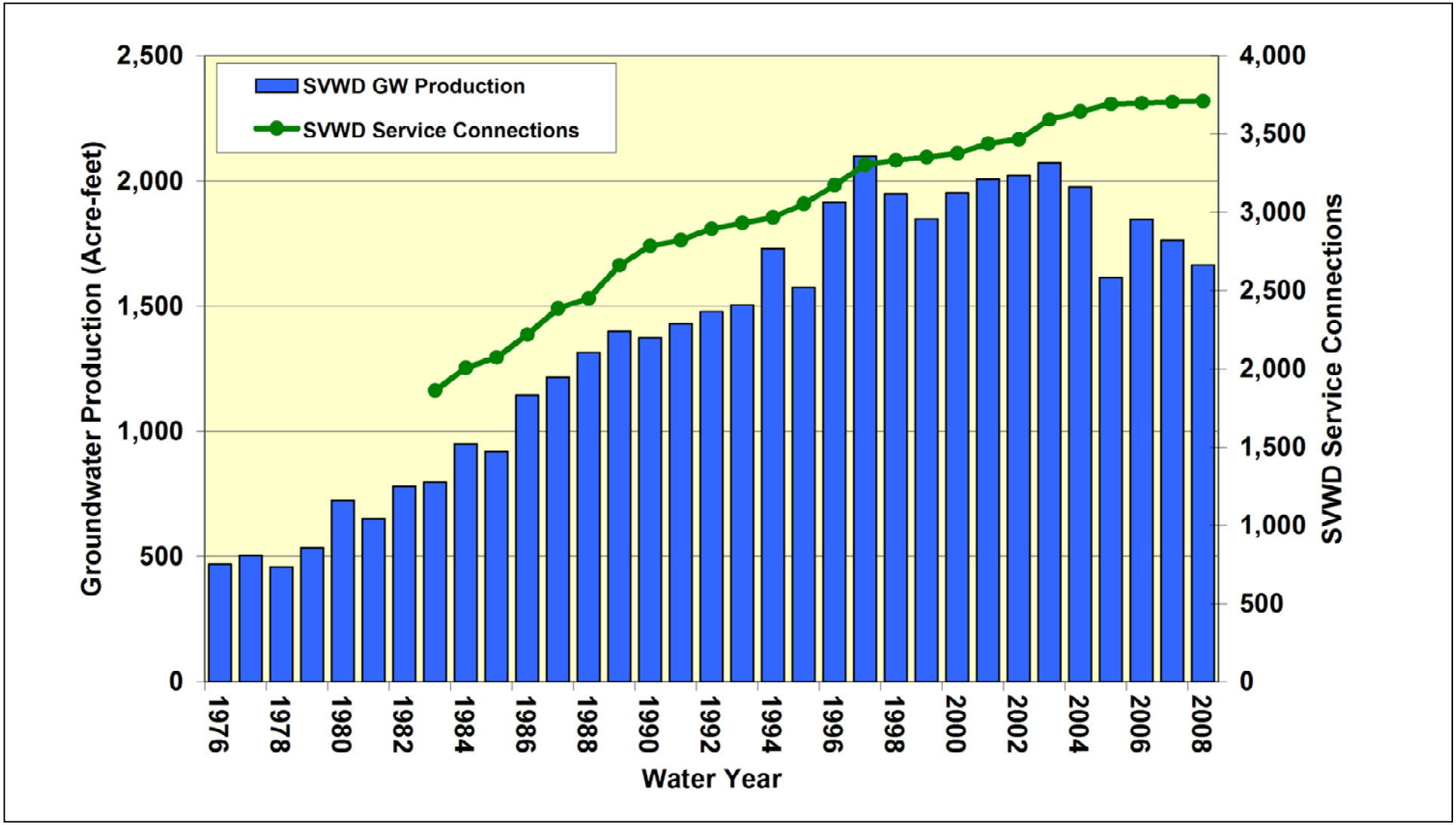
TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Project Area Map with Water District Boundaries**

K/J 0864005
November 2010

**Figure 1**




Source: Kennedy/Jenks 2009a

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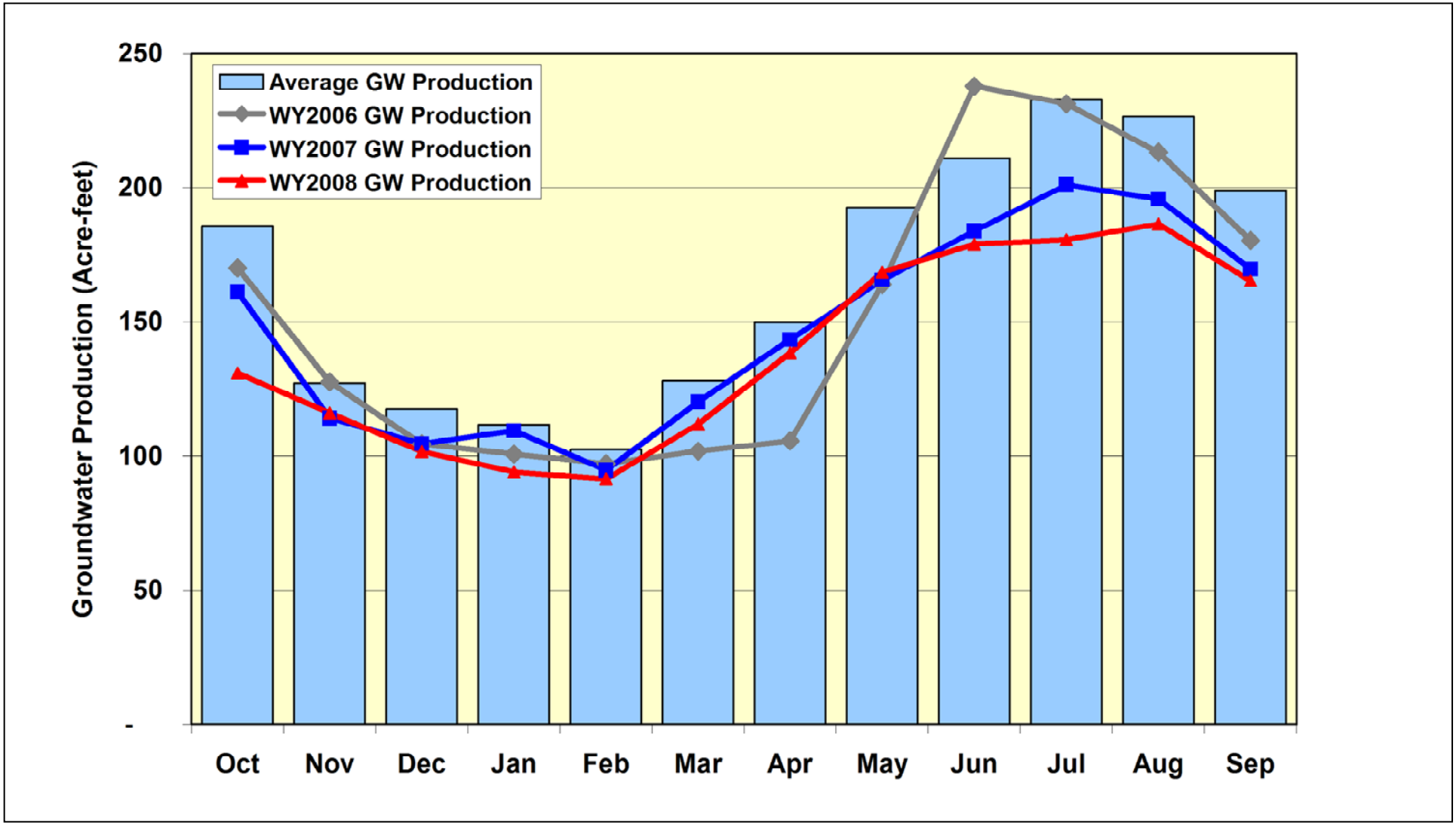
TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**SVWD Annual Groundwater Production and Service Connections**

K/J 0864005
November 2010

**Figure 2**




Source: Kennedy/Jenks 2009a

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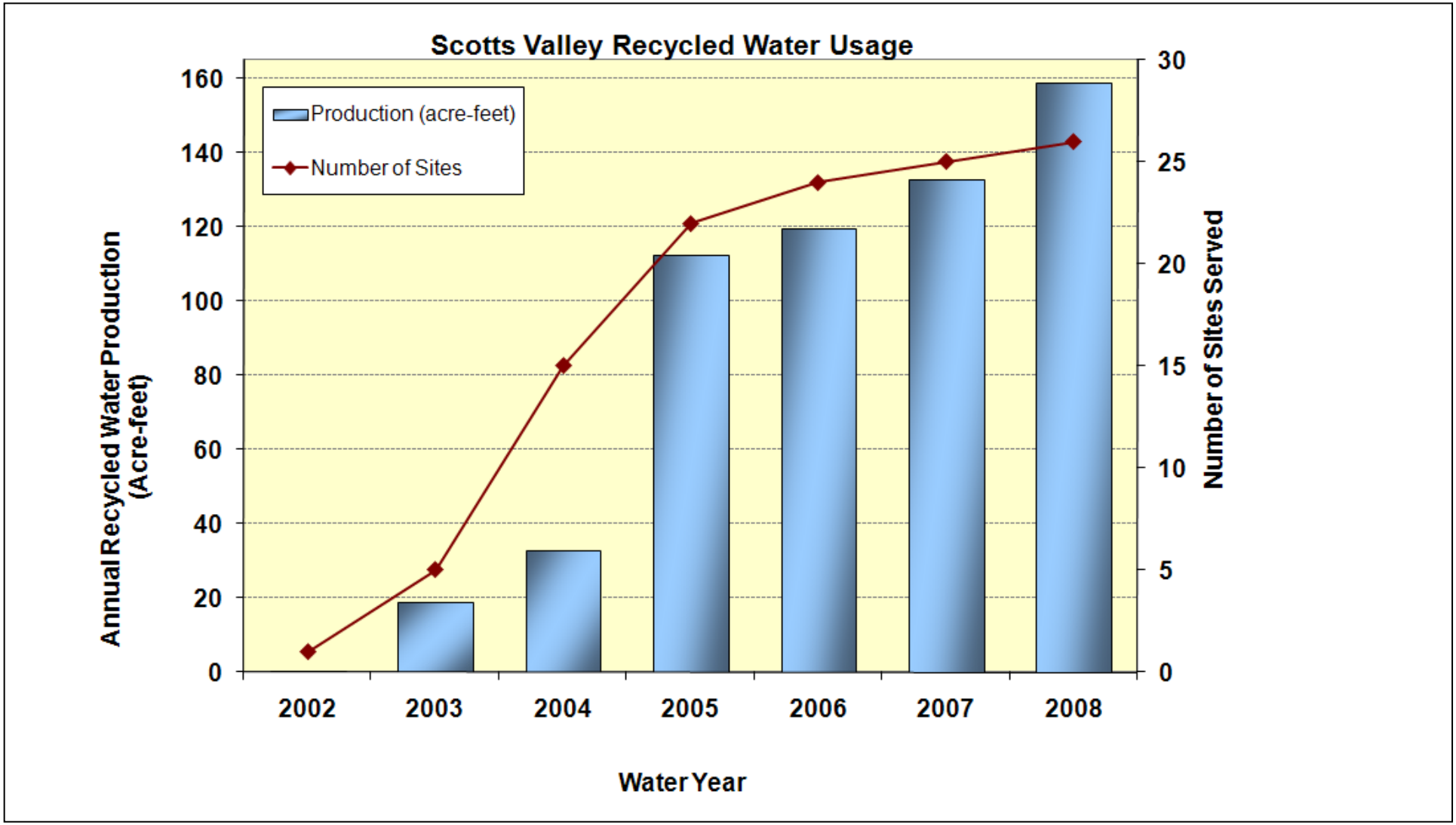
TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Comparison of Monthly SVWD Groundwater Production to WY1997-2004 Average Production**

K/J 0864005
November 2010

**Figure 3**




Source: Kennedy/Jenks 2009a

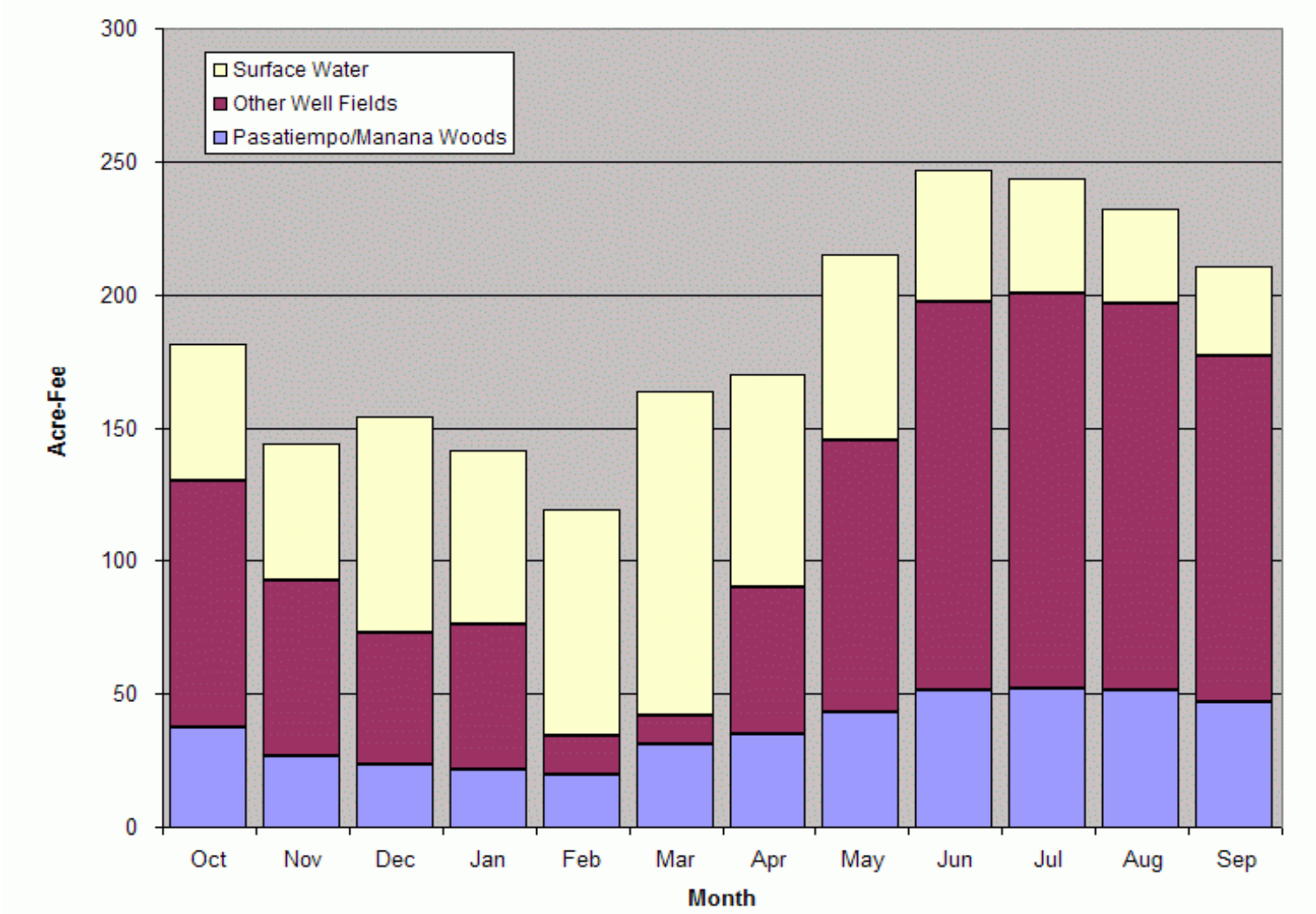
**Kennedy Jenks Consultants**

TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**SVWD Annual Recycled Water Production and Number of Recycled Water Sites**

K/J 0864005
November 2010

**Figure 4**




Source: SLVWD 2008

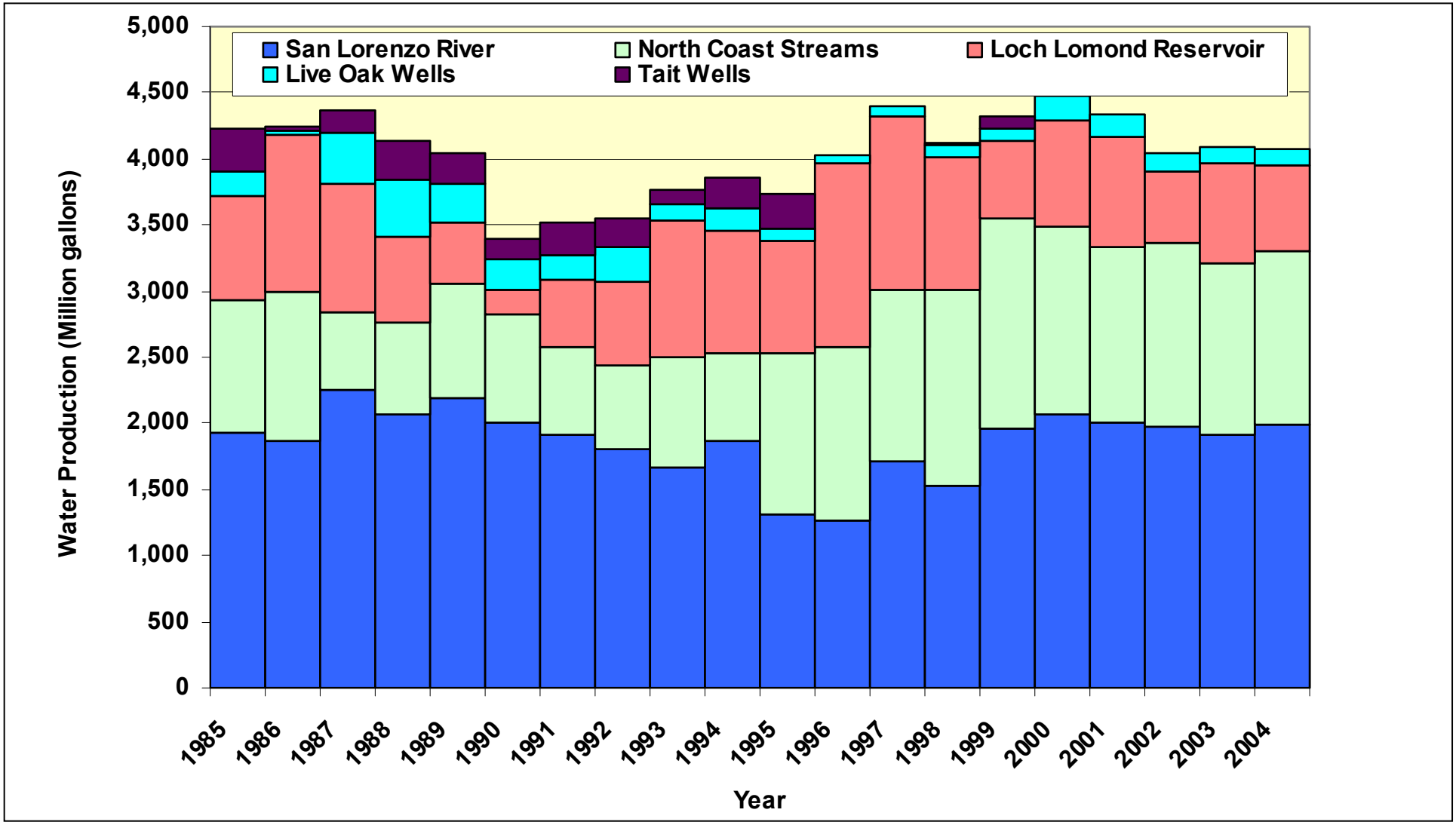
**Kennedy Jenks Consultants**

TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**SLVWD Monthly Water Production for WY 2007**

K/J 0864005
November 2010

**Figure 5**




Source: SCWD, 2006
Note: Beginning in 2000, Tait Well production was reported with San Lorenzo River Production

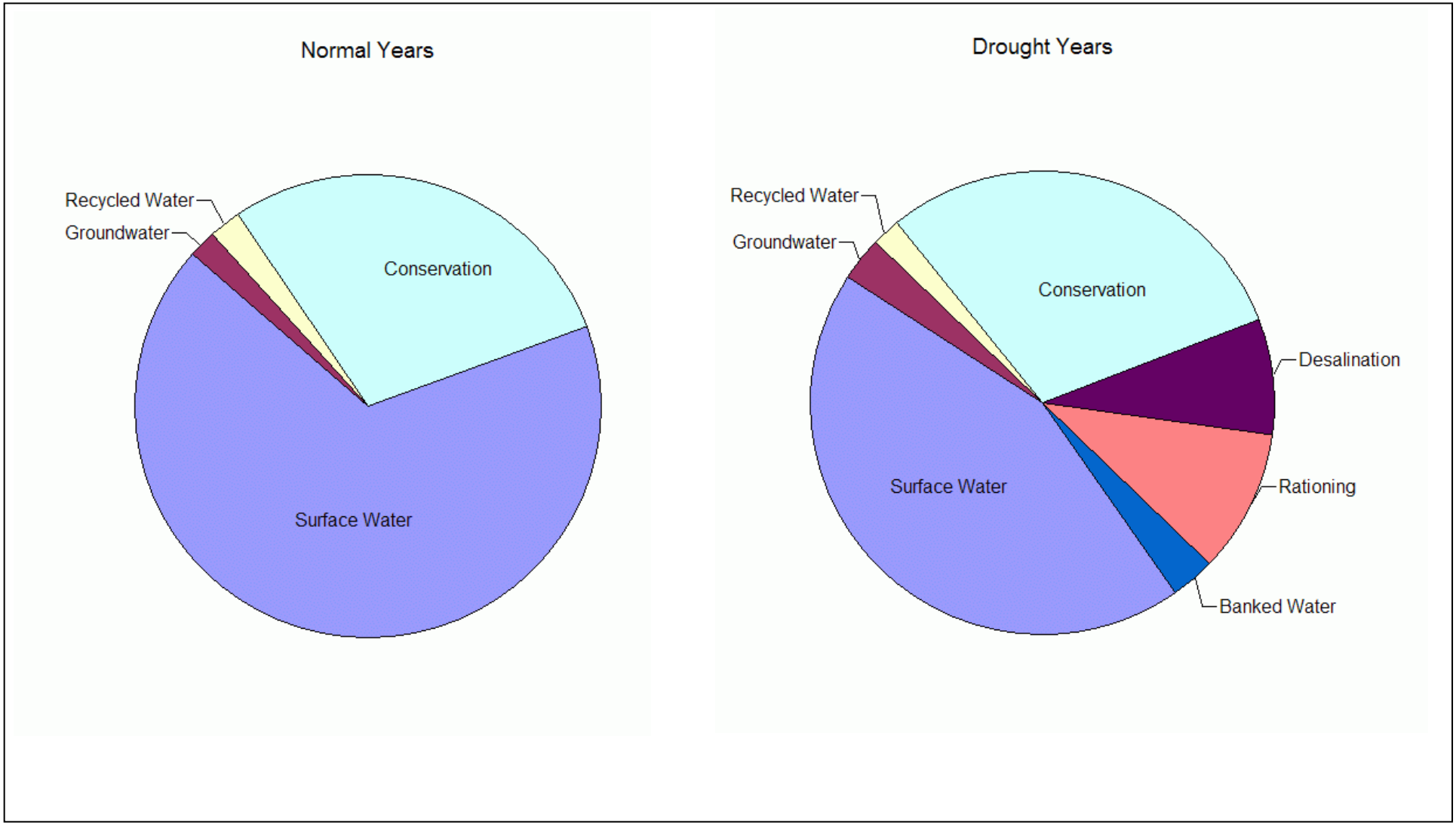
**Kennedy Jenks Consultants**

TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**City of Santa Cruz Annual Water Production for WY2007**

K/J 0864005
November 2010

**Figure 6**




Source: SCWD[2], 2008

**Kennedy Jenks Consultants**

TM4 Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**City of Santa Cruz Water Department**
**Future Water Portfolio**

K/J 0864005
November 2010

**Figure 7**

**Scotts Valley Water District Historic Record**
**El Pueblo Rain Gage**

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | TOT | WY of Ave | Cal Year of Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46-47 | 9.33 | 1 | 4.35 | 1.12 | 4.8 | 5.34 | 0.35 | 0.91 | 0.68 | 0 | 0 | 0 | 27.88 | 67 | 63 |
| 47-48 | 0.8 | 1.1 | 11.2 | 2.5 | 2.59 | 6.01 | 8.62 | 2.12 | 0.55 | 0 | 0 | 0.1 | 35.59 | 85 | 77 |
| 48-49 | 0.1 | 4 | 5.51 | 4.47 | 7.57 | 12.71 | 0 | 0.6 | 0 | 0 | 0 | 1.25 | 36.21 | 87 | 168 |
| 49-50 | 6.58 | 23.68 | 12.87 | 17.52 | 15.83 | 5.53 | 2.72 | 1.12 | 0 | 0 | 0 | 0 | 85.85 | 205 | 168 |
| 50-51 | 2.35 | 4.1 | 20.56 | 6.63 | 2.95 | 3.66 | 1.89 | 1.44 | 0 | 0 | 0 | 0.15 | 43.73 | 105 | 86 |
| 51-52 | 0 | 4.83 | 14.38 | 19.74 | 4.78 | 11.35 | 1.98 | 0.56 | 2.02 | 0 | 0 | 0 | 59.64 | 143 | 112 |
| 52-53 | 0.8 | 4.82 | 0.51 | 9.61 | 0 | 5.75 | 5.95 | 1.54 | 0 | 0 | 0.42 | 0 | 29.4 | 70 | 99 |
| 53-54 | 0 | 7.8 | 9.98 | 7.27 | 5.75 | 8.66 | 3.3 | 0.75 | 0 | 0 | 0 | 0 | 43.51 | 104 | 131 |
| 54-55 | 0.1 | 3.42 | 25.46 | 8.19 | 3.14 | 1 | 5.63 | 0.8 | 0 | 0 | 0 | 0.45 | 48.19 | 115 | 57 |
| 55-56 | 3.18 | 0 | 1.19 | 13.61 | 3.85 | 0.15 | 3.25 | 1.83 | 0 | 0 | 0 | 0.65 | 27.71 | 66 | 92 |
| 56-57 | 6.85 | 1.1 | 7.15 | 8.29 | 11.35 | 3.68 | 3.05 | 7.66 | 0.15 | 0 | 0.2 | 0.5 | 49.98 | 119 | 90 |
| 57-58 | 0 | 0.25 | 2.5 | 10.18 | 22.17 | 14.42 | 9.8 | 0.7 | 0.63 | 0 | 0.25 | 9.5 | 70.4 | 168 | 164 |
| 58-59 | 0 | 0 | 0.75 | 8.05 | 12.22 | 0.5 | 1.1 | 0 | 0 | 0 | 0 | 0 | 22.62 | 54 | 79 |
| 59-60 | 0.18 | 7.8 | 2.91 | 12.35 | 11.72 | 3.33 | 2.42 | 0.4 | 0 | 0 | 0 | 0.15 | 41.26 | 99 | 98 |
| 60-61 | 0.1 | 5.93 | 4.27 | 5.01 | 1.95 | 4.92 | 1.3 | 0.75 | 0 | 0 | 0.23 | 0 | 24.46 | 58 | 65 |
| 61-62 | 6.99 | 0.81 | 5 | 4.6 | 20.33 | 6.77 | 0.35 | 0 | 0 | 0 | 0 | 0.18 | 45.03 | 108 | 110 |
| 62-63 | 3.34 | 9.84 | 0.34 | 9.15 | 8.75 | 6.88 | 9.24 | 1.6 | 0 | 0 | 0 | 0.18 | 49.32 | 118 | 148 |
| 63-64 | 2.79 | 5.66 | 17.51 | 5.99 | 0.15 | 3.43 | 0.81 | 0.46 | 0.82 | 0 | 0 | 0 | 37.62 | 90 | 67 |
| 64-65 | 0.08 | 9.05 | 7 | 6.15 | 2 | 3.29 | 4.83 | 0 | 0 | 0.32 | 0.05 | 0.27 | 33.04 | 79 | 84 |
| 65-66 | 0 | 9.14 | 9.03 | 3.39 | 4.83 | 0.4 | 1.25 | 0.16 | 0.15 | 0 | 0 | 0 | 28.35 | 68 | 42 |
| 66-67 | 0.47 | 2.22 | 4.51 | 17.33 | 0.7 | 9.84 | 9.52 | 0.24 | 1.8 | 0 | 0.4 | 0.05 | 47.08 | 113 | 143 |
| 67-68 | 2.27 | 4.55 | 12.89 | 7.1 | 5.63 | 6.15 | 1.05 | 0.57 | 0 | 0 | 0 | 0.1 | 40.31 | 96 | 95 |
| 68-69 | 3.92 | 2.16 | 12.89 | 22.93 | 16.57 | 2.36 | 4.22 | 0.03 | 0.02 | 0 | 0 | 0 | 65.1 | 156 | 170 |
| 69-70 | 1.05 | 12.69 | 10.74 | 17.58 | 3.48 | 3.99 | 1.11 | 0.02 | 0.42 | 0 | 0.11 | 0.37 | 51.56 | 123 | 96 |
| 70-71 | 0.02 | 3.54 | 9.47 | 2.85 | 0.65 | 4.19 | 2.25 | 0.38 | 0 | 0.25 | 0 | 1.41 | 25.01 | 60 | 80 |
| 71-72 | 4.52 | 13.15 | 3.75 | 3.36 | 2.79 | 0.42 | 3.08 | 0.08 | 0.29 | 0 | 0 | 0.29 | 31.73 | 76 | 83 |
| 72-73 | 3.67 | 13.18 | 7.47 | 12.22 | 15.21 | 5.28 | 0.23 | 0.04 | 0 | 3 | 0 | 0 | 60.3 | 144 | 110 |
| 73-74 | 2.36 | 1.93 | 5.66 | 7.63 | 1.82 | 10.18 | 4.16 | 0.02 | 0.38 | 0.12 | 0.57 | 0.08 | 34.91 | 83 | 77 |
| 74-75 | 5.72 | 0.55 | 0.98 | 0.86 | 10.26 | 9.72 | 4.11 | 0 | 0.07 | 0 | 1.89 | 1.68 | 35.84 | 86 | 84 |
| 75-76 | 0.61 | 2.9 | 3.06 | 0.37 | 1.74 | 5 | 3.24 | 0 | 0.3 | 0 | 0 | 2.67 | 19.89 | 48 | 61 |
| 76-77 | 0.53 | 3.62 | 8.08 | 2.66 | 1.84 | 2.99 | 4.88 | 1.25 | 0.09 | 0 | 0 | 1.5 | 27.44 | 66 | 53 |
| 77-78 | 0 | 5.44 | 1.27 | 18.16 | 8.66 | 9.26 | 6.56 | 0 | 0 | 0.34 | 0 | 0 | 49.69 | 119 | 149 |
| 78-79 | 5.7 | 2.99 | 10.28 | 11.98 | 10.71 | 5.42 | 2.15 | 1.03 | 0 | 0.84 | 0 | 0 | 51.1 | 122 | 89 |
| 79-80 | 0.03 | 0.18 | 4.59 | 13.45 | 13.12 | 2.74 | 3.19 | 0.91 | 0.04 | 0 | 0 | 0.28 | 38.53 | 92 | 135 |
| Blair Ranch, 80-81 | 2.47 | 12.29 | 7.88 | 11.21 | 3.06 | 9.72 | 0.47 | 0.64 | 0 | 0 | 0 | 0 | 47.74 | 114 | 102 |
| El Pueblo 81-82 | 0.14 | 11.2 | 5.9 | 28.8 | 6.88 | 8.26 | 8.4 | 0.03 | 0 | 0 | 0.04 | 1.28 | 70.93 | 170 | 186 |
| 82-83 HIGH YEAR (tot 86.26") | 5.35 | 10.5 | 7.74 | 13.9 | 18 | 19.9 | 7.8 | 0.98 | 0 | 0 | 0.17 | 1.91 | 86.25 | 206 | 216 |
| 83-84 | 1.7 | 12.7 | 12.9 | 0.54 | 2.49 | 2.62 | 1.13 | 0.02 | 0.18 | 0.01 | 0 | 0.25 | 34.54 | 83 | 64 |
| 84-85 | 2.8 | 13.8 | 2.95 | 1.72 | 4.2 | 7.92 | 0.73 | 0.11 | 0.15 | 0.09 | 0.02 | 0.54 | 35.03 | 84 | 63 |
| 85-86 | 1.12 | 7.14 | 2.62 | 7.38 | 22.4 | 15 | 0.48 | 0.83 | 0 | 0 | 0 | 1.3 | 58.27 | 139 | 120 |
| 86-87 | 0.03 | 0.05 | 2.47 | 4.51 | 9.06 | 6.31 | 0.7 | 0 | 0.02 | 0 | 0 | 0 | 23.15 | 55 | 84 |
| 87-88 | 1.19 | 2.3 | 10.7 | 4.58 | 0.68 | 0 | 3.13 | 1.07 | 0.16 | 0 | 0 | 0 | 23.81 | 57 | 59 |
| 88-89 | 0.19 | 5.9 | 8.89 | 2.06 | 1.39 | 10.6 | 0.67 | 0.08 | 0.03 | 0 | 0.03 | 0.83 | 30.67 | 73 | 50 |
| 89-90 LOW YEAR (tot 21.17") | 3.53 | 1.58 | 0.01 | 3.42 | 3.69 | 2.13 | 0.16 | 5.79 | 0 | 0 | 0.12 | 0.15 | 20.58 | 49 | 43 |
| 90-91 | 0.5 | 0.24 | 1.65 | 0.61 | 5.39 | 17.19 | 0.51 | 0.06 | 0.4 | 0 | 0.02 | 0.07 | 26.64 | 64 | 80 |
| 91-92 | 2.37 | 1.46 | 5.42 | 3.03 | 15.3 | 4.65 | 0.45 | 0 | 0.82 | 0 | 0.05 | 0 | 33.55 | 80 | 95 |
| 92-93 | 3.41 | 0.2 | 11.54 | 18.51 | 10.22 | 3.17 | 1.37 | 0.96 | 0.68 | 0 | 0 | 0 | 50.06 | 120 | 105 |
| 93-94 | 0.73 | 2.74 | 5.52 | 3.51 | 9.72 | 0.68 | 2.75 | 2.1 | 0.01 | 0 | 0 | 0.05 | 27.81 | 66 | 81 |
| 94-95 | 1.79 | 8.29 | 4.78 | 23.88 | 0.65 | 13.62 | 3.79 | 0.89 | 1.04 | 0.01 | 0 | 0 | 58.74 | 140 | 130 |
| 95-96 | 0 | 0.32 | 10.03 | 13.52 | 11.35 | 5.14 | 2.38 | 4.31 | 0.03 | 0 | 0 | 0 | 47.08 | 113 | 166 |
| 96-97 | 2.89 | 6.95 | 22.43 | 12.33 | 0.17 | 1.5 | 0.58 | 0.16 | 0.12 | 0 | 0.54 | 0 | 47.67 | 114 | 73 |
| 97-98 | 0.68 | 10.12 | 4.06 | 14.21 | 21.81 | 6.17 | 2.85 | 3.65 | 0.01 | 0 | 0.01 | 0.17 | 63.74 | 152 | 146 |
| 98-99 | 1.02 | 9.11 | 1.85 | 9.25 | 11.08 | 5.22 | 2.58 | 0.03 | 0.36 | 0 | 0.02 | 0.14 | 40.66 | 97 | 85 |
| 99-00 | 0.35 | 5.69 | 0.53 | 18.02 | 17.57 | 2.77 | 2.69 | 1.01 | 0.18 | 0 | 0.2 | 0.4 | 49.41 | 118 | 121 |
| 2000-2001 | 5.14 | 1.38 | 0.94 | 8.68 | 10.65 | 4.05 | 2.67 | 0 | 0.07 | 0 | 0 | 0.16 | 33.74 | 81 | 129 |
| 2001-2002 | 1.13 | 9.93 | 16.45 | 4.97 | 2.69 | 4.66 | 0.52 | 0.9 | 0 | 0 | 0.05 | 0 | 41.3 | 99 | 98 |
| 2002-2003 | 0 | 5.8 | 21.4 | 2.77 | 2.95 | 2.54 | 5.75 | 1.09 | 0.16 | 0 | 0 | 0 | 42.46 | 101 | 89 |
| WY2004 | 0.19 | 3.93 | 17.55 | 4.44 | 9.69 | 0.35 | 0.65 | 0.07 | 0 | 0 | 0 | 0 | 36.87 | 88 | 96 |
| WY2005 | 7.24 | 3.25 | 14.39 | 8.3 | 7.2 | 10.01 | 3.79 | 2.13 | 0.94 | 0.02 | 0 | 0.08 | 57.35 | 137 | 138 |
| WY2006 | 0.19 | 2.84 | 21.73 | 6.55 | 5.26 | 15.29 | 10.44 | 1.01 | 0.01 | 0 | 0.01 | 0 | 63.33 | 151 | 115 |
| WY2007 | 0.25 | 3.30 | 5.67 | 0.89 | 9.24 | 0.30 | 2.17 | 0.46 | 0.00 | 0.10 | 0.01 | 0.33 | 22.72 | 54 | 52 |
| WY2008 | 1.93 | 0.52 | 5.5 | 17.59 | 6.96 | 0.36 | 0.22 | 0 | 0 | 0.01 | 0 | 0.04 | 33.13 | 79 | 86 |
| WY2009 | 1.59 | 4.8 | 4.38 | 1.8 | 15.28 | 3.47 | 0.52 | 1.42 | 0.01 | 0 | 0 | 0.26 | 33.53 | 80 | 91 |
| WY2010 | 9.7 | 0.33 | 5.21 | 11.37 | 8.66 | 4.35 | 5.41 | 1.17 | 0 | 0.01 | 0.07 | 0 | 46.28 | 111 | 133 |
| WY2011 | 3.92 | 5.13 | 15.36 | 1.97 | 10.59 | 13.4 | 0.75 | 3.42 | 3.4 | 0 | 0.04 | 0.02 | 58 | 139 | 96 |
| WY2012 | 2.93 | 3.41 | 0.15 | 6.8 | 2.84 | 12.33 | 3.64 | 0.02 | 0.2 | 0.02 | 0 | 0.02 | 32.36 | 77 | 125 |
| WY2013 | 1.61 | 11.32 | 13.25 | 1.31 | 0.47 | 2.2 | 0.89 | 0.01 | 0.11 | 0 | 0 | 0.7 | 31.87 | 76 | 18 |
| WY2014 | 0.01 | 0.87 | 0.78 | 0.05 | 11.52 | 4.02 | | | | | | | 17.25 | | 37 |
| 58-Year Average Precipiation | 2.10 | 5.19 | 7.81 | 8.45 | 7.63 | 5.96 | 2.96 | 0.93 | 0.26 | 0.08 | 0.08 | 0.46 | 41.84 | | |
| Min | 0.00 | 0.00 | 0.01 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.25 | | |
| Max | 9.70 | 23.68 | 25.46 | 28.80 | 22.40 | 19.90 | 10.44 | 7.66 | 3.40 | 3.00 | 1.89 | 9.50 | 86.25 | | |
| Max | 1.13 | 3.97 | 5.67 | 7.19 | 6.32 | 4.96 | 2.42 | 0.60 | 0.02 | 0.00 | 0.00 | 0.08 | 39.42 | | |

| | |
|---|---|
| # of yrs > 75% | 51 |
| # of yrs total | 67 |
| % of yrs> 75% | 0.761194 |

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# Technical Memorandum 1B- Evaluation of Recharge Potential for Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project:

February 2011

Prepared for

County of Santa Cruz
Environmental Health Services
701 Ocean Street
Room 312
Santa Cruz, CA 95060-4011

K/J Project No. 0864005

**Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.**

20 February 2011

# Technical Memorandum 1B

To: Mike Cloud and John Ricker, Santa Cruz County Health Services Agency

From: Michael Maley and Matt Baillie, Kennedy/Jenks Consultants

Subject: **Evaluation of Recharge Potential**
Santa Cruz County Conjunctive Water Use and Enhanced Aquifer Recharge Study
K/J 0864005

## 1. Introduction

Kennedy/Jenks Consultants (Kennedy/Jenks) is pleased to provide the Santa Cruz County Health Services Agency (County) with Technical Memorandum 1B (TM1B) in support of the Conjunctive Use and Enhanced Aquifer Recharge Project (Conjunctive Use Project). The Conjunctive Use Project is one of fifteen projects funded by a Proposition 50 Water Bond grant from the California State Water Resources Control Board to the Community Foundation of Santa Cruz County. The Conjunctive Use Project is Project 3 of the grant and is being administered by the County.

### 1.1. Conjunctive Use Project Overview

The objective of the Conjunctive Use Project is to assess the most appropriate approaches for coordinating water projects and increasing groundwater storage to improve the reliability of drinking water supplies primarily for the Scotts Valley Water District (SVWD) and San Lorenzo Valley Water District (SLVWD), mitigating declines in groundwater levels in the Santa Margarita Groundwater Basin (SMGB), and increasing stream baseflow in the lower San Lorenzo River Watershed. The Conjunctive Use Project evaluates the opportunities to use water exchanges, winter streamflow diversion, enhanced stormwater capture and recharge, and/or reclaimed wastewater to replenish groundwater storage.

The two goals of the Conjunctive Use Project are to increase the volume of groundwater in aquifer storage, and to increase summertime baseflow in streams by increasing groundwater levels. An understanding of the factors controlling the ability to recharge water to the aquifer in the Scotts Valley area is important for the Conjunctive Use Project. This TM provides an evaluation of the recharge potential in the study area and provides an initial screening-level analysis appropriate for evaluating potential alternatives.

The study area is focused on the Scotts Valley area (Figure 1B-1). For the Conjunctive Use Project, the study area covers the portion of the Santa Margarita Groundwater Basin (SMGB) south of Bean Creek (Figure 1B-1).


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## 1.2. Scope

TM1B summarizes the work performed as part of Task 1 Evaluate Recharge Potential of the Conjunctive Use Project Scope of Work. This tech memo provides an evaluation of the following items:

- A general evaluation of the recharge potential of the project area. The objective of this task is to identify and prioritize the areas where active groundwater recharge would help mitigate groundwater supply issues in the project area.
- The recharge potential of the various surface soils and shallow geological units will be provided. This evaluation will be used to develop unit recharge potentials for recharge ponds and injection wells within the project area.

Based on this evaluation, a map was produced that defines the areas where active groundwater recharge by either surface ponds or injection wells would help mitigate groundwater supply issues in the project area.

This technical memorandum is intended for use in assessing feasibility, and is not appropriate for design, which would require additional site specific investigations and testing. The opinions presented in this technical memorandum have been formulated in accordance with generally accepted engineering practices that exist at this time. They are based on the investigation and evaluation methods described herein, and the assumptions implicit in those methods. The objectives of the recharge potential evaluation include:

- Identify the factors that influence recharge potential,
- Evaluate the range of sizes of an aquifer recharge facility to ensure adequate capacity to process a set range of discharge flow rates, and
- Identify additional data needs for future Conjunctive Use Project design.

## 1.3. General Approach

This evaluation was used to evaluate the recharge potential of various aquifer recharge methods. Based on this evaluation, a map was produced that defines the areas where active groundwater recharge by either surface ponds or injection wells would help mitigate groundwater supply issues in the project area. The potential options for active groundwater recharge considered in this tech memo include:

- **Percolation Ponds.** Large, shallow ponds situated above the groundwater level and enclosed by dikes or levees. Ponds are filled intermittently, followed by periods of drying and recharge water is delivered to the groundwater either directly to the saturated zone or through the unsaturated zone.


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- **Infiltration Basins.** Deep recharge basins that are designed to continuously hold water and are typically excavated below the groundwater level.
- **Leach Fields.** A system of perforated pipes installed in a series of shallow trenches backfilled with highly permeable material to disperse the discharge flow. Discharge flow percolates through the unsaturated soils to reach groundwater.
- **Injection and Extraction Wells.** A series of wells drilled into a suitably transmissive zone in the underlying groundwater flow system. Recharge water is pumped under low pressures into these wells and allowed to flow directly into the aquifer, bypassing the unsaturated zone. Injection and extraction could be accomplished in a single well or in separate wells depending on site-conditions and future operational design.
- **Low Impact Development.** A series of distributed treatment/runoff measures that include constructed wetlands, infiltration basins, vegetated swales and buffer strips that allow percolation of stormwater runoff.

## 2. Key Recharge Potential Factors

This section provides an overview of the criteria considered when determining the sustainable rate at which recharge water can be discharged indirectly.

### 2.1. Soil Infiltration Rate

The U.S. Department of Agriculture (USDA) has compiled the soil survey for Santa Cruz County (USDA, 1980). In the soil survey report, the soils are classified throughout the country with respect to a variety of soil properties for a variety of hydrologic properties such as the permeability and available water capacity. Soil classifications have been grouped into four hydrologic groups according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. These designations are useful for evaluating the recharge potential. The four hydrologic soil groups are:

- **Group A:** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained to excessively drained sands or gravelly sands. These soils have a high initial rate of infiltration, generally greater than 2.0 inches per hour.
- **Group B:** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well- or well-drained soils that have moderately fine to moderately coarse texture. These soils have a moderate initial rate of infiltration, generally 0.6 to 2.0 inches per hour.


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- **Group C:** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine or fine texture. These soils have a slow initial rate of infiltration, generally 0.2 to 0.6 inches per hour.
- **Group D:** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow and overlie impervious material. These soils have a very slow initial rate of infiltration, generally 0.06 to 0.2 inches per hour.

Figure 1B-2 shows a map of the four soil groups throughout the study area. Most soils in the area fall into groups A and B, indicating that soil permeability is at least 0.6 inches per hour though most of the basin.

Soils of Group A (the most permeable) occur throughout most of the western and southern parts of the basin. These soils mostly overlie, and are likely derived from, outcrops of the Santa Margarita Sandstone (Figure 1B-2).

Soils of Group B generally occur in areas underlain by alluvium along Bean and Carbonera Creeks, the Purisima, Monterey and Locatelli Formations (Figure 1B-2). These soils also occur across much of the central to eastern portions of the City of Scotts Valley.

Group C and D soils generally coincide with areas underlain by the Santa Cruz Mudstone in northern Scotts Valley. Isolated areas of Group C and D soils are also mapped in areas of alluvium along Bean and Carbonera Creeks, as well as other areas around the City of Scotts Valley.

## 2.2. Aquifers

The primary groundwater aquifers in the SMGB in the Scotts Valley area are the Santa Margarita Sandstone (Santa Margarita), the Lompico Sandstone (Lompico) and the Butano Formation (Butano). The Butano is exposed at the surface only in the northern parts of the basin and occurs at depths greater than 1,000 feet below Scotts Valley. Therefore, the Butano is not considered as a candidate for direct aquifer recharge. A summary of aquifer characteristics is provided below for the Santa Margarita and Lompico. Additional information on the hydrogeology is provided in TM1A (Kennedy/Jenks, 2011).

### 2.2.1. Santa Margarita

The Santa Margarita generally consists of massive, fine-to-medium-grained sandstone that forms a distinctive formation of white sand that can be observed in cliffs around the area (Clarke 1981). In the southern areas of Scotts Valley, the Santa Margarita occurs at the surface whereas it is overlain by the Santa Cruz Mudstone in the northern portions of Scotts Valley


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(Figure 1B-3). Where the Santa Margarita is present at the surface, there is potential for using surface spreading; however, areas overlain by mudstone preclude the use of surface spreading. The areas where the Santa Margarita is exposed at the surface have the potential for surface spreading.

The upper Miocene age Santa Margarita can be up to 300 feet thick and generally consists of massive, fine-to-medium-grained sandstone. Laboratory analyses of this sandstone indicate that it is typically 85 to 90 percent sand, 7 to 8 percent silt, and 4 percent clay (USDA 1980). For the Santa Margarita, the hydraulic conductivity can range from 1 to 3,000 feet per day (ft/d) but more typically ranges between 2 to 50 feet per day (ft/d). The specific yield can range from 0.02 to 0.18 but typically ranges between 0.07 and 0.12 (Johnson, 2002, ETIC, 2006).

Thin, dense, lower permeability layers have been identified within the Santa Margarita. These layers have been known to form perching horizons, for example at the Watkins-Johnson site in Scotts Valley (Stollar and Associates, 1988). The perched aquifer formed above this horizon has been noted to have a significantly higher groundwater elevation compared to the regional Santa Margarita. However, these horizons are likely not continuous. Identification of these perching horizons is important because of their potential to impact aquifer recharge. If present, these layers could act as a barrier to aquifer recharge capacity and lead to groundwater mounding issues in the vicinity of surface aquifer recharge facilities.

Historically, groundwater levels have been significantly higher in the Scotts Valley area than they are today; however, these recent declines are mostly localized. Some areas have experienced over 200 feet of groundwater level declines, whereas nearby areas have experienced relatively little change in groundwater levels during the same period. The volume of groundwater in the Santa Margarita has declined by as much as 5,000 acre-feet from 1985 through 2007 (Johnson 2002, ETIC 2005, 2006, Kennedy/Jenks 2008, 2009, 2010). The areas with large historical declines in groundwater levels provide the potential capacity for a Conjunctive Use Project.

Groundwater in the Santa Margarita in the Scotts Valley area primarily flows from south to north. Discharge is primarily to springs along outcrops of the Santa Margarita where Bean Creek has eroded through to the underlying Monterey Formation (Monterey). The groundwater gradient is generally on the order of 0.02 to 0.03 feet per foot (ft/ft). These gradients can steepen in the vicinity of large production wells. Pumping rates for production wells in the Santa Margarita typically range between 100 and 200 gallons per minute (gpm) where sufficient saturated thickness exists. Higher pumping rates may have been achievable historically when groundwater levels were higher.

### 2.2.2. Lompico

The Lompico is found in the subsurface throughout much of the basin; however, the few outcrops found in the Scotts Valley area are limited to the basin margins (Figure 1B-3). The


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Lompico is typically 200 to 350 feet thick (Clark, 1981, Brabb 1997). The lower third of the unit consists of thick beds of light-gray, medium-grained sandstone whereas the upper two-thirds of the unit are composed of massive yellowish-gray, fine-grained sandstone beds (Clark 1981). Geophysical logs from local wells show thin shale interbeds within the Lompico that may affect vertical flow within the unit. For the Lompico, the horizontal hydraulic conductivity ranges from 0.6 to 7 ft/d (Johnson, 2002, ETIC, 2006). The specific yield ranges from 0.04 to 0.07 and the storativity ranges from 0.0001 to 0.01 (Johnson, 2002, ETIC, 2006).

Groundwater level declines in the Lompico have been more widespread than in the Santa Margarita. Groundwater levels have declined by 100 to 250 feet over broad areas underlying Scotts Valley. The volume of groundwater in the Lompico has declined by up to 10,000 acre-feet from 1985 through 2007 (Johnson 2002, ETIC 2005, 2006, Kennedy/Jenks 2008, 2009, 2010). The areas with large historical declines in groundwater levels provide the potential capacity for a groundwater recharge project.

Groundwater flow in the Lompico is primarily from north to south. The groundwater gradient is also generally on the order of 0.02 to 0.03 ft/ft. Discharge is primarily to the large groundwater pumping wells operated by Scotts Valley Water District (SVWD) and San Lorenzo Valley Water District (SLVWD). These gradients can steepen in the vicinity of large production wells. Pumping rates for large production wells in the Lompico typically range between 200 and 400 gpm.

The lack of surface exposure of the Lompico in the Scotts Valley area means that any recharge applied to this unit must first pass through another, overlying unit. The Lompico is typically overlain by the low-permeability Monterey Formation. The thickness of the Monterey varies widely across the study area as a result of geologic deformation and erosion prior to deposition of overlying layers. Where present, the Monterey forms a significant aquitard that limits groundwater movement between the Santa Margarita and the Lompico; in these areas, there is little potential for surface spreading as a mechanism for recharge to this unit.

In parts of the Scotts Valley area, especially within a strip along the southern and eastern portions of the basin (i.e. the eastern rim of the SMGB), the Monterey was eroded away prior to deposition of the Santa Margarita, so that the Santa Margarita lies directly upon the Lompico. In these areas, there is no known barrier to percolation of groundwater from the Santa Margarita to the Lompico, so surface recharge would have the potential to reach the Lompico. The distribution of this contact forms a strip along the southern and eastern portions of the basin (Figure 1B-4).

### 2.2.3. Butano

The Butano has been mapped in surface outcrop along the northern SMGB margin (Figure 1B-3) by Clark (1966, 1981), Brabb (1997), and McLaughlin and others (2001). The Butano Sandstone consists largely of sandstone and interbeds of mudstone, shale, and siltstone.


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Specifically, the Butano consists of three members that include the lower sandstone member, the middle siltstone member, and the upper sandstone member (Clark, 1981).

The Butano is a thick sandstone unit that forms a wedge along the northern portion of the SMGB (Clark 1981). The Butano has a total stratigraphic thickness of up to 5,000 feet; however, due to structural deformation and erosional history the thicknesses found in the Scotts Valley area is several hundred to a thousand feet thick (Clark, 1981, Brabb 1997). For the Butano, the horizontal hydraulic conductivity was estimated at 1.25 ft/d, the specific yield at 0.06 and the storativity at 0.0001 (ETIC, 2006).

Groundwater recharge is most likely from infiltration of precipitation and from the streams that flow over the Butano Formation in these exposure areas north of Scotts Valley. Correspondingly, the Butano Formation appears to have few natural discharge points.

Groundwater level declines in the Butano are not as well understood as those in the Lompico and the Santa Margarita due to a lack of monitoring wells completed entirely within the Butano. Static groundwater levels fluctuate about 100 feet seasonally due to pumping, but overall groundwater levels have maintained a relatively stable trend. This suggests that the Butano is actively recharged, allowing groundwater levels to recover each year in spite of the high volume of groundwater produced by these wells. Annual groundwater production from the Butano is estimated to range from 500 to 1,000 acre-feet per year.

The Butano is over 1,000 feet deep underneath most of Scotts Valley, and few wells have been drilled deep enough to encounter the Butano. The lack of surface exposure and overlying fine-grained layers precludes any surface recharge methods for the Butano. The Butano is absent over much of the Study Area, and is only present at depths over 1,000 feet in the northern portions of Scotts Valley causing increased injection well installation costs. Because of these limitations, the Butano is not considered to be a viable candidate for groundwater recharge by the Conjunctive Use Project.

## 3. Other Factors Influencing Recharge Potential

Several factors can influence the overall recharge potential. A brief overview of these factors is provided.

### 3.1. Aquifer Characteristics

Transmissivity (T) is a parameter that defines the ability of the aquifer to transmit water. The higher the transmissivity, the higher the flow of water the aquifer is capable of accepting (Morris and Quinn, 1999). An effective infiltration system requires an unconfined aquifer with high transmissivity to allow lateral flow away from infiltration system and minimize mounding (Bouwer, 2002). The soils overlying the aquifer must have high hydraulic conductivity (K) with


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sufficient thickness to convey the required quantity of water. Clay soils tend to have the lowest hydraulic conductivity and coarse sands tend to have the highest hydraulic conductivity.

### 3.2. Groundwater Mounding

Groundwater mounding typically occurs immediately below indirect discharge facilities. Because groundwater moves relatively slowly, a localized increase in groundwater elevation, or mound, develops. If the mound rises to near the recharge facility, this can significantly limit the amount of water that can be recharged. The presence of shallow clay or hardpan layers can increase mounding due to their low hydraulic conductivity. The height of the mound is controlled by the permeability of the sediments, the application rate of water at the surface, and the depth to groundwater. A greater the depth to groundwater allows for a larger vertical separation between the facility and the groundwater, leaving more space for mound development. Under similar soil permeability conditions, the greater depth to groundwater would allow for a greater potential for recharge.

### 3.3. Clogging and Plugging

Several mechanisms can lead to soil/aquifer plugging during aquifer recharge. Clogging rates increase with increasing infiltration rates, increasing injection pressures in injection wells and increasing the water depth in infiltration basins (Bouwer, 2002). A summary of these mechanisms is provided below.

#### 3.3.1. Clay Expansion and Dispersion

Expansion and dispersion of clay particles which are naturally present in aquifers can occur by ion-exchange reactions and can significantly reduce hydraulic conductivity. Ion exchange involves the replacement of ions absorbed on the surface of clay particles in aquifers by ions (primarily sodium, calcium, and magnesium) in solutions. This process is known as base or cation exchange (Todd, 1980).

From the Santa Cruz County Soil Survey (USDA, 1980), the Group A and B soil hydrology groups typically have low clay content. The Group C soil hydrology group may have fine-grained sediments that could experience clogging. The Group D soil hydrology group would have a high likelihood of containing shallow clay layers that could potentially lead to significantly more clogging.

#### 3.3.2. Mineral Precipitation

Chemical reactions can occur between groundwater and recharged water introduced to the aquifer, causing precipitation of insoluble compounds (e.g. calcium carbonate, iron, and


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manganese oxides). The chemical reactions generally depend on chemical and physical-chemical conditions, including pH, temperature, and availability of a surface area for precipitate deposition (ASCE, 2001). Mineral precipitation would be most problematic for injection wells and leachfields where buildup of mineral precipitates within well screens would have the potential to significantly reduce the total open area of the screen, resulting in a loss in efficiency. If mineral precipitates develop on the well screens, additional maintenance costs would be incurred to mitigate the buildup through physical and chemical rehabilitation treatments.

Plugging by mineral precipitation generally has not been a serious problem in percolation ponds and infiltration basins because: (1) the total volume of precipitation is too small to significantly affect the hydraulic conductivity; (2) precipitation typically occurs in isolated pore spaces (interstices) with little effect on the hydraulic conductivity; and (3) the slow kinetics of the reactions cause precipitation to occur over a large area of the aquifer rather than at the recharge water-aquifer interface (Wood, 1980).

### 3.3.3. Physical Plugging

Physical plugging is caused mainly by the accumulation in pore spaces of suspended solids contained in recharge water. The solids can consist of fine inorganic particles like silt, fine sand, clay, and flocs, and/or organic solids such as algal cells or decaying organic matter (ASCE, 2001). For surface spreading system, physical clogging occurs on the bottom and sides of the basin. In an injection well, this can occur on the well screen, in the sand or gravel pack, or in the surrounding aquifer.

As discussed by Bouwer (1997), clogging due to accumulation of suspended solids is a major consideration for aquifer recharge because solids either settle or are strained out, mainly on the soil surface. Clogging layers can range from 1 millimeter to several tens of millimeters thick and with time the hydraulic impedance of a clogging layer can increase and become the limiting factor of the infiltration process.

Previous experiments have shown that recharge water used for percolation applications should have suspended solids (SS) levels below 2 milligrams per liter (mg/l) to reduce physical plugging problems. Other research conducted in the same aquifer system showed no problem when recharge water with SS levels in excess of 25 mg/l was used (Rinck-Pfeiffer et al, 1999).

### 3.3.4. Biological Plugging

Plugging of well screens and aquifers is also caused by biological growth primarily of bacteria. The actual plugging results from both physical plugging caused by the growth of cells and accumulation of waste products and chemical plugging resulting from chemical reactions induced by biological activity (Wood, 1980). Similar to mineral precipitation, bacteria or other biological buildup can develop on well screens and reduce their efficiency. If biological buildup


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does develop on the well screens, additional maintenance costs would be incurred to mitigate the buildup through physical and chemical rehabilitation treatments.

A potential drawback of shallow recharge basins is weed growth. Biological growth requires energy and a nutrient source, and rates of biological growth are enhanced by warm temperatures, sunlight, and greater concentrations of nutrients in the form of dissolved and suspended solids. Pretreatment of the water to remove nutrients (phosphorus and nitrogen) may reduce clogging. Biological plugging also can be reduced by disinfection (e.g. chlorination and UV).

### 3.4. Hydraulic Loading

Long-term average infiltration rates should be developed when determining the hydraulic capacity of percolation ponds. Initial infiltration rates will decrease over time due to clogging and the ponds must be dried periodically for cleaning. According to Bouwer (2002), hydraulic loading rates for percolation ponds in warm, relatively dry climates with good-quality water range from 30 m/year in fine textured soils to 500 m/year for coarse, clean sands. Evaporative losses are small compared to percolation rates so they are not included in sizing calculations.

The water depth of the percolation basins should be carefully selected. As discussed by Bouwer (1997, 2002), while high hydraulic heads (corresponding to large water depths) produce higher infiltration rates, they also tend to compress clogging layers, thereby increasing the hydraulic resistance of the clogging layer. Thus, contrary to intuitive expectations, deep basins can produce lower average infiltration rates than shallow basins in similar settings.

### 3.5. Temperature and Viscosity

As discussed by Bouwer (2002), infiltration rates vary inversely with viscosity. Viscosity can cause winter infiltration rates to be as low as half the summer infiltration rate in areas with high seasonal temperature fluctuations. Therefore, temperature can have large effects on infiltration rates if recharge water temperature fluctuates widely. Indirect discharge facility capacities should be designed using the coldest regional temperatures when infiltration rates are lowest.

## 4. Sustainable Rate Assessment of Percolation Ponds

Utilizing both the unsaturated (vadose) zone and the saturated zone, percolation ponds are large, shallow ponds that are filled intermittently and are enclosed by dikes or levees. The pond bottom is situated above the water table (the upper boundary of the saturation zone in a groundwater system). The recharge water percolates through the unsaturated soils to reach groundwater. Thus, the ponds have no direct connection to underlying groundwater.

The primary benefit of percolation ponds is the improvement of water quality realized due to the fact that the water passes through the unsaturated zone. Soil aquifer treatment is provided by


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filtration, sorption, chemical precipitation and reaction, and biological transformation of constituents in the percolating water. Another benefit is that percolation ponds are a well-known technology with a well-established, reliable work history. Percolation ponds have been used reliably for decades in the study area and elsewhere. Yet another benefit of percolation ponds is their relatively lower construction, maintenance and energy costs as compared to other indirect discharge options. Percolation ponds are the least susceptible to long-term flood impact because fines can be removed manually after the flood events.

### 4.1. Percolation Pond Sizing

The sizing of percolation ponds is controlled by a range of site specific factors including soil conditions, geological factors, and operational issues. These will need to be addressed during future studies of potential sites and as the operational considerations are better developed. For the purposes of this evaluation, the following technical specifications are used as conservative assumptions for making a preliminary estimate of the size of the percolation ponds. The specifications have been used for some percolation ponds, but variations to the specific design for use in the Scotts Valley area may be appropriate. The assumed technical specifications used for this analysis include the following:

- Discharge season is 180 days/year.
- Ponds operate 6 months/year.
- Initial soil percolation rates are (USDA, 1980):
    - 2 in/hr for Type A Soil
    - 0.75 in/hr for Type B Soil
    - 0.25 in/hr for Type C Soil
- De-rate factor is 6 to account for reductions in the percolation rate as the pore space below the facility is filled (Bouwer et al., 1974, Bouwer, 2002). For example, the sustainable percolation rate in Type A soil is 2 in/hr; however, the long-term infiltration rate is considered to be 0.33 in/hr or 0.67 feet per day. Without site-specific testing, using a de-rate factor of 6 is a conservative assumption that provides a factor of safety that the percolation ponds are of adequate size to handle the anticipated discharge rates.
- Each pond is flooded 10 days/month.
- Drying time for each pond is 18 to 21 days/month.
- Facility consists of multiple ponds so that some ponds are active while other ponds are drying at any given time.
- Initial pond loading depth is 3 feet.


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The designed loading depth marks the operational range of water levels in the ponds at any one time. An additional 0.75 feet would be provided to accommodate a large, single-day rain event of 9 inches. Two-feet of freeboard would be provided for all berms. Percolation ponds facility sizes are determined using the following additional criteria:

- Berms are constructed between ponds to provide separation and access for maintenance vehicles. Berm design assumptions include:
    - Height of 5.75 feet
    - Base width of 35 feet
    - Top width of 12 feet
    - Side slope of 2:1
- Additional land would be included for an operations facility and a 150-foot wide buffer zone surrounding the ponds to accommodate groundwater mounding.

A percolation facility to accommodating 1 million gallons per day (mgd) of aquifer recharge on Type A soil would require approximately 13 acres of active pond area (including berms) and approximately 15 acres for the entire facility site, including the buffer and operations facilities. Table 2 provides pond sizes and total facility sizes (based on Bouwer, 1997, 2002) needed to accommodate various discharge rates and soil percolation rates.

Table 1: Percolation Pond Sizing for Varying Discharge Rates and Soil Type

| | | 0.5 mgd | | 1.0 mgd | | 2.0 mgd | | 4.0 mgd | |
|---|---|---|---|---|---|---|---|---|---|
| **Soil Type** | **Initial Percolation Rate** | **Total Pond Area (acres)** | **Total Facility Size (acres)** | **Total Pond Area (acres)** | **Total Facility Size (acres)** | **Total Pond Area (acres)** | **Total Facility Size (acres)** | **Total Pond Area (acres)** | **Total Facility Size (acres)** |
| **A** | **2 in/hr** | 8 | 9 | 13 | 15 | 22 | 25 | 40 | 47 |
| **B** | **0.75 in/hr** | 28 | 32 | 53 | 61 | 78 | 89 | 102 | 118 |
| **C** | **0.25 in/hr** | 78 | 89 | 152 | 175 | 226 | 260 | 300 | 345 |

Note: Actual pond capacity would depend upon site-specific soil and aquifer characteristics.

## 4.2. Operations and Maintenance

Maintenance of percolation ponds should be an integral part of percolation performance optimization. The primary maintenance consists of periodically scraping off the top later of accumulated sediment and organic material from the pond bottom (Bouwer, 1985, 1997, 2002). According to Bouwer (1997), if the clogging layer is primarily organic, drying to partly decompose, crack, and curl up the organic material can be an effective method of restoring


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percolation rates until the clogging process repeats itself. The preferred mechanism to treat the organic material is manual raking and removal of the material. The organic layer can be shaved off or removed with a loader or similar equipment. However, the process disperses the organic material into the soil and compacts the soil, reducing future percolation rates. The organic layer can also be treated by discing of the soil, which disturbs the organic layer and can temporarily increase percolation rates. However, the discing process distributes the organic material in a thicker zone which can then act to impede long-term percolation rates; therefore, discing should be avoided if possible. If the clogging layer is inorganic (silt or clay), the layer should be mechanically removed. Much of the pond maintenance would be done during the dry summer months.

Ridges located in the bottom of a recharge basin and furrows adjacent to the ridges facilitate cost effective maintenance of the basin using the naturally occurring forces of gravity, water currents, and wave action. The ridges are normally formed from material taken from the furrows into shapes that facilitate sediment migration from the ridges into the furrows. While submerged, sediment settles on the ridges and furrows. The sediment on the submerged ridges tends to migrate toward and into the furrows. The basins are routinely dewatered allowing wind-driven or induced wave action against the sides of the ridges to wash the sediments from the ridges into the furrows, thereby maintaining the permeability of the ridges (Peyton, 2002).

Regular operation of the ponds would involve two ponds actively percolating while the remaining four are resting. The assumed operational rotation has two ponds to receiving discharge for 10 days, followed by a 20-day resting period. During the resting period, the ponds are allowed to drain completely to allow for partial subsidence of groundwater mounding and drying and settling of accumulated sediments and organics. Drying the ponds also helps to minimize bacterial growth on the bottom of the pond that may impede long-term percolation. Rotating the ponds with regular resting periods is good practice to maintain long-term sustainable percolation rates (Bouwer, 1985, 1997, 2002).

## 4.3. Assessment

The size of an aquifer recharge facility using percolation ponds would be based on the site-specific conditions. The smaller the size of the facility the lower the overall capital and O□M costs to maintain the facility. Placing the facility in areas of high permeability soils would improve performance and maximize infiltration potential. Locating the facility over areas with significant unsaturated aquifer material would limit mounding problems and maximize the potential percolation rates.

The primary limitation of percolation ponds is the requirement for significant land area. Land acquisition is a significant capital cost. Another limitation is the aesthetic impacts due to the visibility of percolation ponds from the surface and overhead. To minimize the size of the aquifer recharge facility, percolation ponds would best be located in areas with


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- Hydrologic Soil Group A soils,
- Santa Margarita near the surface,
- Absence of the Santa Cruz Mudstone,
- Sufficient available groundwater storage, and
- Absence of the Monterey where the Santa Margarita and Lompico are in direct contact is preferable.

Figure 1B-5 provides a map of the study area showing the distribution of areas that are likely to have these characteristics, and are therefore suitable for large-scale surface recharge using percolation ponds. Those areas that coincide with the area where the Santa Margarita and Lompico are in direct contact would have the highest potential because aquifer recharge from the surface could reach the Lompico. This includes the southern portion of the Hanson Quarry. In the areas north of the direct contact area, surface recharge from percolation ponds would be restricted to only the Santa Margarita.

### 4.4. Additional Data Needs

Based on the relative benefits and limitations, percolation ponds are considered a viable mode of aquifer recharge for further evaluation. Testing should be performed to provide the following data that are needed prior to developing a percolation pond facility:

- Site specific soil conditions,
- Field test of percolation rates,
- Site specific groundwater levels and characteristics,
- Field test of clogging rate, and
- Site specific geotechnical analysis.

## 5. Infiltration Basins

Infiltration basins are similar to percolation ponds except that they are much deeper and the basins remain filled with water throughout the year. Typically, infiltration basins discharge directly to the saturated zone. Water discharged into an infiltration basin escapes the basin through the basin side or bottom via installation.

### 5.1. Infiltration Basin Sizing

The size required for an infiltration basin is comparable to that of percolation ponds for the same recharge water flows because groundwater mounding during seasonally high groundwater, is


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the primary factor controlling the size of both types of facilities. The basins may be excavated as much as 10 to 50 feet deep. If the basin is completed through the unsaturated zone, the recharge water is allowed to infiltrate directly into the groundwater aquifer.

The specifications for infiltration basins will require additional evaluation to develop a design appropriate for the Scotts Valley area. The sizing of infiltration basin is controlled by a range of site specific factors including soil conditions, geological factors, and operational issues. These will need to be addressed during future studies of potential sites and as the operational considerations are better developed.

## 5.2. Operations and Maintenance

Operation of the facility consists of discharging water into the infiltration basin through a single discharge pipe. Piping at the site consists of a single discharge pipe from the main conveyance to the site and two discharge structures.

Although high hydraulic heads in infiltration basins can result in higher infiltration rates, they also tend to compress clogging layers, which increases hydraulic resistance of the clogging layer. Therefore, it is assumed that after a period of time, the hydraulic capacity of an infiltration basin would be limited by the permeability of the clogging layer and would be equivalent to that of a percolation pond.

Because groundwater mounding is a primary concern, a monitoring well system should be planned to aide in monitoring the local groundwater mounding from facility operations. The facility would include 10 monitoring wells to monitor water levels. The monitoring wells would typically be installed within 100 feet of the basin margins. One set of wells with well screens completed to different vertical depths is assumed to be completed downgradient of the basin to evaluate vertical flow characteristics.

Clogging due to fines and organics may reduce the permeability at the interface with the soil and form a limiting condition that reduces inflow. Because the basin would be saturated year round, it is more difficult, time-consuming and expensive to clean the basin or control biological growth after it has been constructed. Removal of the built-up material would require expensive dredging operations. Without dredging, the performance of the infiltration basin would decline over time (Bouwer, 1999, 2002; Oaksford, 1985). Flood events would cause long-term degradation to sustainable flow rate because of the additional fines introduced into the basin without a means to dry the basin and remove the top layer of soil, as in a percolation pond.

A limitation of infiltration basin is the long-term maintenance of the basins to ensure a sustainable discharge rate. Control of algal growth on the basin surface and of biological growth on the embankments is an important part of maintenance. If left unchecked for extended periods of time, could compromise infiltration rates and water quality. Periodic algaecide application may be necessary to ensure continued performance of the infiltration basins if conditions become problematic.


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### 5.3. Assessment

The primary benefit of an infiltration basin would be if the site area was covered by low permeability sediments, but a high-permeability aquifer was present at a lower depth. The infiltration basin allows for higher discharges in this situation by circumventing the low-permeability sediments.

Infiltration basins can be used opportunistically where an existing excavation is already present, such as from a sand mining operation, as making use of existing features can significantly reduce construction costs.

The primary limitations of infiltration basins are the cost and time required for their construction of a large basin. The cost of excavation would depend on the size and depth of the basin. Construction of infiltration basins would require heavy equipment and significant slope stabilization depending on the excavation depth. During construction, this facility would look like a sand mining operation. After heavy earthwork construction activities, the infiltration basin site development would be similar to that of a percolation pond site. The excavated material would need to be trucked offsite for disposal if a buyer cannot be found.

### 5.4. Additional Data Needs

Based on the relative benefits and limitations, infiltration basins are considered a viable mode of aquifer recharge for further evaluation. Testing should be performed to provide the following data that are needed prior to developing a percolation pond facility:

- Site specific soil conditions,
- Field test of percolation rates,
- Site specific groundwater levels and characteristics,
- Field test of clogging rate, and
- Site specific geotechnical analysis.

## 6. Sustainable Rate Assessment of Leach Fields

A leach field utilizes a system of perforated pipes installed in a series of shallow trenches backfilled with highly permeable material to disperse the discharge flow. The pipes and trenches are situated above the water table. A leach field uses the same principle as a percolation pond, namely percolation of discharge water to the water table through the unsaturated zone. Thus, the trenches have no direct connection to underlying groundwater.


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## 6.1. Leach Field Sizing

A leach field is assumed to be of a comparable size to a percolation pond facility; therefore, to accommodating 1 mgd of aquifer recharge on Type A soil would require approximately 15 acres.

The primary advantage of a leach field is that it may be less visually intrusive compared to percolation ponds. As with an injection well field, a leach system may be landscaped to produce an aesthetically pleasing indirect discharge site. Similar to the percolation ponds, the leach field has the water quality benefit of having the discharge water pass through the unsaturated zone. Another advantage of the leach field is the potential flexibility of design.

## 6.2. Operations and Maintenance

Flow through the system would be controlled by a series of valves. Flow in each distribution line would be controlled such that the leach field can be operated in a manner similar to the percolation ponds with part of the system operational and part of the system resting at any given time. Each lateral would have a valve to control flow and ensure even distribution of flow among the laterals. Additional pumping facilities may be necessary to provide enough pressure for rapid percolation of the discharge flow.

The primary disadvantage of the leach field concerns long-term maintenance. Since the perforated piping is completed above the water table, the system cannot be backflushed by pumping groundwater to remove sediments and organics that may clog the perforations (Bouwer, 2002). The perforated piping can be accessed and mechanically swabbed. For this purpose, each lateral would be equipped with a cleanout. However, without the inflowing water, this method may further smear the clogging material causing the situation to deteriorate further. If clogging becomes too severe, the perforated pipes may require re-excavation and replacement. This would significantly impact the long-term maintenance costs. Based on this, leach fields are a less desirable option for indirect discharge compared to percolation ponds, infiltration basin and injection wells.

## 6.3. Assessment

The conditions suitable for leachfields are considered to be similar to those for percolation ponds. Figure 1B-5 provides a map of the study area showing the distribution of areas that are likely to have these characteristics suitable for percolation ponds and leachfields. Similar to the percolation ponds, the highest potential areas are those that overlie the area where the Santa Margarita and Lompico are in direct contact because recharge from leachfield near the surface could reach the Lompico.


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### 6.4. Additional Data Needs

Testing should be performed to provide the following data that are needed prior to developing a leach field facility:

- Site specific soil conditions,
- Field test of percolation rates,
- Site specific groundwater levels and characteristics,
- Field test of clogging rate, and
- Site specific geotechnical analysis.

## 7. Sustainable Rate Assessment of Low Impact Development

An alternative to dedicated multi-use aquifer recharge facilities is smaller, more distributed sites using Low Impact Development (LID) techniques. These consist primarily of small-scale infiltration structures that collect stormwater and allow it to percolate into the shallow soil and ultimately to the aquifer. The primary advantage of LID is that it can be more readily incorporated into developed areas due to its smaller size. It can have advantages for aquifer recharge due to its distributed nature so that aquifer recharge is not focused into a single area. A disadvantage is that the distribution is controlled by development and land use patterns that may not be optimal for aquifer recharge. It should be noted that there are potential cumulative benefit of these structures in helping to meet other stormwater management issues. Scotts Valley currently has an ordinance requiring use of LID structures where geologic conditions are appropriate. The retrofitting existing developments would also have a potentially significant benefit.

### 7.1. Operations and Maintenance

LID is primarily designed to be operated passively. Small infiltration facilities are constructed that capture a portion of the stormwater runoff, and it is allowed to percolate into the ground. This type of facility tends to have significantly lower operational costs than other types of aquifer recharge facilities discussed above. The infiltration facilities require maintenance to remove the buildup of fine-grained sediments or organics. The type of maintenance would vary depending on the type of facility. Additional information about LID is provided in TM3 (Kennedy/Jenks, 2010).

### 7.2. Assessment

The size of LID facilities is significantly smaller than large-scale aquifer recharge using percolation ponds. Therefore, these facilities are less sensitive to site specific conditions as


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these facilities can be successfully located in areas that would not be suitable for a large percolation pond. The conditions suitable for LID development include the following:

- Hydrologic Soil Group A or B soils,
- Santa Margarita near the surface, and
- Absence of the Santa Cruz Mudstone.

Figure 1B-6 provides a map of the study area showing the distribution of areas that are likely to have these characteristics suitable for LID. The areas shown on Figure 1B-6 as suitable for surface recharge using LID facilities meet the criteria listed above.

Because of the smaller scale of LID, it can be applied in more areas than the large-scale surface spreading. LID is applicable to many of the developed areas along Scotts Valley Drive and Mount Hermon Road in southern Scotts Valley. Those areas that coincide with the area where the Santa Margarita and Lompico are in direct contact would have the highest potential because recharge water could reach the Lompico.

### 7.3. Additional Data Needs

Testing should be performed to provide the following data that is needed prior to developing an LID facility:

- Site specific soil and geology conditions,
- Field tests of percolation rates,
- Field tests of clogging rate, and
- Site-specific geotechnical analysis.

## 8. Sustainable Rate Assessment of Injection Wells

The injection well option of indirect discharge consists of a series of wells drilled into a suitably transmissive zone in the underlying groundwater flow system. Discharge water is pumped under low pressures into these wells and allowed to flow into the aquifer. Recharge water is discharged directly to the saturated zone, bypassing the unsaturated zone. Therefore, the injection well option would produce water quality benefits from flow through the aquifer, but not the benefits that would result from flow through the unsaturated soils (Bouwer, 1985, 1997, 2002; Morris and Quinn, 1999).

The advantage of injection wells is that they require less land area than do percolation ponds. Additionally, the facility could be interspersed among existing land use areas, which would minimize the visual impact of the wells. The ground surface between the wells can either be left in its original state or landscaped. These wells could be designed as individual injection and


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extraction wells, or as dual-function injection and extraction wells depending on site-conditions and future operational design. The use of dual-function wells may save on capital costs, but may have higher operation and maintenance costs. However, dual-function wells may help SLVWD and SVWD with water management in the region.

## 8.1. Injection Well Sizing and Construction

Inside the well casing, the buildup of the water level in the well is a function of the injection rate of water into the well and the transmissivity of the aquifer. Injection rates would vary with water levels (Morris and Quinn, 1999). Actual flow rates for each well need to be developed based on testing after installation. Sizing of injection wells is based on the following assumptions:

- Recharge rate for each well is 0.2 mgd (about 150 gpm), or about half of the average pumping rate.
- Two-thirds of the installed wells operate at any given time to allow for maintenance.

The number of injection wells would vary depending on the intended volume of aquifer recharge. Additional injection wells would be needed to allow for maintenance. Spacing of the injection wells would depend on aquifer conditions and land use constraints. The estimated number of injection wells for different aquifer recharge volumes based on the assumptions above is estimated as the following:

- A 0.5 mgd aquifer recharge facility would require 4 wells,
- A 1.0 mgd aquifer recharge facility would require 8 wells,
- A 2.0 mgd aquifer recharge facility would require 15 wells, and
- A 3.0 mgd aquifer recharge facility would require 22 wells.

Each injection well would be drilled to the base of the Lompico to access the greatest thickness of aquifer material. The well depths would vary from 500 to 800 feet depending on the local site conditions.

## 8.2. Operations and Maintenance

In an injection well, water is added to the well through a drop pipe with some type of submerged hydraulic restriction. The restriction ensures that back pressure can be maintained on the drop pipe during operation to prevent the introduction of air (Morris and Quinn, 1999). A minimum pressure of 5 pounds per square inch (psi) needs to be maintained to avoid air entrainment in the well which would otherwise seriously impact performance.

Well operations can be very sensitive to clogging. Clogging occurs when sediments in the recharge water or biological growth cause a buildup on the well screen. This buildup reduces the open area of the well screen, thereby reducing the flow rate of water into the aquifer. Geochemical interactions with the aquifer can also cause buildup due to precipitation of iron and


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manganese oxides or hydroxides as dissolved oxygen levels change, and to solution and precipitation of calcium carbonate due to changes in pH and dissolved carbon dioxide levels (Bouwer, 2002). Testing of site-specific conditions would be required to understand the potential geochemical interactions.

Air entrapment can cause air binding in injection wells when the recharge water contains entrained or dissolved air and/or is cooler than the soil or aquifer with which it comes into contact. The injected water warms up in the soil or aquifer; air leaves solution and forms entrapped air, which reduces the hydraulic conductivity by reducing the amount of effective pore space available to groundwater flow (Bouwer, 2002). To monitor for the effects of clogging and air entrapment, each well would require automated level controls and shut-off valves. It is essential to have appropriate level controls to shut down the well in case of a problem. Unlike percolation ponds, injection wells essentially have no excess storage capacity that would be available to handle short term operation or maintenance issues. Level controls and shut off switches could be set either at a control box at each individual well site or at a central location.

Maintenance of injection wells typically constitutes periodic backwashing of each well to remove the buildup of sediments and organic materials. To facilitate this activity, each well would be equipped with a submersible pump at the bottom of the well casing to provide suction pressure and thus clean out any accumulated obstructions in the well screens.

More intensive maintenance activities, such as chemical cleaning or well redevelopment, may be necessary if a well demonstrates further deterioration in performance. Chemical cleaning would entail the application of hydrogen peroxide solution or equivalent to remove organic buildup on the well screen. Well development would entail using a drilling rig to mechanically swab the well screen to break up heavy buildup of mineral precipitates that resist other forms of maintenance. Ongoing maintenance and replacement of pumps and valves would also be required. A pump maintenance area may also be necessary for cleaning and maintaining the dedicated well pumps.

## 8.3. Assessment

The capacity of each well is estimated to be 0.2 mgd based on known groundwater extraction rates in the Scotts Valley area and assuming that groundwater injection is less efficient than groundwater pumping. Installation of injection wells for aquifer recharge would be best located in areas of significant historic drawdown so that there is sufficient groundwater storage capacity available. Due to the complex geologic structure of the Scotts Valley area, wells would best be located (from a cost standpoint) in the Lompico in areas where the Lompico is not too deep to reduce drilling costs. There may be some benefit to locating the wells in the area where the Santa Margarita is in direct contact with the Lompico because the Lompico is found at shallower depths and the Santa Margarita potentially provides additional storage capacity.


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Figure 1B-7 provides a map of the study area showing the distribution of areas that are likely to have these characteristics suitable for injection wells. This includes a wide area of southern Scotts Valley.

The primary advantage of the injection well option is the flexibility of the wellfield layout. The wells are also less visible at the ground surface than the percolation ponds. The primary limitation of injection wells is the time and cost associated with operation and maintenance (Bouwer, 1985, 1997, 2002; Morris and Quinn, 1999). Injection wells would require more active management than percolation ponds or infiltration basins. Based on this analysis, injection wells are considered a viable option.

### 8.4. Additional Data Needs

Testing should be performed to provide the following additional data that is needed prior to developing an injection well facility:

- Installation of test wells,
- Aquifer injection tests,
- Site specific groundwater levels and characteristics,
- Potential geochemical interactions with the aquifer, and
- Groundwater modeling to evaluate long-term mounding and other effects.

## 9. Conclusions

Overall, the soils in the Scotts Valley area have high infiltration rates and the aquifer has high storage capacity and transmissivity which are favorable for aquifer recharge. Large-scale surface spreading options, including percolation ponds and leachfields, would be feasible in the Scotts Valley area. The primary factors for siting these types of facilities include the following:

- Hydrologic Soil Group A soils,
- Santa Margarita near the surface,
- Absence of the Santa Cruz Mudstone, and
- Absence of the Monterey where the Santa Margarita and Lompico are in direct contact.

In general, those areas that coincide with the area where the Santa Margarita and Lompico are in direct contact would have the highest potential because aquifer recharge from the surface would benefit both the Santa margarita and Lompico. This includes the southern portion of the Hanson Quarry. In the areas north of the direct contact area, surface recharge from percolation


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ponds would be restricted to only the Santa Margarita where there would be minimal increase in aquifer storage.

Smaller scale surface spreading options, best characterized by the LID facilities, could be feasible over a wider range including large portions within the City of Scotts Valley. LID facilities are less sensitive to site-specific conditions due to their smaller size so they can be sited in more areas. However, LID is associated with specific development and land use patterns that may not be optimal for aquifer recharge. The primary factors for siting LID facilities include the following:

- Hydrologic Soil Group A or B soils,
- Santa Margarita near the surface, and
- Absence of the Santa Cruz Mudstone.

LID facilities are less sensitive to site-specific conditions due to their smaller size so they can be sited in more areas. However, LID is associated with specific development and land use patterns that may not be optimal for aquifer recharge.

Injection wells are another feasible method for adding aquifer recharge. The anticipated capacity of injection wells completed in the Lompico is anticipated to be about 0.2 mgd or about 150 gpm. To achieve the potential aquifer recharge operation of 1.0 mgd would require 8 wells, including redundancy to accommodate down time of equipment, controlling development of local groundwater mounds, and variation in local conditions at wells (not all wells would be as efficient as others). A 1.0 mgd operation operated for 6 months per year. Injection well locations can be dispersed to minimize mounding, but this would cause of a more widely distributed recharge zone. A more compact well field would need to consider capacity for mounding.

The advantage of injection wells is that they can more efficiently emplace water in the Lompico which has the highest potential for groundwater storage. The wells are also less visible at the ground surface than the percolation ponds. The water quality benefit resulting from the filtering and biological activity associated with percolation through the vadose zone is lost with injection wells. For operation and maintenance, wells would require periodic backwash to remove fines and organics. If mineral or organics buildup up at the well screen is severe, chemical well development methods may be necessary. Injection wells are considered a viable option for indirect discharge.

For these aquifer recharge facilities, the total annual aquifer recharge potential for various facility sizes would be as follows (assuming that they are operated for 6 months per year):

- A 0.5 mgd aquifer recharge facility would add 275 acre-feet per season;
- A 1.0 mgd aquifer recharge facility would add 550 acre-feet per season;
- A 2.0 mgd aquifer recharge facility would add 1,100 acre-feet per season; and


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- A 3.0 mgd aquifer recharge facility would add 1,650 acre-feet per season.

The actual aquifer recharge would be dependent upon the availability of water and the any operational constraints.


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# FIGURES


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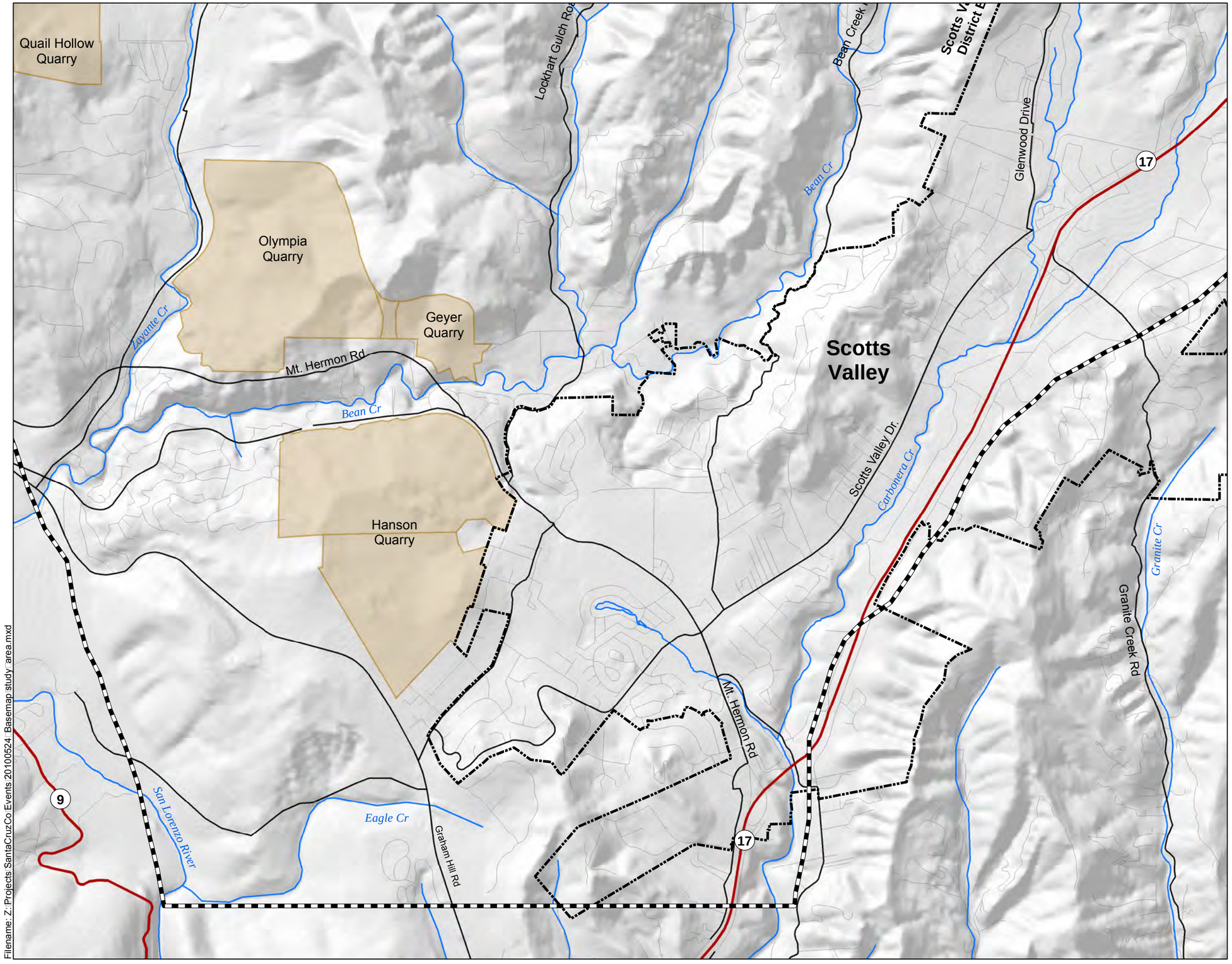


Filename: Z:\Projects\SantaCruzCo\Events\20100524_Basemap study area.mxd

**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Quarry

N

0 1,700

Scale: Feet

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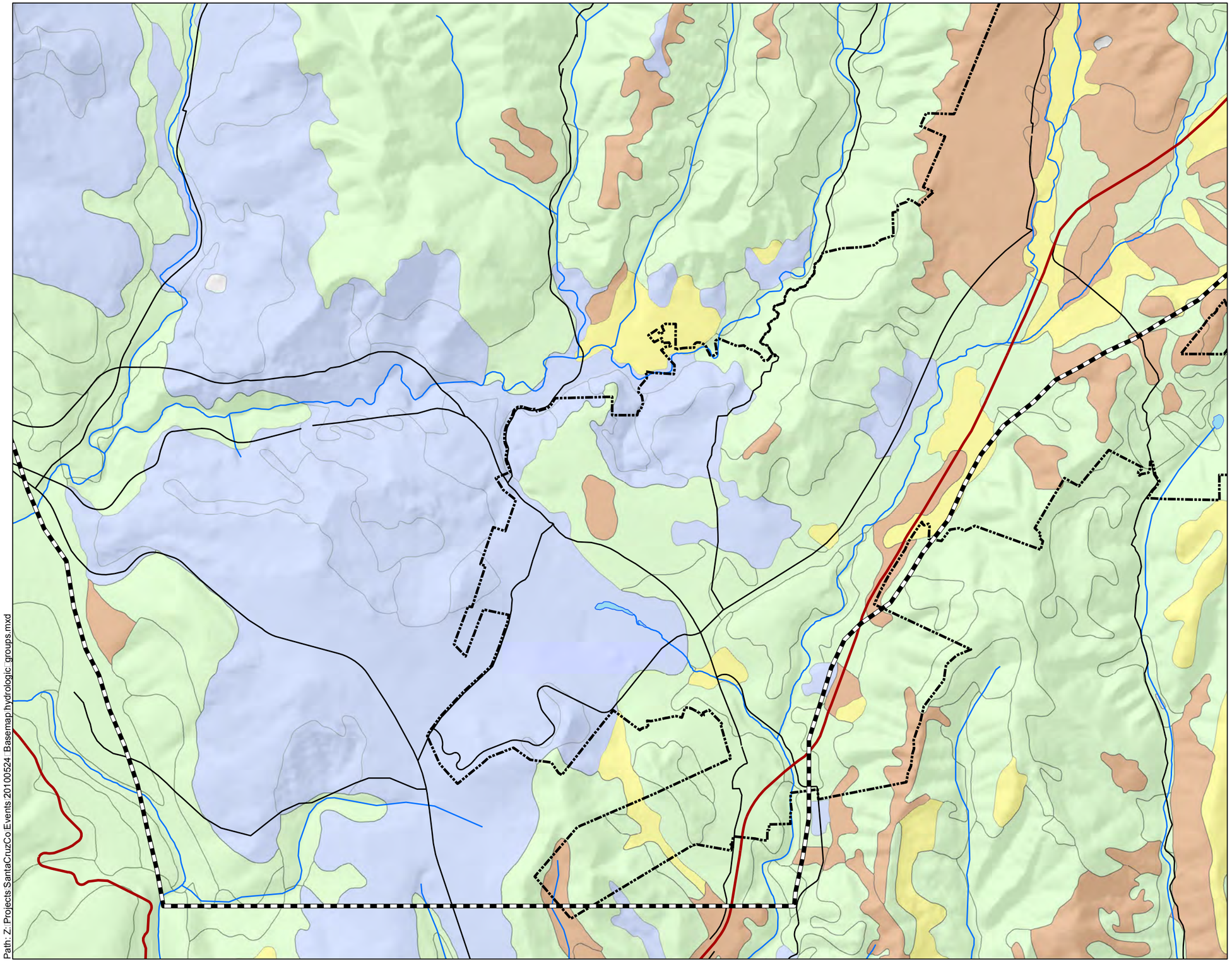
DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Conjunctive Use Project Study Area**

K/J 0864005
November 2010

**Figure 1B-1**



**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Soil Hydrologic Group A
- Soil Hydrologic Group B
- Soil Hydrologic Group C
- Soil Hydrologic Group D

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Feet

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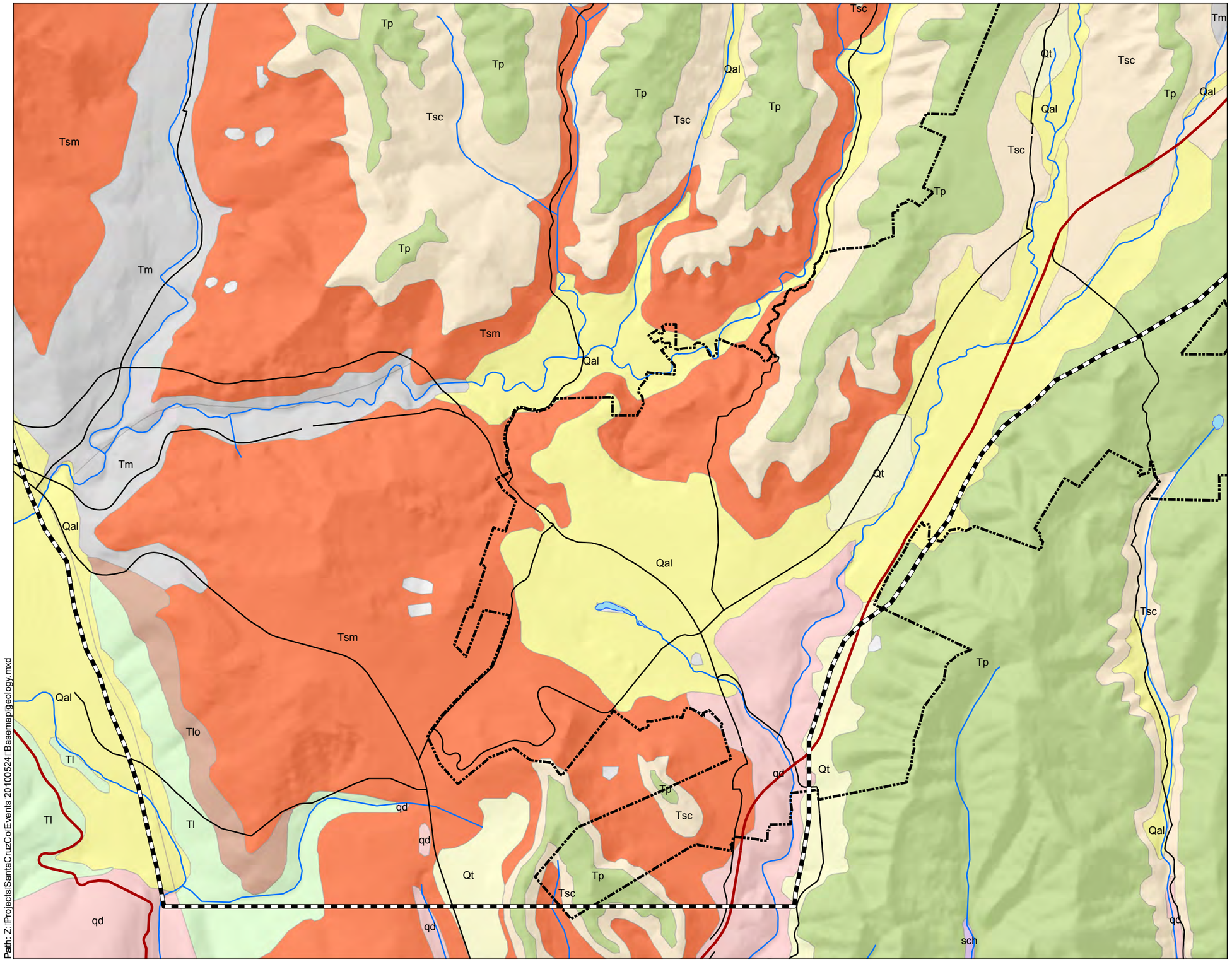
DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Distribution of Soil Hydrologic Groups**

K/J 0864005
November 2010

**Figure 1B-2**




## Legend

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Alluvium
- Purisima
- Marine Terrace
- Santa Cruz Mudstone/Purisima
- Santa Margarita
- Monterey
- Lompico
- Zayante
- Butano
- Locatelli
- Granite
- Metasedimentary

N

0 1,700
Feet

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DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Geologic Map for Conjunctive Use Project Study Area**

K/J 0864005
November 2010

**Figure 1B-3**

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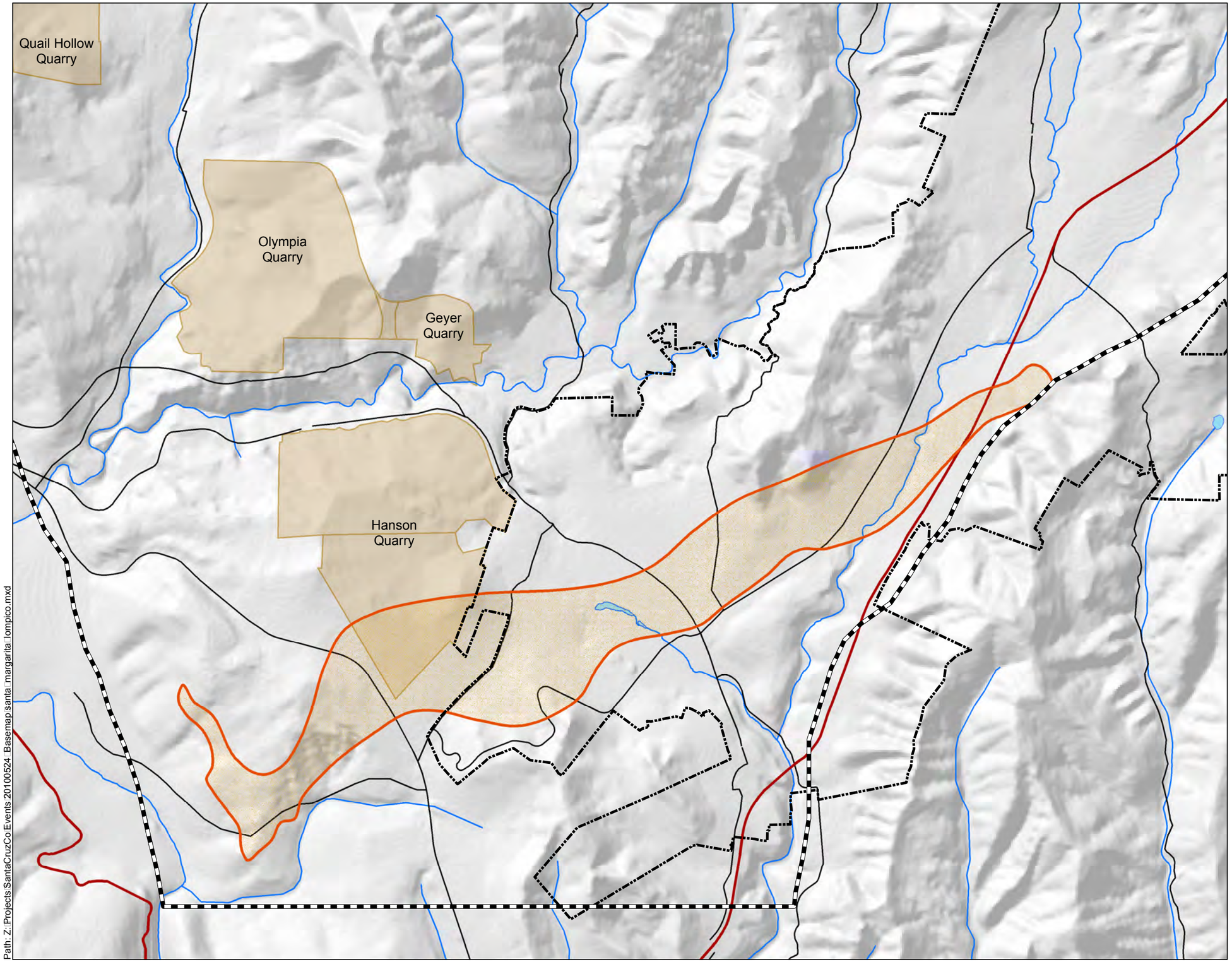


**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Quarry
- Location of Direct Contact Between the Santa Margarita Sandstone and the Lompico Sandstone

N

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Feet

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DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Location of Direct Contact of Santa Margarita and Lampico Sandstones**

K/J 0864005
November 2010

**Figure 1B-4**

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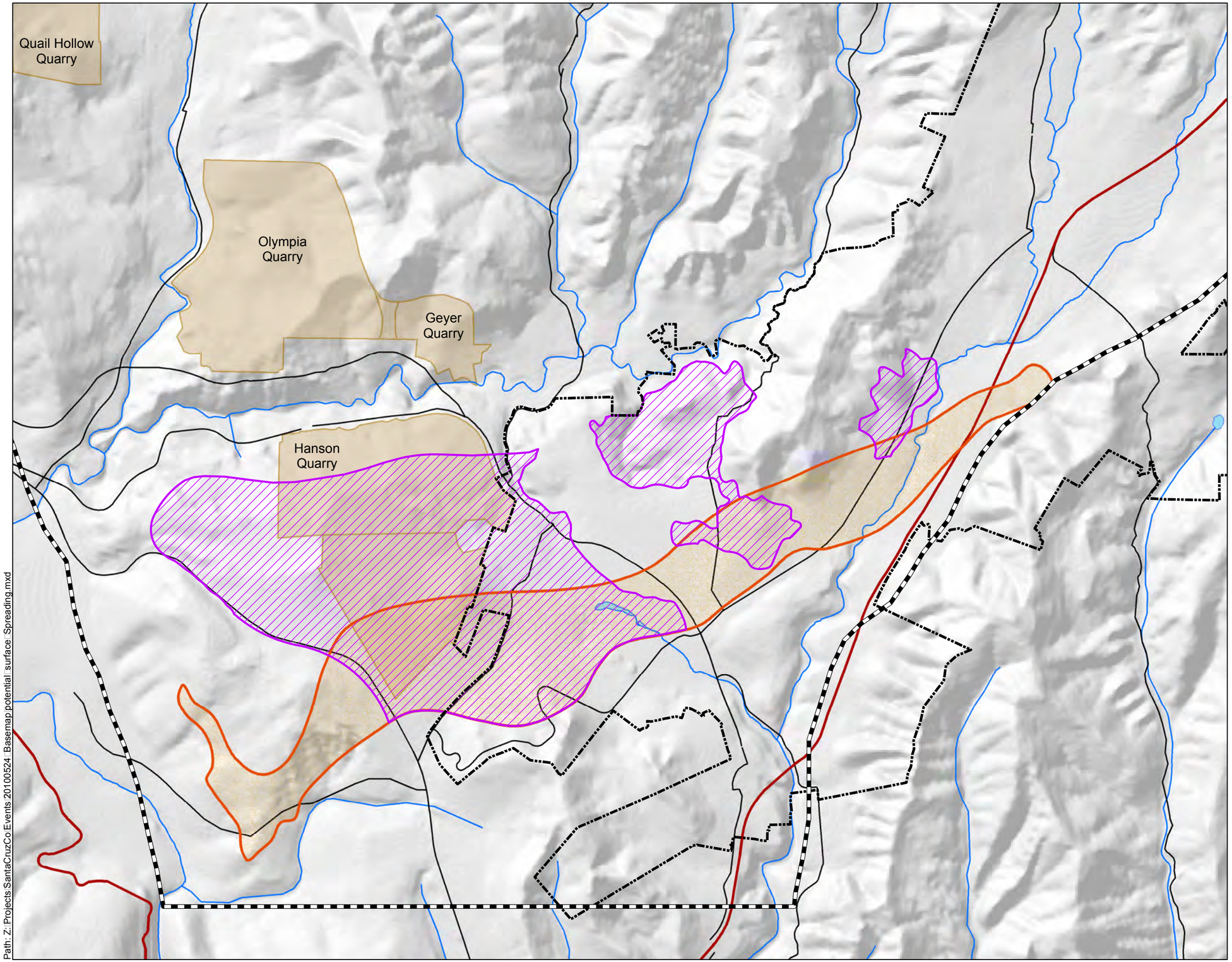


**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Quarry
- Location of Direct Contact Between the Santa Margarita Sandstone and the Lompico Sandstone
- Area of Potentially Suitable for Large Scale Surface Spreading

N

0 1,700
Feet

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DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Area Potentially Suitable for Large Scale Surface Spreading**

K/J 0864005
November 2010

**Figure 1B-5**

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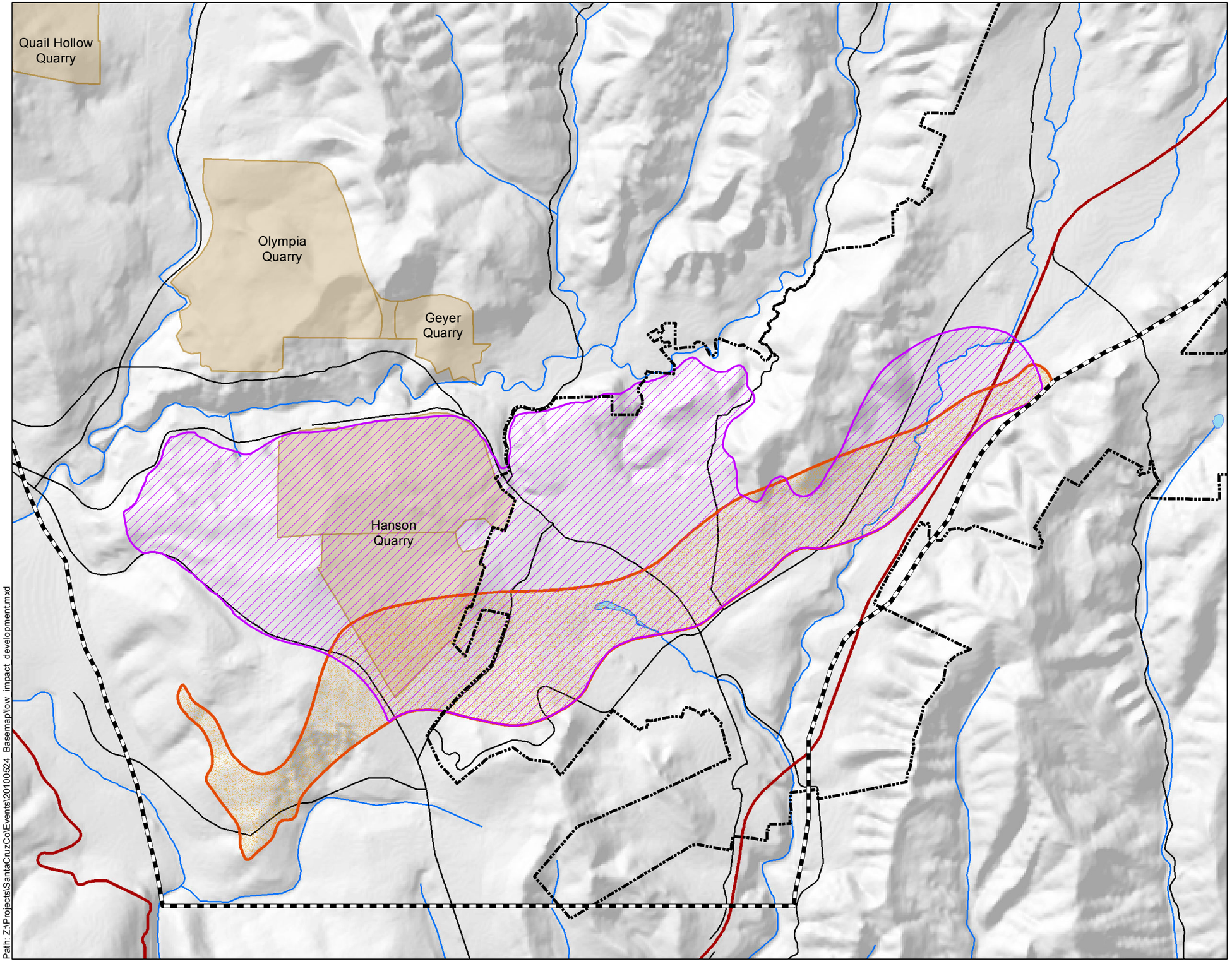


**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Quarry
- Location of Direct Contact Between the Santa Margarita Sandstone and the Lompico Sandstone
- Area of Potentially Suitable for Low Impact Development for Aquifer Recharge

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Feet

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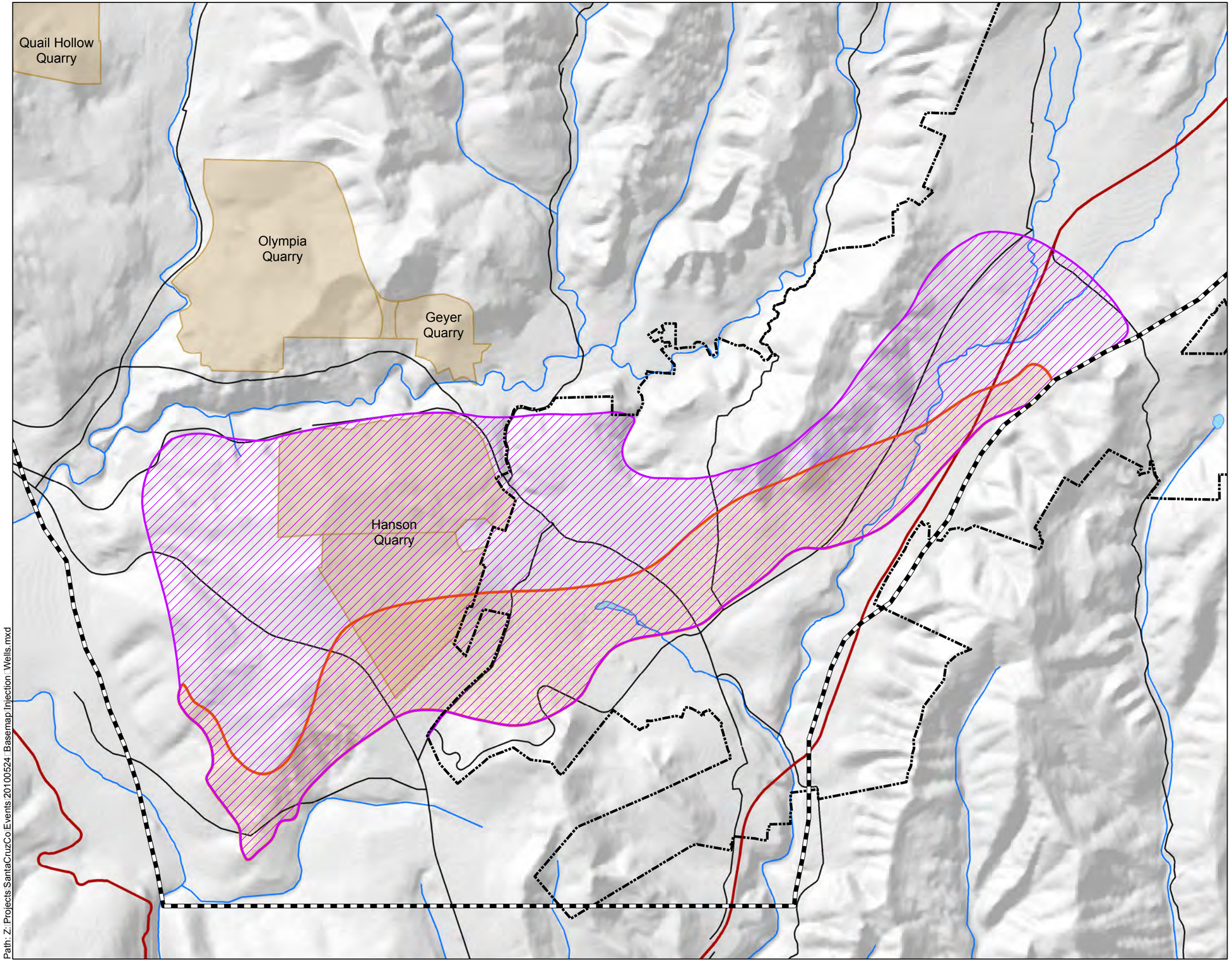
DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Area Potentially Suitable for Low Impact Development**

K/J 0864005
November 2010

**Figure 1B-6**




**Legend**

- Groundwater Basin Boundary
- Scotts Valley City Limits
- Quarry
- Location of Direct Contact Between the Santa Margarita Sandstone and the Lompico Sandstone
- Area Potentially Suitable for Injection Wells

N

0 1,700
Feet

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DRAFT TM 1B - Regional Water Demand
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Area Potentially Suitable for Injection Wells**

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November 2010

**Figure 1B-7**

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# Technical Memorandum 2A- Water Rights Evaluation for Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project:

November 2010

Prepared for

County of Santa Cruz
Environmental Health Services
701 Ocean Street
Room 312
Santa Cruz, CA 95060-4011

K/J Project No. 0864005

**Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.**

16 November 2010

# Technical Memorandum 2A – Water Rights

To: Mike Cloud and John Ricker, Santa Cruz County Health Services Agency

From: Steven Wallner, Meredith Clement, Sachi Itagaki, Michael Maley, Kennedy/Jenks Consultants

Subject: **Water Rights Evaluation**
Santa Cruz County Conjunctive Water Use and Enhanced Aquifer Recharge Study
K/J 0864005

## 1. Introduction

Kennedy/Jenks Consultants (Kennedy/Jenks) is pleased to provide the Santa Cruz County Health Services Agency (County) with Technical Memorandum 2A (TM2A) in support of the Conjunctive Use and Enhanced Aquifer Recharge Project (Conjunctive Use Project). The Conjunctive Use Project is one of sixteen projects funded by a Proposition 50 Water Bond grant from the State Water Resources Control Board to the Regional Water Management Foundation, a subsidiary of the Community Foundation of Santa Cruz County. The Conjunctive Use Project is Project 3 of the grant and is being administered by the County.

Water rights in California are a complex legal issue. TM2A provides a brief summary for general informational purposes only and does not constitute legal advice. Because the law is constantly evolving, the information provided in the above summary may not reflect the most current legal developments. A more detailed water rights assessment will be necessary if acquiring water rights is required for the Conjunctive Use Project.

### 1.1 Purpose

The objective of the Conjunctive Use Project is to assess most the appropriate approaches for coordinating water projects and increasing groundwater storage to provide reliable drinking water to the lower San Lorenzo River Watershed (Watershed), mitigate declines in groundwater levels, and increase stream baseflow (Figure 1). The Conjunctive Use Project will investigate the opportunities to use water exchanges, winter streamflow diversion, and/or reclaimed wastewater to replenish groundwater storage in the Santa Margarita Groundwater Basin (Figure 1). It should be noted that the context for this water rights evaluation is framed by the fully appropriated status of the San Lorenzo River and its tributaries during the period from June 1 through October 31. More recently, the fisheries/natural resources agencies have proposed fully appropriating the San Lorenzo River and its tributaries year round. To date, this proposal has not been resolved.

For the Conjunctive Use Project, a source of water is necessary. One potential source of water is unclaimed surface water during high winter runoff periods. For this, it is important to have an understanding of the existing and potentially available water rights in the area. TM2A provides

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a brief summary of the known surface water rights in the Watershed as part of Task 2 Water Rights Assessment of the Conjunctive Use Project Scope of Work. TM2A provides an evaluation of the following items:

- A review of existing water rights by large utilities and water districts within the lower San Lorenzo River watershed to provide an updated tabulation of entitlements held to assist in determining if additional water is available for diversion to a conjunctive use program.
- A tabulation of existing water rights and entitlements to water supplies for diversion and storage for Zayante, Bean, Carbonera and Newell Creeks, and the San Lorenzo River (Figure 2) based on a review of the State Water Resources Control Board (SWRCB) electronic Water Rights Information Management System (eWRIMS).
- A brief description of the potential to modify and/or utilize existing water rights.

The purpose of TM2A is to summarize the existing water rights in the Watershed to provide appropriate background information for the screening-level analysis of alternatives for the Conjunctive Use Project. The focus is on entitlements to divert and store water for domestic, irrigation and municipal uses are held by agencies and individuals on Zayante Creek, Bean Creek, Carbonera Creek, and the San Lorenzo River, as well as on tributaries to these streams in the project area.

# 2. Background

The Conjunctive Use Project will evaluate a wide-range of potential alternatives including winter streamflow diversion, and/or reclaimed wastewater to replenish groundwater storage to use water exchanges.

## 2.1 Study Area

The Watershed covers 138 square miles in the Santa Cruz Mountains along the Central California Coast in northern Santa Cruz County (Figure 1). The San Lorenzo River empties into the Pacific Ocean in the City of Santa Cruz. Small, steep tributaries feed the river from the west at Ben Lomond Mountain, while wider, more gently sloping tributaries feed the river from the east and northeast (Santa Cruz County, 2001, SLVWD, 2009).

The Watershed is home to approximately 41,000 residents inhabiting 17,174 developed parcels, outside of the City of Santa Cruz (County of Santa Cruz, 2001). Approximately 3,150 of the developed parcels are within the City of Scotts Valley (County of Santa Cruz, 2001). The large remainder of the Watershed is unincorporated under county jurisdiction and includes the communities of Felton, Mt. Hermon, Ben Lomond, Brookdale, Boulder Creek, Lompico, and Zayante. All residents of the Watershed derive their water supply from surface and groundwater


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in the Watershed. The River directly provides 60% of the water supply for 90,000 customers served by the City of Santa Cruz (Santa Cruz County, 2001, SLVWD, 2009).

Water use in the Watershed has increased as population has increased. The San Lorenzo Valley was sparsely inhabited and dominated by summer homes through the 1950s. Since then, houses within the watershed have been converted to permanent residences and some 3,300 new units were built by the 1970s (County of Santa Cruz, 2001). With the exception of the City of Scotts Valley, and some small sewered communities, some 13,000 properties are served by individual onsite sewage disposal systems (County of Santa Cruz 2001). The County (2001) reports that, "Growth rates of over 30% occurred in Bear Creek, Upper Zayante, Bean Creek, and Branciforte." Scotts Valley also experienced an increase in development of 80% from 1980 to 2000 including large industrial complexes (Santa Cruz County, 2001, SLVWD, 2009).

The San Lorenzo River historically supported the largest salmon and steelhead fishery south of San Francisco Bay; the fourth largest steelhead fishery in the state. Coho salmon and steelhead are now listed as threatened or endangered species (Santa Cruz County, 2001, SLVWD, 2009).

## 2.2 Water Rights Overview

Since water rights in California are a complex legal issue, a brief overview of California water law is provided. This overview is for general informational purposes only, and does not constitute legal advice. This summary is based on three references which are attached as appendices for more definitive information on California water rights. These include:

- Appendix A – Information Pertaining to Water Rights in California by the California State Water Resources Control Board - 1990
- Appendix B –California Water Rights Fact Sheet, United States Bureau of Land Management (BLM), August 15, 2001
- Appendix C – A Summary of California Law of Surface Water and Groundwater Rights by Bartkiewicz, Kronick & Shanahan, 2006.

California's system of water rights is referred to as a "dual system" in which both the riparian doctrine and the prior appropriation doctrine apply to water rights (SWRCB, 1990, BLM, 2001, Bartkiewicz, Kronick & Shanahan, 2006). There is also a separate doctrinal basis for ground water, so a more accurate classification of California's system would be a "plural system". Water rights in California are use rights. All waters are the property of the state. A water right in California is a property right allowing the use of water, but it does not involve ownership of the water. California's water law is contained in the California Code of Regulations, Title 23, and can found at: http://www.calregs.com/. The primary classes of water rights in California include:


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- Pre-1914 Appropriate Rights
- Riparian Rights
- Appropriative Rights

Appropriative rights are acquired by putting surface water to beneficial use. Prior to 1914, appropriative rights could be claimed by simply diverting and using the water, posting a notice of appropriation at the point of diversion, and recording a copy of the notice with the County Recorder. Since 1914, the acquisition of appropriative rights has required an application through the State Water Board (SWRCB, 1990, BLM, 2001).

Riparian rights result from the ownership of land bordering a surface water source (a stream, lake, or pond). As a class, these rights are senior to most appropriative rights, and riparian landowners may use natural flows directly for beneficial purposes on riparian lands without applying for a permit (SWRCB, 1990, BLM, 2001). A riparian right arises by virtue of ownership of the riparian land, and is not gained by use nor lost by nonuse. Generally, the riparian right is superior to the other types of surface water rights, but the riparian right does not apply to water that is stored for later use. The riparian right may be junior to an appropriative water right that was perfected before a patent on the riparian land was issued by the United States. The riparian rights of owners of land that are riparian to the same source are “correlative,” in that, if there is insufficient water under the riparian right for all riparians, each is entitled to a fair share of the available supply based upon the amount of their land and their reasonable water supply needs (SWRCB, 1990, BLM, 2001, Bartkiewicz, Kronick & Shanahan, 2006).

Appropriative rights to surface water are rights to use unappropriated water, that is, water that is surplus to the needs of riparian owners and prior appropriators and prescriptors. Appropriative rights are based not on land ownership, but on actual diversion and use of water. They are rights of priority, in that, if the available surface water supply is insufficient to meet the needs of all appropriators, the one with the earliest priority date is entitled to satisfy his or her needs fully before those with later priority are entitled to any water. An appropriative right may be established to use water for any reasonable, beneficial purpose on any land no matter where located, and to store water from one season for use in a later season, or from one year for use in subsequent years. Just as appropriative rights are gained by use, conversely, once acquired, they may be lost wholly or in part by five years’ nonuse during a time when the water was physically available for use (SWRCB, 1990, BLM, 2001, Bartkiewicz, Kronick & Shanahan, 2006).

An appropriative water right in California can be maintained only by continuous beneficial use, and can be lost by five or more continuous years of non-use. Riparian rights, on the other hand, cannot be lost through non-use. Appropriative rights can also be lost through abandonment, but to constitute abandonment of an appropriative right, there must be the intent not to resume the


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beneficial use of the water right. As a result, abandonment is always voluntary. The rights to waters lost through abandonment or non-use revert to the public, but only after notice has been given and a public hearing is held (Bartkiewicz, Kronick & Shanahan, 2006). It should be noted that there is the potential for a riparian right to be either diminished or lost during a legal adjudication process, especially if the water is not being put to beneficial use. Similarly, appropriate rights can be diminished or lost if they are found to be damaging to the public trust (i.e. environmental water needs). Discussion and resolution of these water rights topics would likely occur during the process of preparation of the Santa Cruz Water Department's (SCWD) Habitat Conservation Plan, other permitting and/or an adjudication process.

## 2.3 Application for New Water Rights

Any entity in California intending to appropriate water is required to file an application for a water right permit (or a use registration for small scale domestic use) with the SWRCB. The SWRCB provides an example Application for License for Diversion and Use of Water on their website (SWRCB, 2009) and a copy is provided in Appendix D.

The SWRCB has the discretion to decide whether an unappropriated water right exists, and whether the proposed use under the application is reasonable, beneficial and in the public interest. An application for a new water appropriation is approved if it is determined to be for a useful or beneficial purpose and if water is available for appropriation. Approval is conditional on determining that the water use would not result in injury to any other water right and would not unreasonably affect fish, wildlife, or other instream beneficial use (Bartkiewicz, Kronick & Shanahan, 2006). In evaluating an application, the Board considers the relative benefits derived from the beneficial uses, possible water pollution, and water quality. If a permit is approved, it may be approved in full or it may be subject to specified conditions. A decision or order from the State Water Board is reviewable by the Superior Court. Once the State Water Board issues a permit, the use and diversion of water is authorized (SWRCB, 1990, BLM, 2001, Bartkiewicz, Kronick & Shanahan, 2006).

A permit is not required from riparian right holders, ground water users, users of purchased waters, or those who use water from a spring or standing pool lacking a natural outlet on the land they are located. Once the application or registration has been accepted, a priority is established in relation to other appropriators. For domestic registration, the State Water Board provides a Certificate of Registration which establishes general conditions under which the diversion may be made. When an application for a water right permit is filed, public notice is given to interested parties. This indicates an opportunity to file protests against the proposed application (SWRCB, 1990, BLM, 2001, Bartkiewicz, Kronick & Shanahan, 2006).


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# 3. Existing Water Rights by Large Utilities

This section summarizes the water rights for the larger utilities in the lower San Lorenzo Valley Watershed.

## 3.1 City of Santa Cruz

The SCWD follows a variety of policies, procedures, and legal restrictions in operating the water supply system. In general, the system is managed to take advantage of the better quality and least expensive sources as a first priority, and to retain the maximum amount of water possible in Loch Lomond Reservoir to safeguard against future droughts. In addition to considerations for cost, water quality, and storage, legal constraints on the diversion of surface waters contained in the City's water rights govern the operation of the water system (SCWD, 2006). Furthermore, the draft anadromous fish Habitat Conservation Plan (HCP) prepared by SCWD in compliance with the Endangered Species Act and National Oceanographic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) draft Coho Recovery Plan (CRP) for the San Lorenzo River will likely influence instream flow requirements in the future.

### 3.1.1 Existing Water Rights

SCWD has water rights to various water sources to provide water supply to the City. A summary of these water rights, as well as those of the other major water diverters, is presented in Table 1. Water supplies are generally dispatched to meet daily demands in the following order:

- North Coast
- San Lorenzo River
- Live Oak Wells
- Loch Lomond Reservoir

Due to the excellent water quality and the lowest production cost, the North Coast sources are used to the greatest extent possible. As pre-1914 sources, the City's North Coast diversions are least affected by water rights limitations. Diversion from these sources is therefore limited primarily by flows. Daily production varies seasonally from 5 million gallons per day (mgd) in spring to 2 mgd in fall (SCWD, 2006). The City's North Coast Diversions are currently not subject to any water right limitations. Diversions from these sources are therefore limited only by flows (Gary Fiske & Associates, 2003).


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Additional water needed to meet daily demands is pumped from the San Lorenzo River at Tait Street. Under normal operating conditions, about 7.5 mgd will be produced from the Tait Street Diversion and wells throughout the dry season (SCWD, 2006). The San Lorenzo River diversion at Tait Street (including the wells) is subject to a 12.2 cubic feet- per-second (cfs) (or 7.9 mgd) maximum diversion rate year round (Gary Fiske & Associates, 2003).

During the summer and fall, when the City's flowing sources are inadequate to meet peak season daily demands, supplemental water is brought in from the Live Oak Wells and from Loch Lomond Reservoir (SCWD, 2006).

The San Lorenzo River diversion at Felton is subject to a 20 cfs (12.9 mgd) year-round diversion rate limit. In addition, the water right for this diversion is limited by instream flow requirements ranging from 10 cfs (8.4 mgd) to 25 cfs (16.2 mgd) in different months of the year with the requirements occuring between September and June (Gary Fiske & Associates, 2003).

On a typical summer day the Live Oak Wells contribute about 1.0 mgd. Withdrawals from the reservoir vary between 2 and 4 mgd depending on weather, customer demand, and the amount of treated water held in storage at the Bay Street Reservoir (SCWD, 2006).

Withdrawals are also made from Loch Lomond during the winter season when the North Coast and San Lorenzo River sources become untreatable due to excessive turbidity from storm runoff. The Felton Diversion is operated intermittently as needed. It is normally used in the winter months of dry years, but the diversion dam is inflated every year for maintenance purposes and to facilitate fisheries research (SCWD, 2006).

### 3.1.2 Water Rights Submittals

The City of Santa Cruz is also in the process of developing and submitting filings to the SWRCB to rectify a historical technical deficiency in the water rights on Newell Creek and the San Lorenzo River (at Felton), and to extend the time within which the City can put water to full beneficial use on its permits for diversion to storage on the San Lorenzo River in Felton. Based upon the original filings, which were thought to be adequate due to the anticipated use of Loch Lomond storage reservoir, these water rights allow only for diversion to storage and not for direct diversion. This circumstance makes the water supply technically unavailable as a source for City use during times when, for example the reservoir is receiving more inflow from Newell Creek than is released downstream. The water rights filings are intended to correct this historical deficiency and bring the water rights and current operations into conformance. The City will ensure California Environmental Quality Act (CEQA) compliance for these actions, which are independently required and useful to perpetuate the City's ability to use these sources on an ongoing basis (EDAW, 2005).


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The Water Rights Conformance Proposal seeks to add the right of direct diversion to the City's Newell Creek and San Lorenzo River at Felton water rights, rectifying an oversight in the original water right filings (EDAW, 2005). License 9847 at Newell Creek Reservoir allows diversion to storage of up to 5,600 acre-ft per year (AFY) between September 1 and July 1. The Felton water rights allow diversion of up to 3,000 AFY to storage in the reservoir between September 1 and June 30th (Permit No. 16123) and October 1 to June 1 (Permit No. 16601).

## 3.2 San Lorenzo Valley Water District

SLVWD's surface water supply flows primarily from creeks on the western side of the watershed. Together, these creeks, which are tributaries to the San Lorenzo River, provide approximately half of the total water supply (SLVWD, 2009). SLVWD currently operates four standalone water systems with separate water supplies: The Northern System, the Southern System, the Mañana Woods System and the Felton System. Together, these four water systems serve approximately 7,400 connections for 22,500 people (Johnson, 2009, SLVWD, 2009). The Southern System and the Mañana Woods System each serve a portion of the Scotts Valley area. The Southern System and the Mañana Woods system rely solely on groundwater. The major SLVWD water rights are included in the Table 1 water rights summary.

### 3.2.1 SLVWD Water Rights

The Northern System serves the unincorporated communities of Boulder Creek, Brookdale, Ben Lomond, Zayante and parts of Felton. To supply its northern service area, the District obtains approximately half its total water supply of 1,600 to 2,100 acre-feet per year from seven surface stream intakes, with a combined contributing watershed area of approximately 1,400 acres on Ben Lomond Mountain. The Northern System is supplied by approximately 57% surface water and 43% groundwater sources (Johnson, 2009, SLVWD, 2009). SLVWD relies primarily on surface water during the wet season and on groundwater during the dry season.

Clear, Foreman, Peavine, Silver and Sweetwater are the primary surface water sources for SLVWD. The more detailed water rights for each creek are listed in Table 2. The current average annual stream diversion is approximately 900 acre-feet. SLVWD has appropriative rights to these creeks, although a poorly documented, pre-1914 water uses include powering mills and hydroelectric generators at fairly high diversion rates (Johnson, 2009, SLVWD, 2009). Several water rights were listed in the SLVWD Water Master Plan (Johnson, 2009) as inactive. These are also listed in Table 2.

SLVWD's water rights for its surface water sources on Ben Lomond Mountain do not specify minimum bypass flows. However, the California Department of Fish and Game (CDFG) have stipulated that the Clear Creek diversions should not capture the entire flow. The District leaves a minimum bypass flow of 30 gallons per minute (0.07 cfs) at Clear Creek for the benefit of aquatic habitat (Johnson, 2009, SLVWD, 2009).


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### 3.2.2 Felton Water Rights

In 2008, SLVWD acquired the water system for the community of Felton from the California-American Water Company. The Felton System serves the community of Felton and relies completely on surface water. The District's newly acquired Felton surface water sources are in the Fall Creek watershed. A listing of the water rights that were originally assigned to the California-American Water Company in the SWRCB (2008) eWRIMS database is listed in Table 2.

The California Department of Fish and Game (CDFG) stipulated minimum bypass flows on Fall Creek for the benefit of aquatic habitat. Required minimum bypass flows vary from 0.05 – 1.5 cubic feet per second, depending on the cumulative monthly runoff of the San Lorenzo River, as measured at the Big Trees gage (Johnson, 2009, SLVWD, 2009).

### 3.2.3 SLVWD Loch Lomond Water Right

In 1958, SLVWD sold 2,500 acres of its property along Newell Creek to the City of Santa Cruz with the agreement that SLVWD would be entitled to purchase 12.5% of the annual safe yield from the future Loch Lomond, to a maximum of 500 acre-feet per year. This percentage was roughly equivalent to the portion of the reservoir project area owned by SLVWD. The City created Loch Lomond Reservoir with the completion of Newell Creek Dam in 1960. The City stipulated in 1965 that SLVWD was entitled to 313 AF/yr (102 MG/yr), or 12.5% of 2.500 acre-feet per year. This was based on Loch Lomond's estimated annual yield of 3,230 acre-feet per year minus the required constant release of 1 cubic foot per second (cfs) or 724 acre-feet per year (Johnson, 2009).

SLVWD has lacked the infrastructure to treat Loch Lomond water in compliance with current federal standards. Thus, SLVWD has not included Loch Lomond among its active water supply sources. In 1996 the City of Santa Cruz provided SLVWD with a draft agreement that (a) acknowledged SLVWD's right to purchase 313 AF/yr (102 MG/yr) of raw Loch Lomond water and (b) offered to sell SLVWD the same amount of treated City water with the exception that it would be interruptible during declared water-shortage emergencies (Kocher. May 1996). In its 2005 Urban Water Management Plan, the City of Santa Cruz stated that 10% of its maximum annual right to divert from Loch Lomond (320 AF or 104 MG) is technically available to SLVWD. SLVWD has taken no action in recent years and has no current plan to exercise its entitlement. Future deliveries to SLVWD of raw Loch Lomond water or treated City water are included as potential future sources of water in the SLVWD Water Master Plan (Johnson, 2009).


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## 3.3 Other Water Districts and Organizations

Other water districts and organizations have water rights to the surface streams in the Watershed. Descriptions of those listed by the SWRCB that are in the vicinity of the Conjunctive Use Project are provided below.

### 3.3.1 Lompico County Water District Water Right

The Lompico County Water District (LCWD) was issued a permit in 1966 to serve drinking water to the Lompico area which consists of mostly single-family homes with an estimated population of 1,500 people and about 500 service connections. The surface water sources are Lompico and Mills Creeks with a small diversion dam on Lompico Creek (SLVWD, 2009). Lompico Creek is a tributary to Zayante Creek. LCWD has an appropriative right of 26.9 acre-feet per year with a requirement for a minimum release of 0.10 cfs at all times.

### 3.3.2 Mount Hermon Association Water Right

The Mount Hermon Association is located near to Bean Creek upstream from the confluence with the San Lorenzo River. The Association has three water rights listed in the eWRIMS database. These include:

- A licensed appropriative right to 137.6 acre-feet per year from an unspecified location dated September 1961.
- An appropriative right to Acadia Springs for an unspecific volume dated March 1978.
- An appropriative right to Redwood Springs for 79.1 acre-feet per year dated April 2001.

### 3.3.3 San Lorenzo Valley Unified Schools Water Right

The San Lorenzo Valley Unified School System is located near to Felton near the San Lorenzo River. The School System has a water right listed in the eWRIMS database for 56.4 acre-feet per year from Ashley Creek dated January 1954.

# 4. Water Rights Search

Kennedy/Jenks Consultants completed a water rights search using the eWRIMS database (SWRCB, 2008). The search focused on streams and rivers within Santa Cruz County that could potentially be diverted to provide a water supply to recharge the Santa Margarita Groundwater Basin. Coastal streams within the County were not considered for this analysis. In addition, unnamed streams/diversions within Santa Cruz County that may be within the San


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Lorenzo River system were not included because it is assumed that these are small diversions. If and when a water rights filing or modification is made, a more detailed analysis of these smaller water rights should be conducted using the eWRIMS GIS map function.

The following streams and rivers and their tributaries were analyzed as shown on Figure 2 that follows:

- Bean Creek
- Zayante Creek
- San Lorenzo River
- Carbonera Creek
- Newell Creek

## 4.1 Search Methodology

The online eWRIMS database managed by the SWRCB was used to collect data for the water rights analysis. Information obtained from the database was processed as follows and can be found in Table 3. The process used to evaluate the water rights using the eWRIMS systems are as follows:

1. All water rights from Santa Cruz County were extracted from the database and exported to a Microsoft Excel worksheet and sorted by stream.

2. Water rights for the five creeks and rivers listed above were extracted and combined with their tributaries to form a complete set of water rights for each creek system.

3. Database inputs for all appropriative rights on the streams in question were downloaded from the eWRIMS database and checked individually. Unlike riparian rights, appropriative rights allow water to be allocated for beneficial uses including storage by properties not immediately adjacent to a water body. These rights are therefore able to serve a larger number of uses and typically have much larger quantities than riparian rights. As a permit or license is required for these rights, there is typically more background information available from the eWRIMS database on their terms and restrictions of use, than for riparian water rights.

4. Statements of Diversions (SODs) represent those records that could include riparian water rights and pre-1914 rights. SODs were typically not quantified by the eWRIMS database and the report for each right has to be individually downloaded and checked to obtain this information. Due to the small size of most of these rights and the large number of filed SODs, an alternative method was used to estimate the amount of water


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claimed by SODs. Rights on the eWRIMS database are categorized as one of the following - Individual, Corporate or Government. It is more likely that the Corporate and Government SODs would have larger quantities associated with them, so these were downloaded and used to conservatively calculate an average diversion amount for each SOD. The average diversion was 12 acre-feet per year which was then assumed to be the amount of each SOD. Although this was a conservative estimate, the results for SODs were not significantly distorted as 12 acre-feet per year is a relatively insignificant amount when compared to the appropriative rights on the streams.

5. When tallying up volumes for water rights, the maximum annual volume was used as a conservative estimate. It is unlikely that this full allowance would be used at all times. If needed, the actual volume used could be determined by a manual search of Annual Water Rights Reports as described previously.

6. In the case where only a maximum direct diversion rate was presented and not a volume, the rate was applied for 365 days per year to estimate a total maximum use, which is also a conservative estimate.

7. This evaluation did not include estimates of future demands for riparian water based on changes/maturing of land uses because such estimates would be extremely speculative.

8. There was a desire to review Annual Water Rights Reports submitted by diverters to the SWRCB's eWRIMS database, however this database is no longer maintained. The Annual Water Rights Reports are filed by diverters to report use of entitlement. It is possible to go in person to the SWRCB offices and manually photocopy hardcopies of the reports, however it is recommended that this task be deferred until it is determined that there is a real need for it.

## 4.1 Search Results

Based on the summary of water rights and the available supply, the following conclusions can be drawn. Table 4 summarizes water rights on the five creek/river systems.

Flows on Bean Creek are largely not appropriated and may be available subject to evaluation of fishery requirements. From Table 4, the eWRIMS database contained 12 SODs and the total estimated existing water rights on Bean Creek were 111 acre-feet.

In 1985, the Santa Cruz City Council relinquished its water rights to Zayante Creek with the request that the State Water Resources Control Board reserve this amount in the name of North Santa Cruz County (Gary Fiske & Associates, 2003). The State Water Resources Control Board holds an inactive right for 17,000 AF of storage held for use by Northern Santa Cruz County. If claimed this would account for more than the entire available flow from Zayante


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Creek. From Table 4, the eWRIMS database contained 7 SODs and the total estimated existing water rights on Zayante Creek were 68.5 acre-feet.

The City of Santa Cruz is the dominant holder of water rights on the San Lorenzo River and this supply forms a critical part of the City's water supply portfolio. From Table 4, the eWRIMS database contained 31 SODs and the total estimated existing water rights on the San Lorenzo River were 339.3 acre-feet. Although the details of each water right have been simplified for this analysis, the City of Santa Cruz holds the following rights on the San Lorenzo River:

- 4,489 AF/yr consisting of a right to divert 6.2 cfs year round (Permit ID # 2372)
- 4,344 AF/yr consisting of a right to divert 6.0 cfs year round (Permit ID # 2738)
- 3,000 AF/yr storage right between 1 September to 1 June (Permit ID # 16123)
- 3,000 AF/yr storage right between 1 October to 1 June (Permit ID # 16601 in conjunction with Permit ID # 16123)

Flows on this Carbonera Creek are largely not generally appropriated and may be available subject to evaluation of fishery requirements. From Table 4, the eWRIMS database contained three SODs and the total estimated existing water rights on Bean Creek were 36 acre-feet.

The City of Santa Cruz holds an appropriative right for 5,600 acre-feet per year of storage between 1 September and 1 July. This right is used to supply the Loch Lomond Reservoir. It is likely that there are some bypass flows available over the 5,600 acre-feet per year storage water right during wet months of wet years. Utilizing this water would require a separate diversion downstream of the reservoir and would therefore require a new water right. From Table 4, the eWRIMS database contained six SODs and the total estimated existing water rights on the San Lorenzo River were 72 acre-feet.

## 5. Potential Options to Utilize Water Rights

Three potential options are summarized below for utilizing existing or applying for new appropriate water rights. These potential options were prepared for TM2A for general informational purposes only, and do not constitute legal advice. The purpose of this section is to illustrate the anticipated level of effort necessary to obtain water rights for a range of potential options in support of the screening-level analysis for the Conjunctive Use Project. A more detailed water rights assessment will be necessary if acquiring water rights is required for the Conjunctive Use Project.


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## 5.1 File for Change in Place of Use and Purpose of Use

A holder of a water license can file for a change in place of use and purpose of use. References that describe this process in more detail are presented in Appendices A, B, and C.

Because such a change has the potential to impact other water users or the environment, the SWRCB will notify the Department of Fish and Game, other water right holders, and the public. Entities concerned about the impact of the change in the place of use and purpose of use will be allowed to object to the proposed change by filing a protest form with the State Water Board. Because the State Water Board has discretion over whether or not to approve the requested petition, they will require preparation of a CEQA document before approving the change. Preparation of the CEQA document, negotiations with the SWRCB, and dealing with any protests to the petition can take a considerable amount of time and effort and will require legal counsel.

Some options for filing for a change in place of use could occur either from the SCWD's or SLVWD's current water rights for delivery to customers in the Scotts Valley or for storage of excess wintertime surface water in the Santa Margarita groundwater basin through direct recharge. SLVWD also has rights to the Loch Lomond Reservoir that could be treated at the SLVWD's Felton Water Treatment Plant and delivered to Felton. Existing water rights may preclude delivery of SLVWD's Loch Lomond water to its service area in Scotts Valley. The SCWD has initiated a water rights conformance process to allow for direct diversion of the SCWD's Loch Lomond Reservoir water right.

## 5.2 File for New Appropriative Right

There appears to be potentially unappropriated water on Bean Creek, Carbonera Creek and the San Lorenzo River. An entity, such as Santa Cruz County, can apply to the SWRCB for a permit to appropriate water. There is a formal form and process for submitting a water rights application. References that describe this process in more detail are presented in Appendices A, B, and C. An example water rights application to the SWRCB is provided in Appendix D. A summary is provided below.

A key concept with an appropriative right is "first in time, first in right"; meaning diverters who have older licenses have greater priority to divert than a junior appropriator. The most senior diverter has the right to take water first and the most junior diverter is last in line; in drought years the most senior diverter has the authority to take water up to their full licensed water quantity, while more junior diverts are limited to whatever water is left. Because of this system, any water right obtained by Santa Cruz County would have lower priority than an existing water right, such as held by the City of Santa Cruz. However, if the County of Santa Cruz is not relying on water from this application to meet regular demands, but rather as a replenishment source, having a lower priority is less of an issue.


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A water right applicant must describe the proposed source of diversion, place of use, purpose of use, quantity and season of diversion, the point of diversion, and describe the infrastructure necessary to divert the water. Most significantly the SWRCB will require technical studies on the following:

- Environmental Impacts. As described above, the SWRCB will require compliance with CEQA.

- Streamflow Availability Assessment. The SWRCB has a formal methodology for calculating the amount of water available for diversion given stream hydrology and diversions by those entities with more senior rights (including more senior applications, even if these applications do not yet have permits or licenses). The SWRCB will accept studies of water availability that do not utilize their methodology, but it can increase processing time and the applicant should expect multiple meetings with the SWRCB. Despite this, many entities choose not to use the SWRCB methodology because there is concern that the SWRCB methodology is inappropriate for intermittent streams.

The SWRCB will notify the Department of Fish and Game, other water right holders, and the public of the application to appropriate water. Entities concerned about the impact of the proposed new diversion will be allowed to object to the application by filing a protest with the State Water Board. If protested, a public hearing would be required, a likely outcome for a new water rights application within the County of Santa Cruz.

Depending on the amount of water requested, complexity of the environmental analysis and the number of protests to the water rights application, obtaining a new water right permit can take several years and will require legal counsel.

## 5.3 Partial assignment of the existing Zayante Creek Right held by SWRCB

This right was originally held by the City of Santa Cruz to be used for a proposed dam on Zayante Creek. When the dam project did not go ahead, the right was relinquished and is now held by the State Water Resources Control Board. The right is set aside for use within the Northern Santa Cruz County.

To utilize this right, the County would need to file a petition for partial assignment of a state-filed application. This would require the same level of analysis as if filing for a new appropriative right, including CEQA compliance and a water availability assessment. Additionally, this process would require a mandatory public hearing.

The main advantage of pursuing this course of action is that the original filing date of the right (1986) would be recognized, therefore giving the right a higher priority. This benefit is of little significance in this instance given there are no significant filings subsequent to this date on


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Zayante Creek. The restriction on the 17,000 acre-feet of storage on Zayante Creek will need to be evaluated. It may be that the 17,000 acre-feet includes carry-over storage which may allow a multiple years of storage in the reservoir, but does not allow the right to actually divert 17,000 acre-feet in any single given year.

A change in the place of diversion would also be needed to make the best use of this right. The diversion point specified in the right is at the site of the proposed dam, whereas a diversion point further down stream would capture a greater volume of stream flow.

Again, depending on the amount of water requested, complexity of the environmental analysis and the number of protests to the water rights application, obtaining partial assignment of a State held right can take several years and will require legal counsel.

## 5.4 Costs

If the County wish to pursue more than one of the options discussed in this study, it is possible to file multiple applications at once. This requires payment of multiple application fees which can be significant (approximately $15,000 – $20,000 per application for a 1,000 AF filing).


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# Tables


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**Table 1 Summary of Water Rights on Existing Diversions**

| Source | License Permit Number | Period | Maximum Diversion Rate (cfs) | By pass Flow Require-ment (cfs) | Annual Diversion Storage Limit | Normal Year Annual Diversion Production | Flow Storage Remaining within Water Right | Use for winter exchange with other agencies or GW Recharge? | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **San Lorenzo River (River and Tributaries Fully Appropriated 6 1 -10 31)** | | | | | | | | | |
| City of Santa Cruz: Tait Street Diversion and Wells | 001553<br>007200 | Year-round | 12.2 cfs/7.9 MGD @ Tait | None | None | 7 MGD/10.8 cfs fr Tait and Wells | 1.4 cfs/0.9 MGD/ 1,000 AFY | Yes w/ water rights modification that adheres to Section 10 requirements, benefits aquatic life, and is flexible in its timing. | Available after SCWD needs are met |
| City of Santa Cruz: Felton Diversion to Loch Lomond | 016601<br>016123 | October to June 1, September 1-June 30 | 7.8<br>20.0<br>20.0<br>0.0 | 10<br>25<br>20<br>-- | 3,000 AFY (977 MGY) | 1,700 AFY (550 MGY)/ 10 months | 1,300 AFY (420 MGY)/ 10 months = 1.2 MGD/2 cfs | Yes w/ new water rights change petition that adheres to Section 10 requirements, benefits aquatic life, and is flexible in its timing. | Storage only for pumping to Loch Lomond; Water Rights conformance proposal to add direct diversion right in process; Available after SCWD needs are met |
| San Lorenzo Valley Water District – Northern System Pre 1914 Water Rights | S008669<br>S008668<br>S008670<br>S008416<br>S008671 | Year-round | 1.5 (from five sources detailed in Table 2) | None Non | e | 900 – 1,200 AFY of 2,200 AFY at Max diversion rate | Minimal - max diversion rate limited by hydrology | No | Use of Northern system water likely limited to SLVWD Service Area |
| San Lorenzo Valley Water District –Felton Water rights | A005297<br>A005299<br>A008845<br>A008844<br>A008843<br>A024652 | Year-round | Not applicable (detailed in Table 2) | None | 2,392 AFY | 400 AFY | 933 AFY (licensed) and 1,059 AFY (permitted) | No | A024652 for 1,059 AFY is a water rights permit not yet licensed; the remaining 1,333 AFY are licensed water rights; permits and licenses limit place of use |
| **Loch Lomond Reservoir on Newell Creek:** | | | | | | | | | |
| City of Santa Cruz: Collection to Storage (max amount/year) | 009847 | September 1-July 1 | No limit | 1 (year-round) | 5,600 AFY (1,825 MGY) | Varies from 920 AFY(300 MGY) up to 3,069 AFY (1000 MGY) | Varies by hydrology | Yes | Used to supplement North Coast and Tait Diversion; Water Rights conformance proposal to add direct diversion right in process; Includes SLVWD/SVWD as place of use; SLVWD has 102 MGY entitlement; Available after SCWD needs are met |
| **Other Sources** | | | | | | | | | |
| City of Santa Cruz: North Coast Sources | Pre-1914 | Year-round | No limit | Voluntary releases by SCWD currently occur | None | 100 MG (5 MGD spring/ 2 MGD fall); Likely to be reduced in future | None No | | Highest quality water for SCWD which is used to its maximum when available; diversions limited by available flow; no drought/summer diversions; DFG Streambed alteration permit and HCP in SLR in process; will likeyimpact fish flow requirement |
| North Santa Cruz County (on Zayante Creek, 1985) | Held by SWRCB for County | Not specified | Not specified | Not specified | 17,000 AFY (5,540 MG) | None | Maximum: 17,000 AFY (5,540 MG); Actual is likely less than maximum | Yes w/ formal filing of water rights for GW recharge | Diversion location is at proposed dam location which would likely be changed; potential to use Felton Diversion for high winter flow diversion |

Source – City of Santa Cruz Urban Water Management Plan, (SCWD, 2006) 4/26/10 Discussion with Bill Kocher, Director, Santa Cruz Water Department, and 5/11/10 Discussion with Jim Mueller, General Manager, San Lorenzo Valley Water District


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**Table 2 Detailed Summary of San Lorenzo Valley Water District Water Rights**

| Source | Application Number | Year First Used | Filing Date | Maximum Diversion Rate (cfs) | Maximum Diversion Rate (acre-feet year) |
|---|---|---|---|---|---|
| **SLVWD Active Water Rights** | | | | | |
| Peavine Creek[1] | S008669 | 1905 | 1/1/76 | 0.136 | 98 |
| Silver Creek[1] | S008668 | 1905 | 1/1/76 | 0.11 77 | |
| Foreman Creek[1] | S00867 0 | 1905 | 1/1/76 | 0.061 | 44 |
| Clear Creek[1] | S00841 6 | 1905 | 1/1/76 | 1.2 | 869 |
| Sweetwater Creek[1] | S00867 1 | 1905 | 1/1/76 | 0.03 | 1,110 |
| **Total** | | | | **1.5** | **2,198** |
| **SLVWD Inactive Water Rights** | | | | | |
| Harmon Creek[1] | S00875 8 | 1906 | 3/31/76 | 0.267 | 193 |
| Earl Creek[1] | S00874 3 | 1912 | 3/31/76 | 0.038 | 28 |
| Manson Creek[1] | S00874 4 | 1912 | 3/31/76 | 0.038 | 28 |
| **Total** | | | | **0.3** | **249** |
| **SLVWD Felton Water Rights** | | | | | |
| Bennett Creek[2] | A00529 7 | -- | 12/6/26 | -- | 112 |
| Bennett Creek[2] | A00529 9 | -- | 12/6/26 | -- | 112 |
| Fall Creek[2] | A00884 5 | -- | 12/5/26 | -- | 514 |
| Bull Creek and Bull Spring[2] | A008844 -- | | 12/5/26 | -- | 304.1 |
| Bennett Creek[2] | A00884 3 | -- | 12/5/26 | -- | 291 |
| Bennett, Bull, Fall Creeks and Bull Spring[2] | A024652 -- | | 7/26/74 | -- | 1,059 |
| **Total** | | | | **--** | **2,392.1** |

Source: [1]San Lorenzo Valley Water District Water Master Plan, (Johnson, 2009) and
[2]SWRCB eWRIMS database (SWRCB, 2008)


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**Table 3 – Listing of water rights from Bean, Carbonera, Branciforte, and Newell Creeks and the San Lorenzo River based on SWRCB eWRIMS database.**

| Source | Water Right Type | Status | Holder Name | Org Type | Date | Face Amt (acre-ft/yr) | Application ID | Permit ID |
|---|---|---|---|---|---|---|---|---|
| **Bean Creek System** | | | | | | | | |
| BEAN CREEK | Appropriative | Licensed | KIT SIEMER | Individual | 7/20/1928 | 1.7 | A005990 | 3443 |
| BEAN CREEK | Appropriative | Licensed | KENNETH F UPPSTROM | Individual | 7/30/1957 | 0.7 | A017747 | 11240 |
| BEAN CREEK | Appropriative | Licensed | TIMOTHY J WOODS | Individual | 11/18/1969 | 0.6 | A023400 | 16217 |
| | | | | **Appropriate Rights Subtotal** | | **3.0** | | |
| BEAN CREEK | Statement of Div and Use | Claimed | BIG REDWOOD PARK WATER IMPROVEMENT ASSN | Corporation | 3/15/1976 | 0 | S008718 | |
| BEAN CREEK | Statement of Div and Use | Claimed | BRADLEY MICHAEL CORSIGLIA | Individual | 3/14/1979 | 0 | S009730 | |
| BEAN CREEK | Statement of Div and Use | Claimed | C W RUSSELL | Individual | 3/14/1979 | 0 | S009738 | |
| BEAN CREEK | Statement of Div and Use | Claimed | CARMEL E HUFHINES | Individual | 3/14/1979 | 0 | S009736 | |
| BEAN CREEK | Statement of Div and Use | Claimed | CLAYTON L FIEDLER | Individual | 3/14/1979 | 0 | S009742 | |
| BEAN CREEK | Statement of Div and Use | Inactive | OCEAN PACIFIC INC | Corporation | 7/30/2008 | 0 | S010962 | |
| BEAN CREEK | Statement of Div and Use | Claimed | REID O GEASE | Individual | 3/14/1979 | 0 | S009735 | |
| BEAN CREEK | Statement of Div and Use | Inactive | | | 5/7/2007 | 0 | S009734 | |
| HOPKINS GULCH CREEK | Statement of Div and Use | Claimed | MICHAEL F WATSON | Individual | 1/1/1975 | 0 | S004923 | |
| | | | **Subtotal estimated volume from Statements of Diversion and Use** | | | **108** | | |
| | | | | | | | | |
| **Carbonera Creek System** | | | | | | | | |
| CARBONERA CREEK | Stockpond Certified | | SERENA THOMPSON KALMAN, UDT 1980 | Corporation | 1/2/1998 | 3 | C005020 | |
| | | | | **Appropriate Rights Subtotal** | | **3.0** | | |
| CARBONERA CREEK | Statement of Div and Use | Claimed | ALFRED ALICE SCHWEIZER | Individual | 3/14/1979 | 0 | S009739 | |
| CARBONERA CREEK | Statement of Div and Use | Claimed | JESSE W WILBUR | Individual | 3/14/1979 | 0 | S009745 | |
| CARBONERA CREEK | Statement of Div and Use | Inactive | WIRT R MACMURDO | Individual | 8/1/2008 | 0 | S009740 | |
| | | | **Subtotal estimated volume from Statements of Diversion and Use** | | | **36** | | |
| | | | | | | | | |
| **Branciforte Creek System** | | | | | | | | |
| BRANCIFORTE CREEK | Appropriative | Licensed | RICHARD J GIOVANNONI | Individual | 9/24/1956 | 25.6 | A017293 | 11495 |
| | | | | **Appropriate Rights Subtotal** | | **25.6** | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | MACLYN MORRIS | Individual | 9/23/2002 | 18.1 | S015297 | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | WILLIAM HAND | Individual | 3/12/1999 | 1.8 | S015270 | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | CHRIS APPLETON | Individual | 3/14/1979 | 0 | S009725 | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | DOLE DRIED FRUIT & NUT COMPANY | Corporation | 1/1/1980 | 0 | S002866 | |


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| Source | Water Right Type | Status | Holder Name | Org Type | Date | Face Amt (acre-ft/yr) | Application ID | Permit ID |
|---|---|---|---|---|---|---|---|---|
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | DONALD M JOHNSTONE | Individual | 5/30/1978 0 | S009598 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | FELIX ROBLES | Individual | 3/14/1979 0 | S009744 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | FRED TAYLOR | Individual | 3/14/1979 0 | S009741 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | GLADYS E NAMAN | Individual | 3/14/1979 0 | S009732 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | HAPPY VALLEY CONFERENCE CENTER INC | Corporation | 4/19/1977 0 | S009207 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | JACK F KIRBY | Individual | 3/14/1979 0 | S009727 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | L CUNEO | Individual | 3/14/1979 | 0 | S009746 | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | LEWIS N ERICKSON | Individual | 3/14/1979 0 | S009720 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | MACLYN MORRIS | Individual | 3/14/1979 0 | S009719 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | ROBERT A MICHAEL | Individual | 3/14/1979 0 | S009718 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | ROBERT J BIXBY | Individual | 5/12/1978 0 | S009589 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Claimed | TOM ROZARIO | Individual | 3/14/1979 0 | S009723 | | |
| BRANCIFORTE CREEK | Statement of Div and Use | Inactive | | | 5/9/2008 | 0 | S009728 | |
| BRANCIFORTE CREEK | Statement of Div and Use | Inactive | | | 11/3/1999 | 0 | S013322 | |
| BRANCIFORTE CREEK AKA (BLACKBURN GULCH) | Statement of Div and Use | Claimed | DAVID WOOD | Individual | 5/13/1991 0 | S013704 | | |
| CRYSTAL CREEK | Statement of Div and Use | Claimed | KYLE FRANDLE | Individual | 5/11/2001 0.7 | S015426 | | |
| CRYSTAL CREEK | Statement of Div and Use | Claimed | GALE A MCGUIRE | Individual | 8/8/1977 0 | S009364 | | |
| **Subtotal estimated volume from Statements of Diversion and Use** | | | | | | **236.6** | | |
| | | | | | | | | |
| **Newell Creek System** | | | | | | | | |
| NEWELL CREEK | Appropriative | Licensed | CITY OF SANTA CRUZ | Government (State/Municipal) | 12/12/1957 | 5,600 | A017913 | 11618 |
| **Appropriate Rights Subtotal** | | | | | | **5,600** | | |
| NEWELL CREEK | Statement of Div and Use | Claimed | EDWARD R HILL | Individual | 6/12/1978 0 | S009680 | | |
| NEWELL CREEK | Statement of Div and Use | Claimed | EMILY RICHEY | Individual | 5/2/1977 0 | S009255 | | |
| NEWELL CREEK | Statement of Div and Use | Claimed | GRACE E REICHERT | Individual | 4/26/1977 0 | S009249 | | |
| NEWELL CREEK | Statement of Div and Use | Inactive | J H MORRISON | Individual | 4/27/2006 0 | S009194 | | |
| NEWELL CREEK | Statement of Div and Use | Claimed | MARILYN A GRAY | Individual | 4/26/1977 0 | S009248 | | |
| NEWELL CREEK | Statement of Div and Use | Claimed | MICHAEL FINLEY | Individual | 4/13/1977 0 | S009200 | | |
| **Subtotal estimated volume from Statements of Diversion and Use** | | | | | | **72** | | |
| | | | | | | | | |


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| San Lorenzo River System | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BENNETT CREEK | Appropriative | Licensed | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) | 12/5/1936 | 291 | A008843 | 5136 |
| BENNETT CREEK | Appropriative | Licensed | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) | 12/6/1926 | 112 | A005297 | 3603 |
| BENNETT CREEK | Appropriative | Licensed | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) | 12/6/1926 | 112 | A005299 | 3605 |
| BENNETT CREEK, BULL CREEK, BULL SPRING, FALL CREEK | Appropriative | Permitted | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) 7/26 | /1974 | 1,059.00 | A024652 | 20123 |
| BULL CREEK, BULL SPRING | Appropriative | Licensed | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) | 12/5/1936 | 304.1 | A008844 | 5137 |
| FALL CREEK | Appropriative | Licensed | CALIFORNIA-AMERICAN WATER COMPANY | Government (State/Municipal) | 12/5/1936 | 514 | A008845 | 5138 |
| KINGS CREEK | Appropriative | Licensed | MT DIABLO COUNCIL, B S A | Organization/ Association | 3/7/1966 | 2 | A022412 | 15261 |
| KINGS CREEK | Appropriative | Licensed | MT DIABLO COUNCIL, B S A | Organization/ Association | 11/16/1959 | 1.8 | A019084 | 12795 |
| LOVE CREEK, UNST Appropria | tive | Permitted | FREDRIC CHARLES WELLS Indiv | idual | 7/21/1988 | 17.3 | A029306 | 21107 |
| SAN LORENZO RIVER | Appropriative | Licensed | CITY OF SANTA CRUZ | Government (State/Municipal) | 6/9/1924 | 4,488 .70 | A004017 | 2372 |
| SAN LORENZO RIVER | Appropriative | Licensed | CITY OF SANTA CRUZ | Government (State/Municipal) | 9/2/1926 | 4,343 .90 | A005215 | 2738 |
| SAN LORENZO RIVER | Appropriative | Permitted | CITY OF SANTA CRUZ | Government (State/Municipal) | 10/20/1965 | 3,000 .00 | A022318 | 16123 |
| SAN LORENZO RIVER Appropria | tive | Permitted | CITY OF SANTA CRUZ | Government (State/Municipal) 3/1/1971 | | 0.00 | A023710 | 16601 (w/ID 16123 = 3,000 AF) |
| SAN LORENZO RIVER Appropria | tive | Licensed | FRENCH AMERICAN INVESTMENT CO INC | Corporation 6/14 | /1937 | 12.7 | A008999 | 5299 |
| UNST (AKA BOULDER CREEK) Appropria | tive | Pending | FOREST LAKES MUTUAL WATER COMPANY | Corporation | 4/2/2003 | 4 | A031409 | |
| | | | | **Appropriate Rights Subtotal** | | **14,245.8** | | |
| CLEAR CREEK | Statement of Div and Use | Claimed | MICHAEL LUSSIER Indiv | idual | 6/9/2000 | 47.7 | S015091 | |
| CLEAR CREEK | Statement of Div and Use | Claimed | MICHAEL LUSSIER | Individual | 11/7/1997 | 0 | S014846 | |
| FALL CREEK | Statement of Div and Use | Claimed | JAMES K HUMPHREYS | Individual | 1/1/1974 | 0 | S008315 | |
| FALL CREEK | Statement of Div and Use | Claimed | SUSAN W CLARRY | Individual | 2/14/1978 | 0 | S009556 | |
| FRITCH CREEK | Statement of Div and Use | Claimed | ARDEENE SWAIN | Individual | 6/3/1996 | 0 | S014580 | |
| FRITCH CREEK | Statement of Div and Use | Claimed | CAROL G EAKLE | Individual | 12/8/1994 | 0 | S014298 | |
| JAMISON SPRING | Statement of Div and Use | Claimed | BIG BASIN WATER COMPANY | Corporation | 12/6/1974 | 0 | S008440 | |


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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOGAN CREEK | Statement of Div and Use | Claimed | KRIS PACHECO | Individual | 7/5/1978 0 | S009700 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | FRANCIS JOHN WEILER | Individual | 1/1/1980 0 | S003137 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | JULIUS HIMMELSBACHER | Individual | 1/1/1975 0 | S002047 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | KENNETH BARTON KORTS | Individual | 1/1/1975 0 | S003236 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | MATTHEW DANIEL SCHWARZBACH | Individual | 12/7/1979 0 | S010011 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | PATRICIA L WILLIAMS | Individual | 1/1/1975 0 | S003239 | | |
| LOVE CREEK | Statement of Div and Use | Claimed | ROSS J HARRIMAN | Individual | 1/1/1975 0 | S002699 | | |
| LOVE CREEK | Statement of Div and Use | Inactive | | | 5/5/2007 | 0 | S009688 | |
| MARSHALL CREEK | Statement of Div and Use | Claimed | JIM KINSLOW | Individual | 11/28/1977 | 0 | S009468 | |
| MARSHALL CREEK | Statement of Div and Use | Inactive | | | 5/7/2007 | 0 | S009704 | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | PARADISE PARK MASONIC CLUB | Corporation | 4/28/2004 2.6 | S015526 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | GERALD D ROGERS | Individual | 10/29/1975 0 | S008632 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | MARK TRAUGOTT Indiv | idual 9/15 | /2003 | 0 | S015785 | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | PARK MUTUAL WATER COMPANY | Corporation | 9/13/1977 0 | S009408 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | RALPH P GULLIVER | Individual | 5/6/1976 0 | S008778 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Inactive | RAYMOND L MORGAN | Individual | 7/30/2008 0 | S008634 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Inactive | SAN LORENZO WOODS IMPROVEMENT ASSN | Corporation | 6/4/1998 0 | S009370 | | |
| SAN LORENZO RIVER | Statement of Div and Use | Claimed | UMESH PATEL | Individual | 7/27/1973 0 | S008186 | | |
| SHINGLE MILL GULCH | Statement of Div and Use | Inactive | JOHN ROBERTS | Individual | 8/1/2008 0 | S009958 | | |
| UNST (AKA LOVE CREEK) | Small Domestic Reg | Registered | RUSS ANDERSON | Individual | 12/7/1987 | 1 | D029149R | |
| **Subtotal estimated volume from Statements of Diversion and Use** | | | | | | **339.3** | | |
| | | | | | | | | |


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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Zayante Creek System** | | | | | | | | |
| LOMPICO CREEK | Appropriative | Licensed | LOMPICO COUNTY WATER DISTRICT | Government (State/Municipal) | 7/1/1925 | 26.9 | A004667 | 2858 |
| LOMPICO CREEK | Appropriative | Licensed | SANDRA TAMAR BERRY | Individual | 1/30/1957 | 3.5 | A017445 | 11284 |
| ZAYANTE CREEK | Appropriative | State Filing | STATE WATER RESOURCES CONTROL BOARD | Government (State/Municipal) | 9/25/1986 | 17000 | A028909 for 17,000 AF | |
| | | | | **Appropriate Rights Subtotal** | | **17,030.4** | | |
| LOMPICO CREEK | Statement of Div and Use | Claimed | TIMOTHY TONSING | Individual | 10/21/1994 | 0.1 | S014249 | |
| LOMPICO CREEK | Statement of Div and Use | Claimed | LEO WEBBER | Individual | 1/1/1976 | 0 | S007405 | |
| LOMPICO CREEK | Statement of Div and Use | Claimed | | | 4/16/1985 | 0 | S012207 | |
| MOUNTAIN CHARLIE GULCH | Appropriative | Licensed | SUMMIT WEST MUTUAL WATER COMPANY | Government (State/Municipal) | 9/14/1967 | 8.4 | A022905 | 15881 |
| ZAYANTE CREEK | Statement of Div and Use | Claimed | HERRICK MORGAN | Individual | 10/9/1996 | 0 | S014717 | |
| ZAYANTE CREEK | Statement of Div and Use | Claimed | ROBERT A FOSBURGH | Individual | 1/1/1975 | 0 | S008541 | |
| ZAYANTE CREEK | Statement of Div and Use | Claimed | RUTH L CLIFFORD | Individual | 3/14/1979 | 0 | S009733 | |
| | | | **Subtotal estimated volume from Statements of Diversion and Use** | | | **68.5** | | |
| | | | | | | | | |
| **Cancelled or Revoked Water Rights** | | | | | | | | |
| BEAR CREEK | Appropriative | Revoked | | | 4/23/1998 | 0 | A026070 | 18106 |
| BEAN CREEK | Appropriative | Revoked | REED J LANGDON | Individual | 4/9/1998 | 0 | A019658 | 13519 |
| CARBONERA CREEK | Appropriative | Revoked | | | 8/8/2007 | 5.5 | A026634 | 19422 |
| GOLD GULCH, TUNNEL GULCH, UNST, WAEZEL GULCH | Appropriative | Revoked | | | 4/10/2002 | 56 | A004842 | 3444 |
| LOMPICO CREEK | Appropriative | Revoked | | | 9/19/2002 | 0 | A017446 | 11285 |
| LOVE CREEK | Appropriative | Revoked | | | 11/21/2005 | 0 | A020447 | 13550 |
| MOUNTAIN CHARLIE GULCH | Appropriative | Cancelled | | | 1/15/2000 | 0 | X | 000121 |
| MOUNTAIN CHARLIE GULCH, UNST | Appropriative | Revoked | | | 5/19/2004 | 1.6 | A026831 | 18929 |
| ZAYANTE CREEK | Small Domestic Reg | Revoked | RAY MURDOCK | Individual | 3/16/2007 | 3 | D031079R | |


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**Table 4 Summary of water rights from Bean, Carbonera, Branciforte, and Newell Creeks and the San Lorenzo River based on SWRCB eWRIMS database**

| Stream | Appropriative rights | | Statements of Diversion and Use | | Total Estimated Existing Water Rights (AF) | Annual Streamflow | |
|---|---|---|---|---|---|---|---|
| | Direct Diversion (AF) | Storage (AF) | Number of claims | Estimated Volume (AF) | | Mean[1] (AF) | Average Annual Yield[1] (AF) |
| Bean Creek System 3 | | | 12 | 108 | 111 | 8,000 | 520 |
| Zayante Creek System | 30.4 | 17,000[5] | 7 | 68.5 | 17,068.5 | 8,000 | 500 |
| San Lorenzo River System[3] | 14,245.8 | | 31 | 339.3 | 14,633.1 | 96,100 | 1,643[4] |
| Carbonera Creek System[2] | 3 | | 3 | 36 | 39 | 4,000 | 480 |
| Newell Creek | | 5,600 | 6 | 72 | 5,672 | Not available | Not available |

[1] From Technical Memorandum 2B (Balance Hydrologics, 2009) for this Conjunctive Use Project.
[2] Branciforte Creek, adjacent to Carbonera Creek, has a Total Estimated Existing Water Rights of 236.6 AF. No estimate of available streamflow was made for Branciforte Creek
[3] Water Rights on creeks within the San Lorenzo River system but on any of the other named creeks in this table were summarized in this category
[4] Quantity remaining of 3,000 AFY diversion right (per City of Santa Cruz permit ID 16123 and 16601) based on WY89 diversion of 1,643 AFY (Ramlit Associates, 2002)
[5] Storage right of 17,000 AF (per Application ID A028909) is inactive and held for use in Northern Santa Cruz County.


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# Figures


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## Legend

- Area Locations
- Water Treatment Plant
- Santa Cruz Water Department Diversions
- City of Santa Cruz Wells (GWUDI only)
- Streets
- Streams
- San Lorenzo River Watershed
- Santa Margarita Groundwater Basin
- Parks and Open Space

N

0 4,000 8,000

Scale: Feet

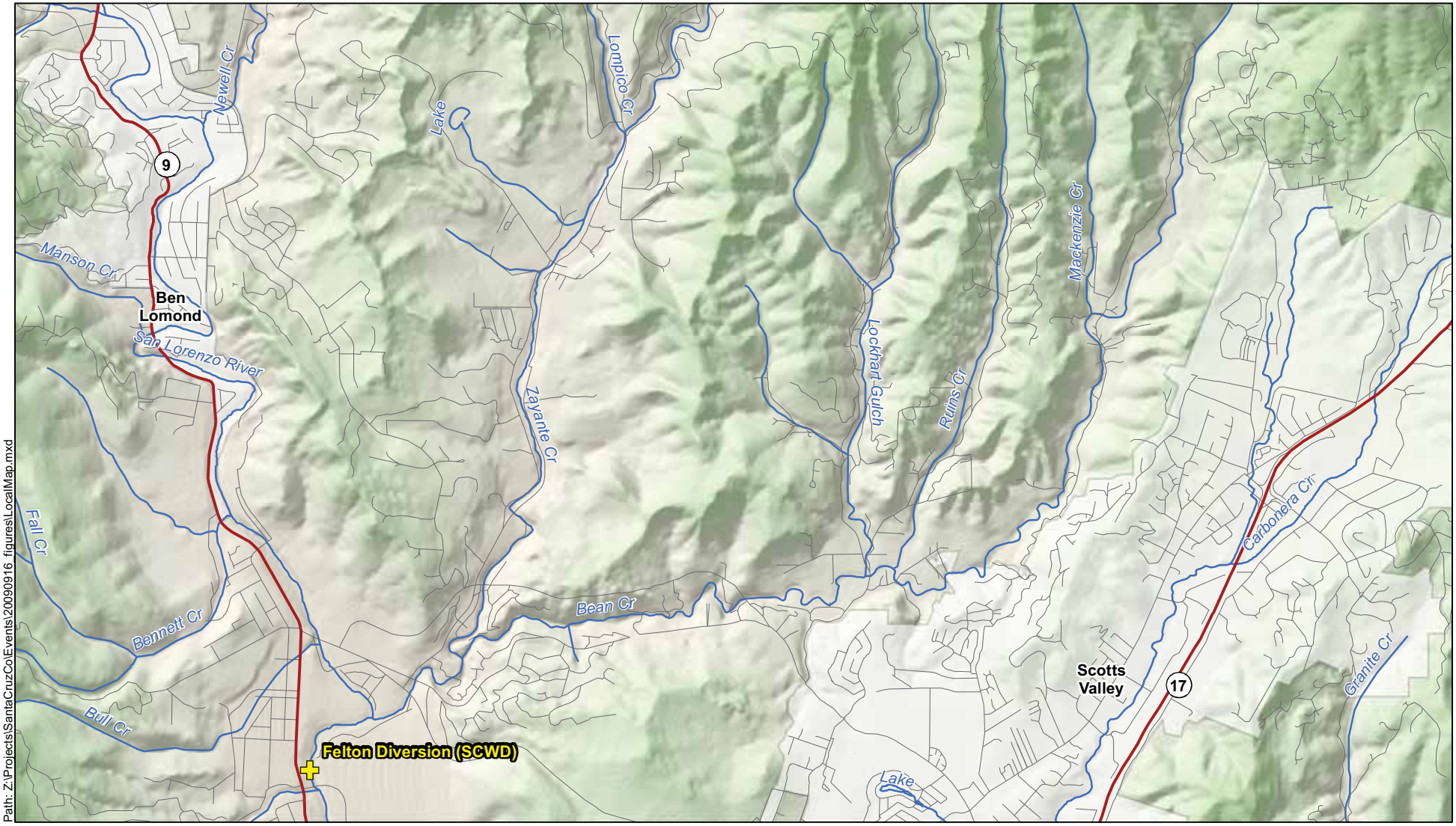
**Kennedy/Jenks Consultants**

TM2A - Water Rights Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**San Lorenzo River Watershed**

K/J 0864005
November 2010

**Figure 1**




Path: Z:\Projects\SantaCruzCo\Events\20090916_figures\LocalMap.mxd

Source: Hillshading derived from a USGS 30 meter Digital Elevation Model, Scale 1:24,000.

**Legend**

- Santa Cruz Water Department Diversions
- State Highways
- Streams
- City Boundary

N

0 1,500 3,000

Feet

**Kennedy/Jenks Consultants**

TM2A - Water Rights Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

**Locations of Streams for Water Rights Evaluation**

K/J 0864005
November 2010

**Figure 2**

# Appendices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# Appendix A

## Information Pertaining to Water Rights in California

# STATE WATER RESOURCES CONTROL BOARD
# INFORMATION PERTAINING TO
# WATER RIGHTS IN CALIFORNIA - 1990

## TABLE OF CONTENTS


INTRODUCTION ..... 2
GENERAL INFORMATION PERTAINING TO WATER RIGHTS ..... 3
APPROPRIATIVE RIGHTS INITIATED PRIOR TO DECEMBER 19, 1914 ..... 3
APPROPRIATIVE RIGHTS INITIATED SUBSEQUENT TO DECEMBER 19, 1914 ..... 4
LOSS OF APPROPRIATIVE RIGHTS ..... 4
RIPARIAN RIGHTS ..... 4
PRESCRIPTION ..... 6
VESTED APPROPRIATIVE AND RIPARIAN RIGHTS NOT AFFECTED BY FILING AN APPLICATION ..... 7
DISPUTES OVER THE USE OF WATER ..... 7
PUBLIC TRUST ..... 8
DETERMINATION OF EXISTING RIGHTS ..... 9
APPROPRIATION OF UNDERGROUND WATER ..... 10
SPRING WATER ..... 11
NO ASSISTANCE RENDERED IN SECURING RIGHT OF ACCESS TO POINT OF DIVERSION OR RIGHT-OF-WAY ..... 11
PATENTS AND HOMESTEADS ..... 11
SUPERVISION OVER DAMS ..... 11
PROVISIONS OF FISH AND GAME CODE ..... 12
STATEMENTS OF WATER DIVERSIONS AND USE ..... 12
STOCKPOND RIGHTS ..... 13
GENERAL INFORMATION PERTAINING TO APPLICATIONS FOR PERMITS TO APPROPRIATE UNAPPROPRIATED WATER ..... 13
WHO SHOULD FILE AN APPLICATION ..... 14
WHO SHOULD NOT FILE AN APPLICATION ..... 14
PURPOSE OF FILING ..... 14
WHEN TO FILE ..... 15
UNAPPROPRIATED WATER AND RESPONSIBILITIES OF PERMITTEES ..... 15
OUTLINE OF ESSENTIAL STEPS ..... 16
PREPARATION OF APPLICATIONS ..... 17
CHANGES IN OWNERSHIP ..... 17
APPENDIX - TABLE OF EQUIVALENTS ..... 17

## INTRODUCTION

Additional information concerning procedures for appropriating water is available in SWRCB's publications entitled, "How to File an Application/Registration to Appropriate Water in California" and "A Guide to California Water Right Appropriations". These free publications may be picked up from the State Water Resources Control Board, Division of Water Rights, 901 P Street, Third Floor, Sacramento, California 95814. If you wish to write for either one or both of these publications, address your request to the Division of Water Rights, Post Office Box 2000, Sacramento, CA 95812-2000 or telephone (916) 657-2170 and request they be mailed to you.

The California Code of Regulations, Title 23. Waters, contains the regulations for the administration of water rights and water quality activities of the State Water Resources Control Board. A complete copy of these regulations may be obtained at the current cost of $15.90 from the California Department of General Services, Publications section, Post Office Box 1015, North Highlands, CA 95660. A renewal service, which provides new and amended regulations also, may be obtained from the California Department of General Services at the current cost of $20.00 per year.

Booklets containing excerpts from the California Code of Regulations and the California Water Code pertaining to water rights may be obtained free of charge from the Division of Water Rights as described in the first paragraph. These booklets, however, contain information only as of the date the booklets were published.

## GENERAL INFORMATION PERTAINING TO WATER RIGHTS

The following general information pertaining to water rights is offered for the guidance and assistance of those who may be interested. While believed to be correct, the information is by no means complete. For additional information, see the California Water Code and case law.

Those to whom this general information is of particular importance or who propose to apply it to specific cases should seek the advice of an attorney or engineer, depending on the kind of information needed.

## APPROPRIATIVE RIGHTS INITIATED PRIOR TO DECEMBER 19, 1914

Prior to 1872, appropriative water rights could be acquired by simply taking and beneficially using water. The priority of the right was the first substantial act leading toward putting the water to beneficial use provided the appropriation was completed with reasonable diligence; otherwise, priority did not attach until beneficial use of the water commenced.

In 1872, sections 1410 through 1422 of the California Civil Code were enacted. These sections established a permissive procedure for perfecting an appropriation of water. Provisions were made for establishing a priority of right by posting a notice of appropriation at the proposed point of diversion and recording a copy of the notice with the respective County Recorder. If these procedures were not followed, the pre-1914 appropriative right did not attach until water was beneficially used.

Once acquired, an appropriative right can be maintained only by continuous beneficial use of water. Regardless of the amount claimed in the original notice of appropriation or at the time diversion and use first began, the amount which now can be rightfully claimed under an appropriative right initiated prior to December 19, 1914 therefore has, in general, become fixed by actual beneficial use as to both amount and season of diversion. The conditions under which an appropriative right may be forfeited in whole or in part are set forth under the heading "Loss of Appropriate Rights".

Successful assertion of an appropriative right which was initiated prior to December 19, 1914, where the validity of the right is disputed, requires evidence of both the original appropriation and the subsequent maintenance of the right by continuous and diligent application of water to beneficial use (see California Water Code section 1202(b)). Frequently such evidence consists of oral testimony of persons who have actual knowledge of the relevant facts. As the years pass, such testimony, dependent upon the recollection of individuals, may become difficult or impossible to secure. At least a partial remedy for this situation may be found in the procedure for perpetuation of testimony set forth in section 2017 of the California Code of Civil Procedure.

A record of water use under "pre-1914 Appropriative Rights" should be established by filing a Statement of Water Diversion and Use with the SWRCB.

## APPROPRIATIVE RIGHTS INITIATED SUBSEQUENT TO DECEMBER 19, 1914

The two methods of appropriation existing prior to December 19, 1914, the effective date of the California Water Commission Act, no longer are available for appropriating water from surface streams, other surface bodies of water, or from subterranean streams flowing in known and definite channels. An appropriation of such water now requires compliance with the provisions of Division 2, Part 2 of the California Water Code.

The steps which now must be taken in order to initiate and acquire an appropriative water right are described under the heading "General Information Pertaining to Applications for Permits to Appropriate Unappropriated Water".

## LOSS OF APPROPRIATIVE RIGHTS

By Abandonment - To constitute abandonment of an appropriative right, there must be concurrence of act and intent, the relinquishment of possession, and the intent not to resume it for a beneficial use, so that abandonment is always voluntary, and a question of fact (1 Wiel, 3d ed., 604, 605).

By Nonuse - Nonuse is distinguished from abandonment. Nonuse means failure to put water to beneficial use for a period of years. The courts have held that pre-1914 rights can be lost as the result of five years' nonuse (Smith v. Hawkins 42 P. 454).

California Water Code section 1241 provides for loss of appropriative rights after five years' nonuse. This section applies only to an appropriative right acquired after December 19, 1914.

## RIPARIAN RIGHTS

No California statute defines riparian rights, but a modification of the common law doctrine of riparian rights has been established in this State by decisions of the courts and confirmed by the provisions of section 3, Article XIV of the California Constitution (see California Water Code sections 100, 101). Lands within the watershed of a natural watercourse, which are traversed thereby or border thereon, with the exceptions and limitations hereinafter, indicated, may be riparian. Each owner thereof may have a right, which is correlative with the right of each other riparian owner to share in the reasonable beneficial use of the natural flow of water, which passes his land. No permit is required for such use. The State Water Resources Control Board's (SWRCB) policy is to consider natural flow as not including return flows derived from use of ground water, water seasonally stored and later released, or water diverted from another watershed. In administering the California Water Code, the SWRCB is governed by the following considerations relative to the doctrine of riparian rights as applied to this State:

1. The riparian right exists by reason of ownership of land abutting upon a stream or body of water and affords no basis of right to use water upon nonriparian land.
   (Rancho Santa Marqarita v. Vail, 11 Cal. 2d 501, 81 P. 2d 533)

2. In order to divert water under claim of riparian right, the diverter must use the water on riparian land but need not own the land at the point of diversion. That is, such diverter may divert at a point upstream from his land so long as permission is granted to use that point of diversion, and intervening land owners between the point of diversion and the place of use are not adversely affected by such practices. (Turner v. James Canal Co., 155 Cal. 82, 99 P. 520 (1909))

3. A parcel of land loses its riparian right when severed from land bordering the stream by conveyance unless the right is reserved for the severed parcel. The riparian right also may be destroyed when purportedly transferred apart from the land by grant, contract, or condemnation. Once lost, it cannot be restored.

4. As between riparian owners, priority of use establishes no priority of right; i.e., one cannot claim superior right merely because water was used first. (Pabst v. Finmand, 190 Cal. 124, 211 P. 11 (1922))

5. The riparian right is neither created by use nor lost by nonuse.

6. If there is insufficient water for the reasonable beneficial requirements of all riparian owners, they must share the available supply. Apportionment is governed by various factors, including each owner's reasonable requirements and uses. In the absence of mutual agreement, recourse to judicial determination may be necessary.

7. As between riparian owners, one of them may take the whole supply if necessary for strictly domestic use; that is, for so-called "natural uses ... arising out of the necessities of life on the riparian land, such as household use, drinking, watering domestic animals." (1 Wiel, 3d ed., Water Rights in the Western States, page 795; Deetz v. Carter, 232 Cal. App. 2d 851; but see Prather v. Hoberg, 24 Cal. 2d 549, 150 P. 2d 405, re an equitable apportionment where the use is commercialized as for resort purposes and therefore is not strictly domestic.)

8. The riparian owner is subject to the doctrine of reasonable use, which limits all rights to the use of water to, that quantity reasonably required for beneficial use and prohibits waste or unreasonable use or unreasonable methods of use or diversion. (Sec. 3, Art. XIV, Const. of Cal.; Peabody v. City of Vallejo, 2 Cal. 2d 351, 40 Pac. 2d 486; Tulare Irr. Dist. et al v. Lindsay Strathmore Irr. Dist., 3 Cal. 2d 489, 45 Pac. 2d 972; Rancho Santa Marqarita v. Vail, 11 Cal. 2d 501, 81 P. 2d 533)

9. A riparian right may be impaired or lost through prescription. Refer to the following section, "PRESCRIPTION".

10. The riparian right attaching to a particular parcel of land is subject to appropriative rights established by diversion upon vacant public domain before the first valid steps were taken to acquire said parcel of land from the United States, whether diversion was made at points upstream or downstream.

11. The riparian right cannot be transferred for use upon another parcel of land.

12. The riparian right does not apply to foreign water; i.e., water originating in a different watershed cannot be used under claim of riparian right. (E. Clemens Horst Co. v. New Blue Point Mining Co., 177 Cal. 631, 171 P. 417; Crane v. Stevinson, 5 Cal. 2d 387, 54 P. 2d 1100; Rancho Santa Marqarita v. Vail, 11 Cal. 2d 501, 81 P. 2d 533)

13. Water cannot be stored and withheld for a deferred use (other than regulatory storage) under claim of riparian right. (Seneca Consol. Gold Mines Co. v. Great Western Power Co., 209 cal. 206, 287 pac. 93; Colorado Power Co. v. Pac. Gas and Electric Co., 218 cal. 559, 24 p. 2d 495; Moore v. CaliforniaOregon Power Co., 22 cal. 2d 725, 140 p. 2d 798)

A record of water use under riparian claim should be established by filing a Statement of Water Diversion and Use with the SWRCB.

**PRESCRIPTION**

A right secured by appropriation does not depend upon use for any given length of time. It is complete immediately upon full beneficial use being made of water pursuant to a permit. The right, however, is subordinate and subject to all prior vested rights, whether appropriative or riparian. This limitation may be removed under certain circumstances by continuous use adverse to prior rights for five years and failure of the owners of the prior rights to file legal action to protect themselves during that time. Their cause of action then becomes barred by the statute of limitations. The right of the subsequent appropriator thereafter no longer is subject to the prior vested rights. This result is called a prescriptive right to the use of water.

In order for an appropriative or riparian claim to ripen into a prescriptive right as against the owner of a riparian or a prior appropriative right, the use must be continuous and uninterrupted for a period of five years. During all of such time, the use must be open and notorious, exclusive, under claim of right, hostile and adverse to the title of the prior owner, and an invasion of the prior owner's right. The prior right owner must have had an opportunity to prevent the adverse use by legal action, and such taxes as are assessed must be paid. Absence of any of these conditions is fatal to the acquisition of a prescriptive water right.

Water users ordinarily have no concern with the use of water by others after it has passed their land or point of diversion. The upstream users thus have no legal right to prevent downstream use. A well-established rule is that a prescriptive water right ordinarily cannot be acquired against an upstream user.

A right cannot be acquired by prescription to use a greater quantity of water than reasonably is necessary for the beneficial purpose served, regardless of the amount actually used, in accordance with the constitutional amendment of 1928 (art. XIV, sec. 3).

Since enactment of the California Water Commission Act on December 19, 1914, a right to appropriate or use water (other than as a riparian or overlying owner, or appropriator of percolating ground water, or stockponds that comply with article 2.5, commencing with section 1226 of chapter 1 of part 2 of division 2 of the California Water Code), cannot have been

secured without first obtaining a permit from the State (see California Water Code section 1225 and Crane v. Stevinson, 5 cal. 2d 387, 54 p. 2d 1100). Although one who now uses water without a permit for a sufficient period of time may, under certain circumstances foreclose objection by those who have been adversely affected, such user thereby does not acquire a right to prevent diversions by others which deplete the supply of water available. California courts have not been called upon to determine this precise question. In view of the uncertainty in this respect and because a prescriptive right can be finally determined only by a court of competent jurisdiction, the policy of the SWRCB is to disregard a claim to water subject to the permit procedure which is based only upon use initiated subsequent to 1914 unless such use is supported by a permit.

In PecDle v. Shirokow (1980) 26 cal. 3d 301, the California Supreme Court addressed the question of whether a person who does not hold a water right permit or license may establish a prescriptive water right to divert and use water. The Court held that the water appropriation procedure established by statute constitutes the exclusive method of acquiring a right to appropriate or use water, which is subject to appropriation. Since Shirokow was using water and held no permit or license authorizing an appropriation of water, the Court concluded that such use of water was improper. In addition, the Court held that the State's governmental interest in regulating the use of public water is a public right, which cannot be lost through prescription.

## VESTED APPROPRIATIVE AND RIPARIAN RIGHTS NOT AFFECTED BY FILING AN APPLICATION

An existing valid riparian or appropriative right will be neither strengthened nor impaired by a permit to appropriate water issued to the owner of such right (see Barr v. Branstetter, 42 cal. app. 725, 184 p. 409). An application to appropriate water may be filed by such owner, however, in the following instances: (1) to initiate a right to additional unused water where water is available for further appropriation in excess of that covered by the existing right; and (2) to establish a new right to water already in use by applicant where the validity of the existing right has not been adjudicated or is in doubt. In either event, the priority of the right acquired by beneficial use under the permit will be the date of filing the application--the priority will not relate back to the time of the first use under a former claim.

The California Code of Regulations, title 23~ section 731, requites an applicant for a permit to list all claims to existing rights for the use of all or part of the water sought by the application. A permit, if issued, will limit the water to be appropriated so that existing rights, combined with the permit will not yield a right to use an unreasonable quantity of water. Subsections (c), (d), and (e) of section 731 contain penalties for anyone who transfers an existing right before, or does not claim an existing right until, a permit or license is issued. This provision is in recognition of the fact that a permit should be issued only for unappropriated water, and that water which is being used pursuant to an existing right is not unappropriated, whether the right is being exercised by the applicant or by another person.

## DISPUTES OVER THE USE OF WATER

The right to use water is a property right and may be protected against infringement in the same manner as any other property right; i.e., by appropriate court action. The SWRCB does not have

the authority to determine the validity of vested rights other than appropriative rights initiated December 19, 1914 or later. The SWRCB, however, may assist the courts in such determination as described in the following paragraphs entitled, "Determination of Existing Rights". The SWRCB will investigate and take appropriate action on a written complaint received alleging (1) a violation of the conditions of a permit or license issued by the SWRCB, (2) waste or unreasonable use of water, (3) illegal diversion or use, or (4) unreasonable effects on public trust or public interest uses of the water. (See title 23, chapter 3, subchapter 2, articles 18 and 22 of the California Code of Regulations; California Water Code section 275 et. seq.; and California Water Code section 1050 et. seq.)

When a complaint of an illegal diversion or use is filed, the SWRCB will take action under section 1052 of the California Water Code. Subsection (a) provides that "The diversion or use of water subject to this division other than as authorized in this division is a trespass." Subsection (d) provides, in part, that "Any person or entity committing a trespass as defined in this section may be liable for a sum not to exceed five hundred dollars ($500) for each day in which the trespass occurs. The Attorney General, upon request of the SWRCB, shall petition the superior court to impose, assess, and recover any sums pursuant to this subdivision. " SWRCB policy is to initiate court action only in a clear instance of unlawful use of water. Where there is a bona fide dispute as to the facts, or where circumstances indicate an adjudication is required, action by the SWRCB under section 1052 generally is not considered appropriate.

**PUBLIC TRUST**

With its roots in Roman law, the doctrine of public trust holds that certain resources are the property of all. In its modern form, the public trust doctrine holds that a state, as sovereign, takes title to tidelands and the beds of nontidal navigable waters at the time the state is admitted to the Union. Holding these lands and the waters above them in trust, the state's duty is to exercise continued supervision over the trust for the benefit of the people. Entities acquiring rights, for example in navigable streams, lakes, marshlands and tidelands, generally hold those rights subject to the trust and can assert no vested right in a manner harmful to the public trust. In other words, rights acquired in public trust resources cannot be placed entirely beyond the direction and control of the state.

The scope of the public trust doctrine continues to evolve as popular perceptions of the values and uses of waterways change. The public trust was traditionally defined to protect navigation, commerce, and fisheries; but recently it has been held to include the right to fish, hunt, bathe, swim, boat, recreate, navigate, and use the bottom of navigable waters for anchoring, standing, or other purposes.

In this century, the California courts have interpreted the legal term "navigable" very broadly to include recreational rafting and kayaking which can take place in very shallow water. Within the last decade, the California Supreme Court has recognized that uses of public trust resources include the preservation of the land, especially tideland, in its natural state to serve as ecological units for scientific study, as open space, and as habitat for birds and aquatic life. In administering the public trust, the courts have allowed the state to favor one use over another.

In its presently-developed form, the public trust doctrine requires the courts and the SWRCB to perform a balancing test to weigh the potential value to society against the impact on trust resources of a proposed or existing diversion. The action which will feasibly protect public trust values must be implemented.

On February 17, 1983, the California Supreme Court filed its decision in National Audubon Society v. Superior Court of Alpine County, 33 Cal. 3d 419, 189 Cal. Rptr. 346 (1983). The Court merged the public trust doctrine with the California water rights system. The Court also held that all uses of water, including public trust uses, must conform to the standard of reasonable use. The Court further held that the SWRCB has a duty to consider public trust values before it approves water right applications. Finally, the Court held that the SWRCB has a continuing duty to supervise the taking and use of appropriated water.

## DETERMINATION OF EXISTING RIGHTS

Court Reference. When a suit is brought by private parties in any court of competent jurisdiction in this State for determination of water rights, sections 2000 and 2001 of the California Water Code provide that the case, at the discretion of the court, may be referred to the SWRCB, as referee, for investigation. All rights of whatever character may be included under this procedure.

Statutorv Adjudication. section 2525 of the California Water Code provides for the initiation of proceedings for the determination of all rights to the water of any stream, lake, or other body of water except percolating underground water. A petition signed by one or more claimants of the right to the use of water from the source involved must be filed with the SWRCB. The procedures outlined in sections 2500 through 2900 of the California Water Code must be followed.

If a determination is undertaken under either the court reference or statutory procedure, the SWRCB thoroughly investigates the stream system and water rights involved. In general, such investigation will include measurements of the water supply and of all diversions from the stream system, a survey of all diversion systems and areas irrigated therefrom, and a determination of the duty of water for irrigation and other uses.

After due notice to all parties, the SWRCB prepares findings which are submitted to the court. The court itself hears those who may be dissatisfied with these findings and enters a decree establishing the various rights involved.

The court also sets forth the relative priority, amount, purpose of use, season of diversion, point of diversion, and place of use of each right. Appeals from such decree may be taken in the same manner and with the same effect as in other civil cases.

By virtue of the above procedures, the SWRCB may supplement with effective and expeditious methods the work of the courts in determining water rights. These procedures lead to a complete and final determination of all the water rights involved, and, should necessity arise, a watermaster may be appointed to administer the stream and insure distribution of the water as decreed.

A copy of the SWRCB's publication, "Regulations and Information Pertaining to Determination of Rights to the Use of Water in California" may be obtained on request.

## APPROPRIATION OF UNDERGROUND WATER

The jurisdiction of the SWRCB to issue permits and licenses for appropriation of underground water is limited by section 1200 of the California Water Code to "subterranean streams flowing through known and definite channels".

If use of underground water on nonoverlying land is proposed and the source of the water is a subterranean stream flowing in a known and definite channel, an application pursuant to the California Water Code is required. A Statement of Water Diversion and Use should be filed for use of water from a subterranean stream on overlying land (see Statements of Water Diversion and Use section of this document).

Underground water not flowing in a subterranean stream, such as water percolating through a ground water basin, is not subject to the SWRCB's jurisdiction. Applications to appropriate such water, regardless of use, should not be submitted. Owners of lands overlying a ground water basin or other common source of supply have the first right to withdraw water for reasonable beneficial use on their overlying lands, and the right of each owner is equal and correlative to the right of all other owners similarly situated. In case of insufficient water to supply fully the requirements of all, the available supply must be equitably apportioned. In these respects, overlying rights are closely similar to riparian rights pertaining to surface bodies of water.

Subject to future requirements on overlying lands, surplus water which may be withdrawn without creating an overdraft on the ground water supply may be appropriated for use on nonoverlying lands. Such appropriation is accomplished simply by use--no permit is required. An application filed to appropriate underground water subsequently may be rejected if the water it seeks to appropriate is not flowing through a known and definite channel.

Division 2 of Part 5 of the California Water Code, commencing with section 4999, requires every person who extracts ground water within the counties of Riverside, San Bernardino, Los Angeles, and Ventura in excess of 25 acre-feet per annum (with certain exceptions) to file a notice with the SWRCB on forms provided by the SWRCB. Copies of the SWRCB's rules, together with further information concerning this requirement, may be obtained on request.

Every person who intends to dig, bore, drill, deepen, or reperforate a water well must file a notice of intent with the California Department of Water Resources. The notice must be filed on forms furnished by the Department and must contain information required by the Department. A report of completion also must be filed with the Department on forms furnished by the Department and containing information required by it (California Water Code sections 13750, 13751). These requirements also apply to any person who converts, for use as a water well, any oil or gas well originally constructed under the jurisdiction of the California Department of Conservation pursuant to the provisions of Article 4, Chapter 1, Division 3 of the California Public Resources Code. Further information or forms may be obtained from the California Department of Water Resources, Division of Planning, Post Office Box 942836, Sacramento, CA 942360001.

## SPRING WATER

Courts have held that water in springs and standing pools which have no natural outlet belong to the owner of the land on which these sources are located (see State v. Hansen, 189 Cal. App. 2d 604). Such water may be used without obtaining a permit.

If a spring contributes to a flowing stream, either by surface or subterranean means, the doctrine of correlative rights applies between the owner of the spring and those riparian to the stream. The right of the owner of a spring likewise is correlative with the right of those using ground water which supplies the spring. A Statement of Water Diversion and Use should be filed for such use.

## NO ASSISTANCE RENDERED IN SECURING RIGHT OF ACCESS TO POINT OF DIVERSION OR RIGHT-OF-WAY

The SWRCB will not assist in the matter of securing right of access to the stream or other source of supply, or in securing rights-of-way for ditches and conduit lines. In accepting an application or in issuing a permit, the SWRCB does not affirm that the applicant or permittee has right of access to the source of supply or necessary rights-of-way. The SWRCB will accept an application for filing before right of access has been secured. The SWRCB, however, may refuse to approve the application when the applicant apparently will be unable to secure right of access (see Title 23 of the California Code of Regulations, sections 775, 776, and 777).

## PATENTS AND HOMESTEADS

All patents granted or homesteads allowed by the U. S. Bureau of Land Management shAll be subject to any vested and accrued water rights as may have been recognized and acknowledged by the local customs, laws, and decisions of courts (30 USCA 278, 287).

## SUPERVISION OVER DAMS

Division 3 of the California Water Code, commencing with section 6000 et seq., requires that construction or enlargement of any dam over a certain height and storage capacity shall not be commenced without written approval of the plans and specifications by the California Department of Water Resources. The California Department of Water Resources ordinarily will require a statement that the SWRCB is satisfied as to the adequacy of the water right.

Dams subject to supervision are as follows:

1. Dams which are 25 feet or more in height from downstream toe to spillway level provided they store more than 15 acrefeet of water.

2. Dams which store 50 acre-feet or more of water provided they are more than 6 feet in height from downstream toe to spillway crest.

Further information concerning construction or enlargement of any dam may be obtained from the California Department of Water Resources, Division of Safety of Dams, Post Office Box 942836, Sacramento, CA 94236-0001.

Further information concerning construction or enlargement of any dam may be obtained from the California Department of Water Resources, Division of Safety of Dams, Post Office Box 942836, Sacramento, CA 94236-0001.

## PROVISIONS OF FISH AND GAME CODE

The owner of a dam is required to allow sufficient water to pass downstream at all times in order to keep fish below in good condition (section 5937, Article 2, Chapter 3, Part 1, Division 6 of the California Fish and Game Code). For purposes of Article 2, "dam" includes all artificial obstructions. Further information relating to the requirements of the California Department of Fish and Game may be obtained from local game wardens or from the California Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814.

## STATEMENTS OF WATER DIVERSIONS AND USE

All diverters of surface water, with certain exceptions, are required to file a Statement of Water Diversion and Use with the SWRCB (see Division 2 of Part 5.1 of the California Water Code). The requirement applies to water diverted under claim of riparian right and to appropriations initiated prior to December 19, 1914, the effective date of the California Water Commission Act. Forms may be obtained from the Division of Water Rights, Post Office Box 2000, Sacramento, CA 95812-2000. One purpose of filing Statements of Water Diversion and Use is to make a public record of all surface diversions not already on file with or known to the SWRCB. The following types of diversions are excluded from the requirement:

1. From a spring which does not flow off the property on which it is located.

2. Covered by an application, permit, or license to appropriate water on file with the SWRCB.

3. Included in a notice filed under the recordation of ground water extractions law (Division 2 of Part 5 of the California Water Code) in the counties of Riverside, San Bernardino, Los Angeles, and Ventura.

4. Regulated by a watermaster appointed by the California Department of Water Resources.

5. Reported by the California Department of Water Resources in its hydrologic data bulletins.

6. Included in the consumptive use data for the delta lowlands published by the California Department of Water Resources in its hydrologic data bulletins.

7. Included in annual reports filed with a court or the SWRCB by a watermaster appointed by a court or pursuant to statute to administer a final judgement determining rights to water, which

reports identify the persons who have diverted water and give the general place of use and the quantity of water which has been diverted from each source.

8. For use in compliance with the provisions of Article 2.5 (commencing with section 1226) of Chapter 1 of Part 2 of Division 2 of the California Water Code concerning stockponds.

A statement should be completed for diversions during a calendar year and should be filed before July 1 of the following year. Supplemental statements are required at three-year intervals thereafter.

## STOCKPOND RIGHTS

**The stockpond program was 'sunset' by the Legislature as of December 31, 1997.** Under certain conditions, the owners of stockponds having a capacity of not more than 10 acre-feet as of January 1, 1975 which were constructed prior to 1969 have a valid water right. Prior to January 1, 1975, a right for seasonal storage of water in a reservoir of any kind could be obtained only by appropriating the water through the application-permit-license procedure, and this is still the only way to obtain a water right for stockponds constructed after January 1, 1969 or which are larger than 10 acre-feet. Claims of rights for such stockponds and applications for this certification should be filed with the SWRCB. The priority of the right will be subject to other stockpond water rights on which certificates have been issued by the SWRCB with an earlier priority, to appropriative water rights with an earlier priority, and to riparian rights. The priority of the right will be the date the claim is filed. Ponds which were the subject of water right litigation between private parties prior to January 1, 1974 are excluded.

Before a certificate of validity of the stockpond right is issued, the SWRCB will verify the location of the pond, its capacity, and that it is used primarily for stockwatering purposes. In some cases, a field investigation is necessary. The original certificate will be filed with the SWRCB and will be available for public inspection. A copy of the certificate will be mailed to the owner of the stockpond. So that the records may be reasonably current, a statement of continued existence of the pond and its use for stockwatering will be solicited from the owner as determined by the SWRCB (currently every 10 years). If the water has ceased to be used primarily for stockwatering, the SWRCB may revoke the certificate after notice and an opportunity for hearing.

A reasonably accurate estimate of the capacity of a stockpond of 10 acre-feet or less can be computed by use of the "onethird rule' as follows:

Stockpond capacity in acre-feet = 1/3 height of dam to spillway crest, in feet, multiplied by the surface area of pond when full, in acres.

## GENERAL INFORMATION PERTAINING TO APPLICATIONS FOR PERMITS TO APPROPRIATE UNAPPROPRIATED WATER

The following information describes the statutory procedure for acquiring appropriative water rights. It is intended as a guide for persons who propose to take water from a surface or

underground source or who are uncertain as to the validity of their present taking. Those who are not already familiar with the procedure should carefully read this information.

## WHO SHOULD FILE AN APPLICATION

Since December 19, 1914, the appropriation of water in surface streams and other surface bodies of water and in subterranean streams flowing through known and definite channels has been governed by the California Water Commission Act (Statutes 1913, Chapter 586) now contained in the provisions of the California Water Code.

New legislation, effective January 1, 1989, modified the California Water Code to provide two methods of appropriating water through the California State Water Resources Control SWRCB. Provisions were added to the law for registering small domestic use appropriations, rather than applying for a water right permit under the existing process.

Small domestic use includes normal domestic use, plus incidental stockwatering of domestic animals and incidental irrigation of one-half acre or less of lawn, garden, and pasture at any single establishment, not exceeding 4,500 gallons per day by direct diversion or 10 acre-feet per annum by storage, the latter including incidental aesthetic, recreational, or fish and wildlife enhancement purposes. Refer to the SWRCB's booklet, "How to File an Application/ Registration to Appropriate Water in California" for specific information on filing for a permit or for registering a small domestic use appropriation.

Anyone who intends to divert water from surface waters or subterranean streams flowing in known and definite channels, either (1) directly to use on land which is not riparian to the source, (2) to storage in a reservoir for later use on either riparian or nonriparian land, or (3) for direct use of water which would not naturally be in the source, should apply with the SWRCB for a permit or small domestic use registration as the first step toward securing an appropriative water right. Persons diverting water under riparian or pre-1914 claims of right, with certain exceptions, are required to file a Statement of Water Diversion and Use with the SWRCB.

## WHO SHOULD <u>NOT</u> FILE AN APPLICATION

Underground water is not subject to the permit procedure unless it is the underflow of a surface stream or otherwise is flowing in a subterranean stream with a known and definite channel. One who proposes to pump ground water (with the exceptions noted) should not file an application. Anyone who pumps ground water in the counties of Riverside, San Bernardino, Los Angeles, and Ventura, with certain exceptions is required to file a notice with the SWRCB (see section 4999 of Division 2 of the California Water Code).

A permit is not required for the proper exercise of a riparian right. Diverters of.surface water, with certain exceptions, are required to file a Statement of Water Diversion and Use with the SWRCB.

## PURPOSE OF FILING

The purpose of filing an application for a permit is to secure a right to the use of unappropriated water; i.e. water that is available and is not already in use under prior and existing rights. The

purpose of filing also is to establish a record of the right sought under the application so that its status in relation to other rights may be determined more readily. One who takes and uses water without possession of a valid right or first obtaining a permit does so at his own risk and is subject to possible court action to enjoin his use.

An application should not be filed in order to adjust a dispute which has arisen over water. Permits issued by the SWRCB cannot serve to ratify or confirm existing rights claimed by the applicant.

## WHEN TO FILE

An application should be filed well in advance of construction of diversion works. An application, however, should not be filed until a definite plan has been formulated for construction of a project for use of water within a reasonable time in the future. What is reasonable depends on the size of the project and the circumstances of each case. In every case, the applicant should be prepared to commence construction work within the time ordered by the SWRCB and thereafter to complete construction and use of water with diligence. For most privately-owned projects designed to serve the individual needs of the applicant, the SWRCB will require actual construction to commence within a few months after issuance of permit. The filing of an application cannot serve to reserve water for an indefinite future use. Requests for undue delay in final disposition of an application will be denied.

## UNAPPROPRIATED WATER AND RESPONSIBILITIES OF PERMITTEES

All applications are for permits to appropriate unappropriated water, and all permits are issued subject to vested rights. In order for the SWRCB to approve an application, unappropriated water must be available to supply the applicant. Water in many streams already has been fully appropriated during the dry seasons of the year. If there is doubt whether unappropriated water is available, the SWRCB's staff should be consulted before an application is filed.

The flow of water in most streams is variable and cannot be predicted with accuracy. Approval of an application and issuance of a permit thus does not guarantee that unappropriated water will be available at all times in the full amount specified in the permit. In some cases, there may be times during the authorized diversion season when no unappropriated water will be available. The holder of a permit should be prepared to accept responsibility for diverting only to the extent and at such times as will not

Impair the prior rights of others, regardless of the amount or season named in the permit. The holder of the permit likewise must defend the right if it is attacked by others. A water right is a property right, and the owner has the same obligation to defend it against encroachment as in the case of any other kind of property.

## OUTLINE OF ESSENTIAL STEPS

The California Water Code and the regulations adopted pursuant thereto prescribe a definite procedure for the initiation and consummation of rights to appropriate water by permit. The essential steps are as follows:

Appropriation bv Permit:

1. An application is filed with SWRCB on forms provided. If the application is not complete, failure to complete it within the time allowed by the SWRCB will result in cancellation.

2. Notice of application is issued by the SWRCB and is posted or published by the applicant, depending on the size of the project.

3. If protests are received which cannot otherwise be adjusted, a hearing or an investigation under a proceeding in lieu of hearing is held. At the discretion of the SWRCB, a hearing also may be held on an unprotested application.

4. The application is reviewed and analyzed for possible environmental impacts as required by the California Environmental Quality Act of 1970.

5. If an application is approved and permit fees paid, a permit is issued. A reasonable time is allowed within which to begin construction of the diversion works, complete the construction, and make full beneficial use of the water. These times may be extended upon request if there are good reasons for doing so. Failure to comply with the time requirements or other-permit terms will be investigated by the SWRCB, and findings against the permittee may result in revocation of the permit.

All permits are issued SUBJECT TO PRIOR RIGHTS, and the permittee is required to respect all prior rights when diverting under the permit.

6. When construction and use of water are complete to the full extent contemplated, an inspection is made for possible issuance of a license. To the extent that beneficial use of the water has been made, as to both amount and season as specified in the terms and conditions of permit, a license may be issued.

A license has no time limit and continues as long as proper use is made for the water and required reports are submitted.

Statutes provide that, under certain conditions, a license may be lost through a five-year period of nonuse.

Appropriation by Registration:

l. Forms to file for appropriation of water by registration are provided by the SWRCB.

2. The Environmental Services Supervisor for the California Department of Fish and Game region in which the diversion will be located (map, address, and telephone number are included on the form) is contacted to discuss the proposed project and to obtain answers to the questions contained on the Fish and Game Information form.

3. Registration forms are filed with both the State Water Resources Control SWRCB and the regional office of the California Department of Fish and Game.

4. If the registration is complete, fees have been paid, and written approval has been received from both the SWRCB and the California Department of Fish and Game, construction of the project may begin and diversion of water made.

5. If the forms are not complete, failure to complete them within the time allowed by the SWRCB will result in the return of all materials and fees.

## PREPARATION OF APPLICATIONS

The SWRCB publishes a pamphlet entitled, "How to File an Application/Registration to Appropriate Water in Californians which will be of assistance in completing the blanks of an application form. When an application fails to comply with provisions of the California Water Code, the application will not be accepted for filing.

## CHANGES IN OWNERSHIP

The SWRCB must be able to communicate with a registrant, applicant, permittee, or licensee. Any changes in ownership or address therefore should be submitted promptly to the SWRCB.

The SWRCB will not settle contests as to ownership but will accept any ownership claim, which is asserted unless the owner of record or an asserted successor objects. In case of contest the SWRCB's record will not be changed until the matter is settled by agreement or by a court decision.

## APPENDIX - TABLE OF EQUIVALENTS

1 CUBIC FOOT PER SECOND (cfs) is a rate of flow passing any point equal to a volume of one cubic foot of water every second (sometimes referred to as second-foot) and is equivalent to:

= 7.48 U.S. gallons per second (gps)
= 448.8 U.S. gallons per minute (gpm)
= 646,317 U.S. gallons per day (gpd)
= 1.98 acre-feet per day
= 40 standard (statute) miners' inches
= 28.32 liters per second

1 ACRE-FOOT (af) is the amount (volume) of water which will cover one acre to a depth of one foot and is equivalent to:

= 43,560 cubic feet
= 325,851 U.S. gallons
= 1,233.45 cubic meters

1,000,000 U. S. GALLONS PER DAY is equivalent to:

= 1.55 cubic feet per second
= 43.81 liters per second
= 3.07 acre-feet per day
= 3,786 cubic meters per day

THEORETICAL HORSEPOWER is calculated by multiplying the vertical fall of water in feet by the rate of waterflow in cubic feet per second and dividing the product by 8.8. One horsepower is equivalent to:

= 550 foot-pounds per second
= 746 watts

# Appendix B

United States Bureau of Land Management, California Water Rights Fact Sheet

# California

## WATER RIGHTS FACT SHEET

## August 15, 2001

**Water Rights System:**

California's system of water rights is referred to as a "dual system" in which both the riparian doctrine and the prior appropriation doctrine apply to water rights. There is also a separate doctrinal basis for ground water, as well as pueblo rights, so a more accurate classification of California's system would be a "plural system". Water rights in California are use rights. All waters are the property of the state. A water right in California is a property right allowing the use of water, but it does not involve ownership of the water. California's water law is contained in the California Code of Regulations, Title 23, and can found at: http://www.calregs.com/.

Riparian rights result from the ownership of land bordering a surface water source (a stream, lake, or pond). As a class, these rights are senior to most appropriative rights, and riparian landowners may use natural flows directly for beneficial purposes on riparian lands without applying for a permit (see Appendix One for Attributes of Riparian Rights).

Appropriative rights are acquired by putting surface water to beneficial use. Prior to 1914, appropriative rights could be claimed by simply diverting and using the water, posting a notice of appropriation at the point of diversion, and recording a copy of the notice with the County Recorder. Since 1914, the acquisition of appropriative rights has required an application through the State Water Board.

In addition to riparian and appropriative rights, California recognizes pueblo rights. These rights are derived from Spanish law whereby Spanish or Mexican pueblos could claim water rights. As a result, pueblo rights are paramount to the beneficial use of all needed, naturally occurring surface and subsurface water from the entire watershed of the stream flowing through the original pueblo. Water use under a pueblo right must occur within the modern city limits, and excess water may not be sold outside the city. The quantity of water available for use under a pueblo right increases with population and with extensions of city limits. In general pueblo rights are limited to use of water for ordinary municipal purposes.

*Responsible agency:*

Responsibility for water in California is shared among several agencies. The State Water Resources Control Board (State Water Board) is responsible for the water rights and water quality functions of the state. They have the jurisdiction to issue permits and licenses for appropriation from surface and underground streams. The board also has the authority to declare watercourses fully appropriated. The California courts have jurisdiction over the use of percolating ground water, riparian use of surface waters, and the appropriate use of surface waters initiated prior to 1914. The Department of Water Resources is responsible for planning the use of state water supplies, and develops, in consultation with the California Water Commission, rules and regulations for this purpose.

**Application Process:**

Any entity intending to appropriate water is required to file an application for a water right permit (or a use registration for small scale domestic use) with the State Water Board. A list of available applications can be seen in Appendix Two. A permit is not required from riparian right holders, ground water users, users of purchased waters, or those who use water from a spring or standing pool lacking a natural outlet on the land they are located. Once the application or registration has been accepted, a priority is established in relation to other appropriators. For domestic registration, the State Water Board provides a Certificate of Registration which establishes general conditions under which the diversion may be made. When an application for a water right permit is filed, public notice is given to interested parties. This indicates an opportunity to file protests against the proposed application. If differences cannot be resolved, either a field investigation (for small applications requesting 3cf or 200 acre-feet per year) or a State Water Board hearing is conducted.

An application for a new water appropriation is approved if it is determined to be for a useful or beneficial purpose and if water is available for appropriation. In evaluating an application, the Board considers the relative benefits derived from the beneficial uses, possible water pollution, and water quality. If a permit is approved, it may be approved in full or it may be subject to specified conditions. A decision or order from the State Water Board is reviewable by the Superior Court. Once the State Water Board issues a permit, the use and diversion of water is authorized (see Appendix Three for a summary of the steps to obtain a permit).

Once the permittee completes the necessary works, the water is put to full beneficial use, and all terms and conditions are met, a license is issued. The license is the final confirmation of an appropriative right and it remains in effect as long as the license conditions are met and the water is put to beneficial use.

The time frame involved in obtaining a license in California is highly variable. Permit decisions are required to be reached within six months on accepted applications for non-protested projects which do not require extensive environmental review. Applications with unique requirements for environmental review and/or require protest resolution, may extend the time frame by months and even years.

*Point of Diversion and Change of Use Procedures:*

In 1928, the California Constitution was amended to require reasonable diversion and use in the exercise of all water rights. The only exception to the point of diversion requirement is for instream flow rights. The State Water Board and the courts have concurrent jurisdiction to apply and enforce diversion and use requirements. The holder of an appropriative right may change the point of diversion, place of use, or purpose of use, so long as other rights are not injured by the change. In order to change an attribute of a water right in California, a change application must be filed with and approved by the State Water Board. Change applications follow the application process described above.

*State Recognized Beneficial Uses:*

Beneficial uses in California include the following:

* Aquaculture - Raising fish or other aquatic organisms not for release to other waters.
* Domestic - Water used by homes, resorts, or campgrounds, including water for household animals, lawns, and shrubs.
* Fire Protection - Water to extinguish fires.
* Fish and Wildlife - Enhancement of fish and wildlife resources, including raising fish or other organisms for scientific study or release to other waters of the state.
* Frost Protection - Sprinkling to protect crops from frost damage.

* Heat Control - Sprinkling to protect crops from heat.
* Industrial Use - Water needs of commerce, trade, or industry.
* Irrigation - Agricultural water needs.
* Mining - Hydraulicking, drilling, and concentrator table use.
* Municipal - City and town water supplies.
* Power - Generating hydroelectric and hydromechanical power.
* Recreation - Boating, swimming, and fishing.
* Stockwatering - Commercial livestock water needs.
* Water Quality Control - Protecting and improving waters which are put to beneficial use.

**Groundwater:**

The vast majority of California's groundwater is unregulated. The state does not have a comprehensive groundwater permit process to regulate ground water withdrawal. There are three legally recognized classifications of groundwater in California: subterranean streams, underflow of surface waters, and percolating groundwater. Subterranean streams and underflow of surface waters are subject to the laws of surface waters and are regulated by the State Water Board. Percolating groundwater, on the other hand, has few regulation requirements.

Percolating groundwater has two subclassifications: overlying land use, and surplus groundwater. Land owners overlying percolating groundwater may use it on an equal and correlative basis. This means that all property owners above a common aquifer possess a shared right to reasonable use of the groundwater aquifer. These rights are similar to riparian rights and since they are correlative, a user cannot take unlimited quantities without regard to the needs of other users. Surplus groundwater may be appropriated for use on non-overlying lands, provided such use will not create overdraft conditions. A permit is not required to use percolating groundwater of either classification, but the appropriation of surplus groundwater is subordinate to the correlative rights of overlying users.

**Water Rights:**

Water rights in California can be held by any legal entity. There are no restrictions on who can hold water rights, thus the owner can be an individual, related individuals, non-related individuals, trusts, corporations, government agencies, etc.. Water rights are considered real property (they can be owned separately from the land on which the water is used or diverted) and can be transferred from one owner to another, both temporarily or permanently. Any transfer (sale, lease, or exchange) is subject to approval by the State Water Board through the application process discussed above. Approval is granted upon finding that the transfer would not result in injury to any other water right and would not unreasonably affect fish, wildlife, or other instream beneficial use.

An appropriative water right in California can be maintained only by continuous beneficial use, and can be lost by five or more continuous years of non-use. Riparian rights, on the other hand, cannot be lost through non-use. Appropriative rights can also be lost through abandonment, but to constitute abandonment of an appropriative right, there must be the intent not to resume the beneficial use of the water right. As a result, abandonment is always voluntary. The rights to waters lost through abandonment or non-use revert to the public, but only after notice has been given and a public hearing is held.

**Adjudications:**

In California, adjudication can be initiated through the court or through statutory procedures. Court initiated adjudication occurs when a water right lawsuit is filed in court (all surface and ground water rights may be included in this procedure). In the case of a court initiated adjudication, the court often asks the State Water Board to act a referee and to conduct an investigation and report back. Statutory adjudications result when one or more entities claim a

right from a specific source and file a petition with the State Water Board. The statutory procedure can be used to determine all rights to any body of water including percolating groundwater. The result of a statutory adjudication is a decree that integrates all rights on the water source and sets quantity, season, priority, etc..

*Ongoing Adjudications:*

As of 2000, sixteen basins in California had been adjudicated.

**Instream flows:**

In 1991, California adopted changes to its water laws which permitted the transfer of existing consumptive water rights to the purpose of instream flow. These transfers can be made for the purposes of enhancing wetlands habitats, enhancing fish and wildlife resources, or increasing recreation on the water. California law allows transfers to be either permanent or temporary changes in use; therefore instream flow rights can be both purchased and leased. New instream flow rights retain the priority date of the original right.

California state law does not permit new appropriations of water for instream flow. The State Water Board may attach conditions requiring bypass flows to new consumptive use appropriations, but these conditions do not constitute newly appropriated instream flow rights. When a new water use permit application is submitted, the State Water Board must notify the Department of Game an Fish, which has the authority to recommend amounts of water necessary to preserve fish, wildlife, and recreation in the affected stream. The board then considers these recommendations and may set instream flow requirements as conditions for the new permit. In this way, current flows can be protected even though new appropriations for instream flow rights are prohibited.

*Recognized Beneficial Uses for Instream Flow:*

Recognized beneficial uses of instream flow in California include enhancing wetlands habitat, enhancing fish and wildlife resources, increasing recreation on the water, and protecting water quality.

*Holdership of Instream Flow Water Rights:*

Under California law, any "person" (public or private) may hold an instream flow right, as long as that right was established through a legal transfer.

**BLM Specific Information:**

The application process in California has proven to be expensive for the BLM. For the appropriation process, the BLM pays $1050 which includes the following: $100 application fee, $850 environmental filing fee, and $100 upon issuance of the permit. Since 1991, water right applicants have been required to pay an $850 environmental filing fee to the California Department of Fish and Game (CDFG) with each application. This is a concern for the BLM because the CDFG's review is redundant to the BLM's NEPA process. The 1991 memo introducing the fee states that "these fees are not intended to reimburse costs specifically identifiable to individual projects, but rather to offset a relative portion of the cumulative effect of all projects". Therefore the BLM cannot request a waiver of this fee. In terms of other water rights applicants, the BLM is required to approve the necessary right-of-ways prior to the approval of the application by the state.

The BLM is not currently involved in any of California's adjudications. In the past, however, the BLM has been involved in the Eagle Lake and Alturas adjudications.

Regarding federal reserved water rights, the BLM California holds a number of PWRs. In order to assert a PWR 107 or other PWR, the BLM provides notice to the State of California. In the past 15 years, there have been relatively few PWR assertions in California and the extent of unasserted PWRs is unknown. There are a number of PWRs that are included in the Master Title Plans on BLM lands, and these probably originated from assertions made before the early 1980's. The BLM does not have any federal reserved water rights on Wild and Scenic Rivers or on wilderness areas in California.

The relationship between the BLM and the State of California is very close and cooperative. The staff of the Division of Water Rights have ben especially helpful to the BLM in interpreting the details involved in each particular water right decision. The staff has a practical mind set and helps the BLM achieve their goals. The BLM also commonly assists the state in their capacity surveys for the BLM reservoirs which are moving from permit to licence. This has expedited the process. The state has also been quite receptive to suggestions from the BLM for streamlining some of the water right reporting requirements.

**Official Contact:**
State Water Resources Control Board
Division of Water Rights
1001 I Street
Sacramento, CA 95814
916-341-5300
http://www.waterrights.ca.gov/
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**Appendix One: Attributes of Riparian Rights:**

* Riparian rights are of equal priority.
* Unless adjudicated, the right is not quantified, rather it extends to the amount of water which can be reasonably and beneficially used on the riparian parcel.
* Riparian rights are correlative. During times of water shortage, the riparian proprietors share the shortage.
* Water may be used only upon that portion of the riparian parcel which is within the watershed of the water source.
* The riparian right does not extend to seasonal storage of water.
* The riparian right is part of the riparian land and cannot be transferred for use on other lands.
* The riparian rights remains with the land when riparian lands are sold.
* When riparian lands are subdivided, parcels which are severed from the adjacent water source lose their riparian rights, unless the rights are reserved.
* A riparian right is not lost by non-use.

**Appendix Two: Types of Applications**

* Water Right Application Form
* Environmental Information Form
* Notice of Assignment Form
* Agent Assignment Request Form
* Application Protest Form
* Cancellation of Application Form
* Registration Form
* Notice of Assignment Form
* Complaint Form
* Answer to Complaint Form
* Petition for Extension of Time Form
* Petition for Correction Form
* Petition for Change Form
* Petition for Change in Distribution of Storage Form
* Petition for Protest Form
* Notice of Assignment Form
* Request for Revocation Form
* Petition for Temporary Permit Form
* Petition for Temporary Urgency Change Form
* Temporary Transfer
* Long term Transfer
* Wastewater Change Petition Form

**Appendix Three: Steps to Obtain a Permit**

| Step | Board's Role | Applicant's Role |
|---|---|---|
| **File Application** | If you need assistance Board engineers will help you prepare application forms, small project maps, and other documents. Incomplete applications won't be accepted. | You prepare an application which meets specific requirements, including a filing fee. |
| **Acceptance of Application** | Board notifies you within 30 days that either your application is incomplete or that it has been accepted. Acceptance of your application establishes your priority as the date of filing. | Unless you are granted an extension, you must provide any additional information requested by the Board within 60 days of notification. If not, your application may be canceled. |
| **Environmental Review** | Your proposed project is assessed to determine to what extent it could alter the environment. | You assume cost for preparation of any required environmental studies. |
| **Public Notice** | The Board will send you a public notice describing your proposed project. Copies of the notice are also sent to known interested parties and to post offices in the area of your project for posting. | For small projects, you must post the notice for 40 consecutive days in two conspicuous places near your project site. For large projects, you must publish the notice in a newspaper at least once a week for three consecutive weeks. |
| **Protests** | During the noticing period, the Board may receive protests against your proposed project from interested individuals or groups. | If protests are filed against your application, you must respond to them in writing and attempt to reach agreements so that protests can be withdrawn. |
| **Hearings** | If protests cannot otherwise be resolved, you and the protestant present your cases at a field investigation or during a hearing conducted by the Board. The Board issues a decision on protested applications based on information gathered at the field investigation or on evidence presented during the hearing. | You prepare testimony and exhibits for presentation at the hearing and cooperate with the Board and protestant toward reaching a satisfactory resolution. |
| **Permit Issuance** | A water right permit is issued when protests, if any, are resolved or dismissed, or when the Board approves the application by decision following a hearing. In addition, a permit fee must be paid. During this phase, the Board determines whether water conservation measures are needed. | Prior to issuance of a permit, you must submit a permit fee as directed by the Board. If water conservation measures are required, they will be included as a condition of your permit |

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# Appendix C

## A Summary of California Law of Surface Water and Groundwater Rights

BARTKIEWICZ, KRONICK & SHANAHAN

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# A SUMMARY OF THE CALIFORNIA LAW OF SURFACE WATER AND GROUNDWATER RIGHTS

Set forth below is a brief discussion of the California law of surface water and groundwater rights, including provisions for transfer of different types of water rights and entitlements. These are general provisions. Please consult an attorney regarding specific water right issues. The State Water Resources Control Board's ("State Board") website (http://www.waterrights.ca.gov/WRINFO/) includes publications that provide additional information on California water rights.

## 1. Reasonable and Beneficial Use Doctrine

Article 10, section 2 of the California Constitution (enacted in 1928) prohibits the waste of water, and requires reasonable use, method of use and method of diversion for all surface and groundwater rights. The doctrine of reasonable and beneficial use is the basic principle defining California water rights: that no one can have a perpetual interest in the unreasonable use of water, and that holders of water rights must use water reasonably and beneficially. (See also Water Code section 275: "The department [of water resources] and [state water resources control] board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state.")

## 2. Riparian Rights

Riparian water rights are rights that an owner of land contiguous to a natural stream possesses to divert the naturally-available supply directly to use, without artificial storage, for reasonable, beneficial purposes on that riparian land. Riparian land is the smallest parcel of such contiguous land, in a single chain of title from the original private owner, that is within the watershed of the stream. The right arises by virtue of ownership of the riparian land, and is not gained by use nor lost by nonuse. Generally, the riparian right is superior to the other types of surface water rights, but the riparian right does not apply to water that is stored for later use. The riparian right may be junior to an appropriative water right that was perfected before a patent on


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the riparian land was issued by the United States. The riparian rights of owners of land that are riparian to the same source are "correlative," in that, if there is insufficient water under the riparian right for all riparians, each is entitled to a fair share of the available supply based upon the amount of their land and their reasonable water supply needs.

Where interests in the riparian parcel are conveyed or the riparian parcel is subdivided, the riparian right as to any subparcel that is no longer contiguous to the source of water may be severed, absent the intent to retain the riparian nature of the severed parcel.

### 3. Appropriative Rights

Appropriative rights to surface water are rights to use unappropriated water, that is, water that is surplus to the needs of riparian owners and prior appropriators and prescriptors. Appropriative rights are based not on land ownership, but on actual diversion and use of water. They are rights of priority, in that, if the available surface water supply is insufficient to meet the needs of all appropriators, the one with the earliest priority date is entitled to satisfy his or her needs fully before those with later priority are entitled to any water. An appropriative right may be established to use water for any reasonable, beneficial purpose on any land no matter where located, and to store water from one season for use in a later season, or from one year for use in subsequent years. Just as appropriative rights are gained by use, conversely, once acquired, they may be lost wholly or in part by five years' nonuse during a time when the water was physically available for use.

Prior to 1914, appropriative rights could be acquired simply by posting or filing a notice, and then diverting and using the water for reasonable, beneficial purposes (referred to as "pre-1914 water rights"). Since 1914, California statutory law has required that an application be filed and a permit obtained from a State agency, now the State Water Resources Control Board. The State Board has the discretion to decide whether unappropriated water exists, and whether the proposed use under the application is reasonable, beneficial and in the public interest. If the State Board finds affirmatively on these issues, it can issue a permit, and then, after the diversion and use facilities have been constructed and the water appropriated has been fully put to beneficial use within the time allowed, the State Board can issue a license confirming that the water right has been perfected by use for the amount used.

Under Water Code sections 5100 through 5108, the holder of an appropriative water right is required to file periodic statements with the State Board of diversion and use of water under the water right. Under section 5108, these statements are for informational purposes only, and neither the failure to file a statement nor any error in information filed will have any legal consequence. From time to time, the State Board has proposed amendments to these provisions that would require filing the statements of diversion and use as a condition to retaining the water


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right.

### 4. Prescriptive Rights to Surface Water

Prescriptive water rights are created by five years' open and notorious use of water under a claim of right that is adverse to one or more existing prior rights: riparian, appropriative or prescriptive. (But see, *People v. Shirokow* (1980) 26 Cal.3d 301, which held that prescriptive rights could not be obtained against the State's interest in allocating water in the public interest.) The use must be reasonable and beneficial. As in the case of appropriative rights, a prescriptive water right can be established for use on any land, and water can be diverted directly to use or stored for later use. Prescriptive rights, however, cannot be acquired against public agencies or public utilities. Prescriptive rights, like appropriative rights, can be lost by five years' nonuse.

### 5. The Public Trust Doctrine

In *National Audubon Society v. Superior Court* (1983) 33 Cal.3d 419, the California Supreme Court held that the State, in accordance with Article 10, section 2 of the State Constitution, as trustee of the "public trust," retains supervisory control over all the State's waters to protect navigation, fishing, recreation, ecology and aesthetics. No person has a vested right to appropriate water in a manner harmful to the interest protected by the public trust. "Once the State has approved an appropriation, the public trust imposes a duty of continuing supervision over the taking and use of the appropriated water. In exercising its sovereign power to allocate water resources in the public interest, the State is not confined by past allocation decisions which may be incorrect in light of current knowledge or inconsistent with current needs. The State accordingly has the power to reconsider allocation decisions. . . . No vested rights bar such reconsideration."

### 6. The County of Origin Law (State Filings)

In the 1920's and 1930's, the State legislature adopted legislation authorizing massive applications by the State for future water development projects. In order to attempt to allay the fears of areas from which water projects might transfer water, the legislature passed certain "area of origin" laws. Specifically, in 1931 the legislature passed the County of Origin Law (Water Code section 1055), and in 1933 the legislature adopted the Watershed Protection Law (Water Code sections 11460 – 11463), which is discussed in the next section of this document.

The State, acting through the Department of Water Resources ("DWR," and previously the Department of Finance), is authorized to appropriate water (and has done so) for future water projects (known as "State filings"). (See Water Code sections 10500 - 10507.) The State Board is authorized to release from priority or assign these State filings to other agencies or entities when the release or assignment is for the purpose of development not in conflict with the State water plan. (Water Code section 10504.) Under the County of Origin Law, the State Board is


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expressly prohibited from assigning or releasing the priority when, in its judgment, the effect could be to deprive the county in which the water originates of water necessary for its development. (Water Code section 10505.)

The legislative intent and effect of section 10505 was to provide protection for the future interest of the counties of origin by placing restrictions on the authority of the State to transfer or dispose of the priorities vested in the State by filing applications to appropriate unappropriated water. (25 Ops.Cal.Atty.Gen. 8, 15 (1955).) Section 10505 applies only to applications filed by the State. The county of origin provisions do not apply to water rights that are not based on assignment or release of a State filing.

**7. The Watershed of Origin Protection Act ("Area of Origin Act")**

The "Watershed of Origin Protection Act" (Water Code sections 11460 – 11465, sometimes referred to as the "area of origin law") operates to protect the priority of water rights within the watershed against State export rights in two major ways: (a) by giving protected areas a preferential right to contract for State-developed water, and (b) by allowing later upstream developments within the watershed to obtain priority as against the State's projects. Water Code section 11460 states: "In the construction and operation by the department of any project under the provisions of this part a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom, shall not be deprived by the department directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein."

The area of origin law does not entitle protected areas to State-developed water free of charge, nor does it allow the protected areas to gain any priority against entities other than the State who may export water out of the watershed. Area of origin rights are not transferable to an area outside the area of origin. The area of origin law does not create any hierarchy of preference between areas included within the same watershed. The Central Valley Basin contains two watersheds: one comprising the Sacramento River and its tributaries down to and through the Delta, and another comprising the San Joaquin River and its tributaries. (29 Ops.Cal.Atty.Gen. 136 (1957).)

The United States must comply with the area of origin law when it seeks a priority established under a state filing (Water Code section 10500). (See 25 Ops.Cal.Atty.Gen. 8, 28 - 29 and Water Code section 10505.5: "Every application heretofore or hereafter made and filed pursuant to section 10500 . . . shall provide that the application, permit or license shall not authorize the use of any water outside the county of origin which is necessary for the development of the county." Under Water Code section 11128, the area of origin law applies to


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the operation of the federal Central Valley Project. (See also, *California v. United States* (1978) 438 U.S. 645.)

### 8. The Delta Protection Act

Article 4.5 of Division 6 of the Water Code (commencing with section 12200) sets forth the Delta Protection Act, which provides a first priority to provision of salinity control and maintenance of an adequate water supply in the Sacramento-San Joaquin Delta ("Delta") Delta for reasonable and beneficial uses of water, and relegates to lesser priority all exports of water from the Delta to other areas for any purpose.

### 9. Groundwater Rights

Groundwater rights attach to percolating groundwater, which includes all groundwater that does not comprise a subsurface stream or the underflow of a surface stream. An underground stream is a stream or river flowing in a definite channel in an underground watercourse. The underflow of a surface stream is the water in the soil, sand and gravel comprising the bed of a stream in its natural state and essential to its existence. Water in a stream's underflow or an underground stream is treated like surface water for legal purposes, including State Board permitting. It usually is in contact with the surface flow, and flows in the same direction. Courts have classified water rights in percolating groundwater as overlying, appropriative or prescriptive. No water right permit is required to pump percolating groundwater.

Overlying groundwater rights are analogous to riparian rights to surface water. Each owner of land that overlies a common groundwater supply has a right to reasonable, beneficial use of the water of that supply on or in connection with the overlying land. The use of each overlying landowner is "correlative" with the rights of all other owners of land overlying the same groundwater supply. In the event of insufficiency of the supply for the requirements of the overlying landowners, the water may be apportioned among them all by a court decree. There is no priority in time among overlying pumpers.

Similar to riparian rights, the transfer of title to an overlying groundwater right, separate from the land, can result in a permanent severance of the right from the land. Once the overlying water right has been severed, the parcel ceases to be an overlying parcel and it loses its overlying groundwater right. One acknowledged way to transfer the right to exercise an overlying right, without causing a severance of the right, is the transfer of the overlying right to a mutual water company, which acts as an agent or trustee of the owners of the overlying right. At least one case has suggested that the right to exercise an overlying right could also be transferred to a public agency or an agent or trustee without resulting in a severance of the right. (See *Orange County Water District v. City of Colton* (1964) 226 Cal.App. 642.)


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Water users that do not use groundwater on their overlying land are not barred from using groundwater. Such water users include public agencies and owners of non-overlying land. They may extract groundwater, but their rights are analogous to appropriative rights to surface water. Unless there has been an adjudication of the groundwater basin rights, their use is limited to surplus water, which is defined as water in excess of the safe annual yield that is not needed for reasonable, beneficial use by the overlying owners. If the basin is in overdraft, use may be restricted to the overlying owners. As between groundwater appropriators, the one first in time is the first in right, and a prior appropriator is entitled to all the water he or she needs, up to the amount he or she has taken in the past, before a subsequent appropriator may take any groundwater.

Prescriptive groundwater rights are not acquired by taking surplus or excess water. An appropriative taking of groundwater that is not surplus is wrongful, and may ripen into a prescriptive right when the use is actual, open and notorious, hostile and adverse to the original owner, continuous and uninterrupted for the statutory period of five years, and under a claim of right. (See, generally, *City of Barstow v. Mojave Water Agency* (2000) 23 Cal.4th 1224.) Prescriptive groundwater rights are most often obtained when someone pumps groundwater during an obvious overdraft condition.

### 10. Groundwater Adjudication

Groundwater rights generally are not quantified unless the groundwater basin is adjudicated. The authority to adjudicate a groundwater basin exists in State courts, and in limited circumstances, with the State Board. In an adjudication, junior groundwater right holders generally try to prove that they have obtained higher priority pumping rights by pumping for at least five years during an overdraft of which the senior groundwater right holders had notice. If the junior right holders prove such a case, then, under the doctrine of "self-help," the senior right holders retain their priority to only as much water as they actually pumped during the relevant period. In such a situation: (1) an overlying landowner's "correlative" right to a reasonable share of a basin's safe yield effectively may be replaced with a right based on its past water usage; and (2) a public agency with only a junior appropriative right may be able to obtain a higher priority. The California Supreme Court has held that Civil Code section 1007 prevents prescription against public agencies' groundwater rights or such rights that a public utility has dedicated to public use. (See *Los Angeles v. San Fernando* (1975) 14 Cal.3d 199; *City of Barstow v. Mojave Water Agency* (2000) 23 Cal.4th 1224; *Hi-Desert County Water Dist. v. Blue Skies Country Club, Inc.* (1994) 23 Cal.App.4th 1723.)

### 11. Conjunctive Use of Surface Water and Groundwater

DWR Bulletin 160-98, *The California Water Plan Update* (November 1998, Volume 2,


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page G-2), defines "conjunctive use" as "the operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the groundwater basin for use by intentionally recharging the basin during years of above-average water supply." Conjunctive use can involve direct recharge or "in lieu" recharge. "In lieu" recharge occurs when someone uses surface water in lieu of pumping groundwater. The storage aspects of the conjunctive operation of a groundwater basin may contemplate both storage of surface water in available basin storage space and increasing pumping from the basin to create additional storage space.

The conjunctive use of surface water and groundwater is favored under California law and policy. (See *Los Angeles v. Glendale* (1943) 23 Cal.2d 68, and *Los Angeles v. San Fernando*, referred to in the previous section.) Water Code section 1242 states that storing water underground, including necessary diversion and spreading operations, is a beneficial use of water if the water stored is later put to beneficial use. Under Water Code section 1005.1, the reduction in the extraction of groundwater by the owner of a right to extract, as result of the use of an alternative supply of water, is deemed to be equivalent to establishing and maintaining a right to extract the groundwater. In other words, a person who reduces his groundwater extraction due to the development of a surface water supply does not diminish, as a result, his groundwater rights.

### 12. Groundwater Management

Although California does not have centralized groundwater regulation, the Legislature has adopted special legislation for the formation of groundwater management districts in various parts of the State, and authorized other local agencies to exercise groundwater management authority. (See, e.g., Water Code sections 10750 through 10755.)

### 13. Water Transfers

#### a. General

The State Board's website (http://www.waterrights.ca.gov/watertransfer/) includes publications that provide additional information on water transfers.

Several sections of the Water Code contain declarations of state policy favoring voluntary water transfers. For example, Water Code section 109 contains a declaration of state policy favoring voluntary water transfers, and directs DWR, the State Board and all other state agencies to encourage voluntary transfers. Water Code section 475 contains legislative findings and declarations favoring voluntary water transfers, states that the coordinated assistance of state agencies is required for voluntary transfers, and directs DWR to establish an ongoing program to facilitate voluntary water transfers.

Several statutory provisions declare that the act of transferring water will not, by itself,


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result in a forfeiture of the underlying water right. For example, Water Code section 1244 states that a water transfer, in itself, will not constitute evidence of waste or unreasonable use, and will not affect any determination of forfeiture of an appropriative right. Water Code section 1745.07 states that no transfer of water pursuant to any provision of law will cause a forfeiture, diminution or impairment of any water right, and that a transfer approved under any provision of law is deemed to be a beneficial use of water by the transferor. (See also, Water Code sections1010, 1011, 1011.5, 1014 - 1017, 1440, 1731 and 1737.)

The transferability of water depends on the source of the water right being transferred. The following provisions of the Water Code provide authority to carry out water transfers: Water Code sections 1011(b) ("Transfer of Conserved Water"), 1020 through 1031 ("Water Leases"), 1435 through 1442 ("Temporary Urgency Change"), 1700 through 1705 ("Permanent Changes"), 1707 ("Transfers for Instream Uses"), 1706 ("Transfer of Pre-1914 Rights"), 1725 through 1732 ("Temporary Transfers"), 1735 through 1737 ("Long-Term Transfers"), 1740 ("Transfer of Decreed Rights") and 1745 through 1745.11 ("Transfers by Water Suppliers"). In addition, the enabling legislation for a number of different types of water districts includes authorization to transfer surplus water. See, for example, Water Code sections 22228 ("Irrigation Districts") and 35425 ("California Water Districts").

#### b. Transfers Under a Riparian Water Right

It is well-settled under California law that a riparian water right is not transferable for use on nonriparian land. (See, e.g., *People v. Shirokow* (1980) 26 Cal 3rd 301, 307.) A riparian owner may, however, enter into a contract under which he or she agrees not to exercise the riparian right for his or her property, so as to increase the downstream water supply. Such an agreement could not prevent a downstream riparian owner from exercising his riparian right. DWR has entered into "water transfer" agreements with riparian landowners in the Delta under which the riparian owner agreed for compensation not to exercise his or her riparian right. Water that was left in the river was pumped from the Delta as part of DWR's Water Bank operations. Under Water Code section 1707, however, riparian rights are among the water rights that may be included within a change petition to the State Board for the purpose of preserving or enhancing wetlands habitat, fish and wildlife resources, or recreation in or on the water. An adjudicated riparian right can be transferred under Water Code section 1740.

#### c. Transfers Under an Appropriative Water Right

An appropriative water right can be sold or transferred off the land by changing the place of use under the right. Under Water Code section 1706, the point of diversion, place of use or purpose of use of a pre-1914 appropriate right can be changed if others are not injured by that change. The transfer or other change involving the exercise of a post-1914 appropriate right


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requires the approval of the State Board under Water Code sections 1020, 1435, 1700, 1707 (for instream uses), 1725 or 1735, and State Board findings that the proposed transfer would not injure legal users or unreasonably effect fish, wildlife or other instream beneficial uses. Under Water Code section 1729, a water transfer under section 1725 for not longer than one year is exempt from the provisions of the California Environmental Quality Act.

#### d. Transfers of Groundwater

There are no general statutory procedures for the transfer of groundwater. Under Water Code section 1220, groundwater may not be pumped for export from the combined Sacramento and Delta-Central Sierra Basins (as defined in DWR Bulletin 160-74), unless the pumping is in compliance with a groundwater management plan that was adopted by ordinance of the county board of supervisors and approved by the voters of the county that overlies the affected groundwater basin. No such plans currently exist. Therefore, groundwater may not be pumped for export from the Delta at the present time. DWR contends that the transfer of groundwater for Delta outflow rather than export purposes would not violate Water Code section 1220.

A number of counties within the Sacramento Valley have adopted ordinances that regulate the direct export of groundwater. One such ordinance has been upheld as a valid exercise of the police power that was not preempted by general state legislation. (See *Baldwin v. County of Tehama* (1994) 31Cal.App.4th 166.)

In groundwater basins that have been adjudicated by a court, the court's judgment often establishes unique conditions concerning the transfer of groundwater rights in the basin.

#### e. Transfers of Water Under a Contractual Entitlement

Under California law, the right to water under a contract or as result of owning land within a water district is not transferable in whole or in part without the consent of the water right holder and the water supplier. (E.g., see Water Code sections 382-383 and 1745.04.) Under section 3405(a) of the federal Central Valley Project Improvement Act (Title 34 of Public Law 102-575), the Secretary of the Interior is authorized to approve an application of an individual water user to transfer his or her federal CVP water entitlement without the consent of the water district that holds the CVP contract under which the water is supplied. However, transfers involving more than twenty percent of the CVP water subject to a long-term contract within a contracting district or agency is also subject to review by the district or agency under the provisions specified in Section 3405(a)(1) of the CVP Improvement Act.

#### f. Transfers by Public Agencies

In addition to the provisions discussed above that deal with the ability to transfer water under different types of water rights, there are numerous statutory provisions that deal with the


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authority of public agencies to transfer water. Before a public agency undertakes a water transfer, it must determine that it has authority in its enabling legislation, or elsewhere, to transfer water for use outside its boundaries. Water Code sections 382 and 1745 - 1745.11 provide alternative sources of authority for a public agency to transfer surplus water for use outside of its boundaries. Under Water Code section 1745.10, surface water that is transferred under these provisions may not be replaced with groundwater unless such groundwater use is consistent with a groundwater management plan adopted pursuant to State law for the affected area, or the substitution of groundwater was approved by the transferring agency after it determined that the transfer would not create or contribute to conditions of long-term overdraft in the affected groundwater basin. The transfer would also have to be carried out in compliance with applicable procedural requirements, such as under Water Code sections 1706 or 1725.

#### g. Determining What Water Is Transferable - The "No Injury" Rule

An important element of any water transfer is determining what quantity, if any, of the water is "transferable," as a result of the application of provisions of the Water Code that are intended to protect other legal users of water and fish and wildlife from the possible adverse effects of a water transfer. The "no injury" rule originates in the common law, and also is reflected in Water Code provisions intended to protect legal users of water from injury from a water transfer. (See, e.g., Water Code sections 1702, 1706 and 1725.) Under the no injury rule, a water transfer would not be authorized to the extent that it reduced the availability of water for downstream users, regardless of the water priority of those users. Under the no injury rule, only "new water" is transferable, i.e., water that is added to the downstream water supply as a result of the transfer. The rationale for the "no injury" rule is as follows: ". . . California water law protects senior water users (those with the oldest water rights) from junior diverters while protecting junior water right holders from the expansion of senior water rights. Junior water right holders would be harmed if seniors could increase the amount of water they divert under their senior priority. Likewise, juniors could be hurt if seniors could change their point of diversion, place of use or purpose of use in a manner that reduces the quantity or quality of water relied upon by juniors for their diversion. The 'no injury' rule protects junior right holders against this kind of harm from senior right holders." (See *A Guide to Water Transfers*, July 1999, pages 3-7 and 3-8, published by the State Board.) Under section 3405(a)(1)(M) of the CVP Improvement Act, however, one CVP contractor can transfer unused entitlement under its CVP water supply contract to another CVP contractor for use within the watersheds of origin.

#### h. Transfers of Conserved Water

Under Water Code section 1011, the right to the use of water that has been reduced as a result of water conservation efforts may be transferred pursuant to any provision of law relating to the transfer of water. For purposes of this section, "water conservation" means the use of less


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water to accomplish the same purpose of use allowed under the existing appropriative water right. In order to obtain the benefits of this section, the water right holder must file periodic reports with the State Board that describe the extent and amount of the reduction in water use due to the water conservation efforts.

On December 28, 1999, the State Board issued Order WR 99-012, which involved a proposed transfer of conserved water under Water Codes sections 1725 and 1011 involving licensed water rights of Natomas Central Mutual Water Company. The State Board determined that Natomas could transfer the right to use of the amount of water that Natomas would have consumptively used but for Natomas' water conservation efforts, but that a reduction in diversions that did not reduce consumptive use could not be transferred under Water Code section 1725. For example, the State Board said that conservation efforts that reduced diversions from the stream and return flows to the stream by equal amounts would not result in consumptive use savings that could be transferred.

State Board Order WR 99-012 describes the purpose of Water Code section 1011 as follows: "Section 1011 preserves an appropriative water right when less water is used under the right due to water conservation efforts. Essentially, section 1011 requires water to be treated as though it were used, when in actuality the water is conserved. Any reduction or cessation in the use due to conservation efforts is 'deemed equivalent to a reasonable beneficial use....' Thus, the right to use the amount of water conserved is not subject to forfeiture for nonuse. The right thereby protected from forfeiture may be used later if needed. The right to use the water conserved may also be transferred pursuant to other provisions of law authorizing transfers."

The State Board order also points out that, since 1980, the State Board has required licensees to document their conservation efforts in the Report of Licensee form that must be filed with the State Board every three years under 23 California Code of Regulations, sections 847 and 848, and that the failure to fill out the section of the form regarding water conservation would deprive the licensee of the benefits of section 1011. The State Board order also states: "It also merits note that Natomas' failure to report conservation efforts in a timely manner called into question the credibility of its claim to have conserved water. Late reporting raises the question whether the nonuse of water was in fact due to conservation efforts, or if the water user is attempting to characterize nonuse that occurred for some other reason as water conservation in order to obtain the protections of section 1011. Conversely, reporting water conservation in a timely manner, while insufficient in itself to prove water conservation, would tend to support a claim that the nonuse of water was the result of water conservation efforts. For this reason, it is in every water user's best interest to report water conservation efforts in a timely manner."

#### i. Use of Conveyance Facilities for a Water Transfer

As a practical matter, State Water Project and federal Central Valley Project facilities are often needed to convey transfer water to the place of use of the transferee, such as for through-


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Delta transfers. Water Code sections 1810-1814 authorize joint use of unused capacity in water conveyance facilities, requiring the state, regional and local public agencies that own water conveyance facilities to make available up to seventy percent of their unused capacity for a bona fide water transfer upon payment of fair compensation, and so long as: (1) no legal user of water would be injured; (2) there would be no unreasonable effect on fish, wildlife or other instream beneficial uses; and (3) there would be no unreasonable effect on the overall economy or the environment of the county from which the water is being transferred. Use of CVP facilities to convey non-CVP water would require a Warren Act contract with the United States (43 U.S. Code sections 523-525 and 2212), which would include provisions to compensate for use of federal facilities and to ensure that the transfer does not interfere with the operation of federal facilities.

### j. Third-Party Impacts from a Water Transfer

There has been confusion from time to time regarding the terms used to refer to potential impacts to others resulting from a proposed water transfer. There generally are three types of potential impacts: (1) injury to legal users of water; (2) unreasonable effects on fish, wildlife or other instream beneficial uses; and (3) unreasonable effects on the overall economy of the area from which the water would be transferred.

The requirement to avoid impacts to "legal users" (discussed above) is set forth in various provisions of existing law. For example, see Water Code section 386 (as to State Board approval of certain water transfers), section 1706 (as to a transfer under a pre-1914 water right), section 1707 (as to a transfer for instream uses), section 1727 (as to a temporary transfer under a water right permit), section 1736 (as to a long-term transfer under a water right permit) and section 1810 (as to determinations of DWR concerning use of surplus conveyance capacity).

The requirement to avoid unreasonable effects on fish, wildlife or other instream beneficial uses is also set forth in various provisions of existing law. For example, see Water Code section 386, section 1707, section 1727, section 1736 and section 1810.

The requirement to avoid unreasonable effects on the overall economy of the area from which the water would be transferred (what is commonly referred to as "third-party economic impacts") is provided for in more limited situations. Water Code section 386 has such a provision, but it is in a chapter on State Board approval of water transfers that is rarely used. Water Code Sections 1725 through 1732 are in the chapter that is generally relied on for State Board approval of a temporary water transfer (i.e., for a term of less than one year), and section 1727 requires the State Board to consider only impacts to legal users and instream uses (i.e., the State Board is not authorized to consider third-party economic impacts). The same section 1727 requirements are also contained in section 1736 for approval of a long-term water transfer.


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Water Code Section 1810(d) requires DWR, however, to consider all three types of impacts (i.e., to legal users, to instream uses and to the economy of the area from which the water would be transferred) in determining whether to allow use of its surplus water system conveyance capacity for a water transfer.

Generally, transfer water is developed through four methods: (1) surplus water released from storage facilities; (2) substituting groundwater for transferred surface water; (3) fallowing agricultural land to make water available for transfer; and (4) undertaking conservation activities that develop surplus water (e.g., under Water Code section 1011). Transfers from storage and transfers resulting from conservation activities have little or no likelihood to cause third-party economic impacts because these types of transfers do not affect crop production or groundwater pumping. Therefore, it would not seem necessary or appropriate to require an analysis of potential third-party impacts from these two types of transfers.

There are other provisions of existing law that have the effect of limiting the extent to which water transfers that involve land fallowing or groundwater substitution would cause third-party economic impacts. For example, Water Code section 1745.05 (which authorizes water suppliers to transfer surplus water) puts a limit on the amount of land that may be fallowed in connection with a water transfer. Subdivision (b) of this section states: "The amount of water made available by land fallowing may not exceed 20 percent of the water that would have been applied or stored by the water supplier in the absence of any contract entered into pursuant to this article in any given hydrological year, unless the agency approves, following reasonable notice and a public hearing, a larger percentage."

Water Code section 1732 states that a petition for State Board approval of a temporary water transfer that involves the increased use of groundwater to replace transferred surface water must be in compliance with Water Code sections 1745.10 and 1745.11. Sections 1745.10 and 1745.11 generally require a water supplier that increases the use of groundwater to replace transferred surface water to determine that the groundwater use: (1) would be consistent with a groundwater management plan adopted pursuant to State law for the affected area; or (2) would not create or contribute to conditions of long-term overdraft in the affected groundwater basin.

Section 3405 of the federal Central Valley Project Improvement Act (Title 34 of Public Law 102-575) includes provisions that would limit the amount of federal water that a water district could transfer. For example, subsection (a)(1) states in part: "Transfers involving more than 20 percent of the Central Valley Project water subject to long-term contract within any contracting district or agency shall also be subject to review and approval by such district or agency under the conditions specified in this subsection … [including a determination by the Secretary of Interior that the transfer would have no significant long-term adverse impact on groundwater conditions]."

### k. Environmental Review of Water Transfers


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In general, water transfers are subject to compliance with the requirements of the California Environmental Quality Act and the National Environmental Policy Act, to the extent applicable. Water Code section 1729 provides an exemption from compliance with CEQA for temporary water transfers under Water Code sections 1725 through 1732.

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# Appendix D

## Application for License for Diversion and Use of Water

STATE OF CALIFORNIA
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

**DIVISION OF WATER RIGHTS**

# License for Diversion and Use of Water

APPLICATION XXXXX PERMIT XXXXX LICENSE **XXXXX**



**THIS IS TO CERTIFY, That**

Name
Address
City, State, Zip

have made proof as of **November 3, 1994** (the date of inspection) to the satisfaction of the State Water Resources Control Board (SWRCB) of a right to the use of the waters of **two Unnamed Streams in Shasta County**

tributary to **Montgomery Creek thence Pit River thence Shasta Lake**

for the purpose of **Irrigation, Stockwatering, Recreational, Wildlife Enhancement, and Fire Protection uses**

under Permit **17974** of the SWRCB; that the right to the use of this water has been perfected in accordance with the laws of California, the Regulations of the SWRCB, and the permit terms; that the priority of this right dates from **October 17, 1979**; and that the amount of water to which this right is entitled and hereby confirmed is limited to the amount actually beneficially used for the stated purposes and shall not exceed **a total of twenty (20) acre-feet per annum to be collected from January 1 to March 31 of each year as follows: (1) 12 acre-feet per annum in Reservoir No. 1, and (2) 8 acre-feet per annum in reservoir No. 2. The maximum withdrawal in any one year from Reservoir No. 1 shall not exceed 3 acre-feet.**

The capacities of Reservoir No. 1 and Reservoir No. 2 covered by this license shall not exceed 12 acre-feet and 8 acre-feet, respectively.

After the initial filling of Reservoir No. 2, licensee's right under this license extends only to water necessary to keep the storage reservoir full by replacing water beneficially used and water lost by evaporation and seepage, and to refill if emptied for necessary maintenance or repair.

(0000041)

This license does not authorize collection of water to storage outside of the specified season to offset evaporation and seepage losses or for any other purpose.

**THE POINTS OF DIVERSION OF SUCH WATER ARE LOCATED:**

(1) Reservoir No. 1 – North 1,200 feet and West 1,800 feet from SE corner of Section 32, T35N, R1E, MDB&M, being within SW¼ of SE¼ of said Section 32; and

(2) Reservoir No. 2 – North 600 feet and West 1,600 feet from SE corner of Section 32, T35N, R1E, MDB&M, being within SW¼ of SE¼ of said Section 32.

**A DESCRIPTION OF THE LANDS OR THE PLACE WHERE SUCH WATER IS PUT TO BENEFICIAL USE IS AS FOLLOWS:**

Stockwatering, Recreational, Wildlife Enhancement and Fire Protection uses at Reservoir No. 1 and Reservoir No. 2, both within SW¼ of SE¼ of Section 32, T35N, R1E, MDB&M, and Irrigation use from Reservoir No. 1 as follows:

20 acres within SW¼ of SE¼ of Section 32, T35N, R1E, MDB&M
10 acres within SE¼ of SW¼ of Section 32, T35N, R1E, MDB&M

30 acres total, as shown on map on file with the SWRCB.

This license is subject to prior rights. Licensee is put on notice that during some years water will not be available for diversion during portions or all of the season authorized herein. The annual variations in demands and hydrologic conditions in the Sacramento River Basin are such that in any year of water scarcity the season of diversion authorized herein may be reduced or completely eliminated on order of the SWRCB made after notice to interested parties and opportunity for hearing.

(0000090)

***The right hereby confirmed to the diversion and use of water is restricted to the point or points of diversion herein specified and to the lands or place of use herein described.***

***Reports shall be filed promptly by the licensee on the appropriate forms which will be provided for the purpose from time to time by the SWRCB.***

***Licensee shall allow representatives of the SWRCB and other parties, as may be authorized from time to time by the SWRCB, reasonable access to project works to determine compliance with the terms of this license.***

***Pursuant to Water Code sections 100 and 275 and the common law public trust doctrine, all rights and privileges under this license, including method of diversion, method of use, and quantity of water diverted, are subject to the continuing authority of the SWRCB in accordance with law and in the interest of the public welfare to protect public trust uses and to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of said water.***

***The continuing authority of the SWRCB may be exercised by imposing specific requirements over and above those contained in this license with a view to eliminating waste of water and to meeting the reasonable water requirements of licensee without unreasonable draft on the source. Licensee may be required to implement a water conservation plan, features of which may include but not necessarily be limited to: (1) reusing or reclaiming the water allocated; (2) using water reclaimed by another entity instead of all or part of the water allocated; (3) restricting diversions so as to eliminate agricultural tailwater or to reduce return flow; (4) suppressing evaporation losses from water surfaces; (5) controlling phreatophytic growth; and (6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this license and to determine accurately water use as against reasonable water requirement for the authorized project. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and opportunity for hearing, that such specific requirements are physically and financially feasible and are appropriate to the particular situation.***

***The continuing authority of the SWRCB also may be exercised by imposing further limitations on the diversion and use of water by the licensee in order to protect public trust uses. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and opportunity for hearing, that such action is consistent with California Constitution article X, section 2; is consistent with the public interest and is necessary to preserve or restore the uses protected by the public trust.***

***The quantity of water diverted under this license is subject to modification by the SWRCB if, after notice to the licensee and an opportunity for hearing, the SWRCB finds that such modification is necessary to meet water quality objectives in water quality control plans which have been or hereafter may be established or modified pursuant to division 7 of the Water Code. No action will be taken pursuant to this paragraph unless the SWRCB finds that: (1) adequate waste discharge requirements have been prescribed and are in effect with respect to all waste discharges which have any substantial effect upon water quality in the area involved, and (2) the water quality objectives cannot be achieved solely through the control of waste discharges.***

***This license does not authorize any act which results in the taking of a threatened or endangered species or any act which is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this water right, the licensee shall obtain authorization for an incidental take prior to construction or operation of the project. Licensee shall be responsible for meeting all requirements of the applicable Endangered Species Act for the project authorized under this license.***

***If construction or rehabilitation work is required for the diversion works covered by this license within the bed, channel, or bank of the affected water body, the licensee shall enter into a streambed or lake alteration agreement with the State Department of Fish and Game. Licensee shall submit a copy of the agreement, or waiver thereof, to the Division of Water Rights prior to commencement of work. Compliance with the terms and conditions of the agreement is the responsibility of the licensee.***

***This license is granted and the licensee accepts all rights herein confirmed subject to the following provisions of the Water Code:***

Section 1625. Each license shall be in such form and contain such terms as may be prescribed by the SWRCB.

Section 1626. All licenses shall be under the terms and conditions of this division (of the Water Code).

Section 1627. A license shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code) but no longer.

Section 1628. Every license shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article (of the Water Code) and the statement that any appropriator of water to whom a license is issued takes the license subject to the conditions therein expressed.

Section 1629. Every licensee, if he accepts a license, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any license granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any licensee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any licensee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Section 1630. At any time after the expiration of twenty years after the granting of a license, the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State shall have the right to purchase the works and property occupied and used under the license and the works built or constructed for the enjoyment of the rights granted under the license.

Section 1631. In the event that the State, or any city, city and county, municipal water district, irrigation district, lighting district, or political subdivision of the State so desiring to purchase and the owner of the works and property cannot agree upon the purchase price, the price shall be determined in such manner as is now or may hereafter be provided by law for determining the value of property taken in eminent domain proceedings.

STATE WATER RESOURCES CONTROL BOARD

*Victoria A. Whitney, Chief*
*Division of Water Rights*

Dated: XXX XX, XXXX

**Kennedy/Jenks Consultants**

303 Second Street, Suite 300 South
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# Technical Memorandum 3-Engineered Facilities Evaluation for Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project:

November 2010

Prepared for

County of Santa Cruz
Environmental Health Services
701 Ocean Street
Room 312
Santa Cruz, CA 95060-4011

K/J Project No. 0864005

**Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.**

November 2010

# Technical Memorandum No. 3

To: Mr. Mike Cloud and Mr. John Ricker
Santa Cruz County Health Services Agency

From: Sachi Itagaki, P.E. and Gregg Cummings, P.E.
Kennedy/Jenks Consultants

Subject: Engineered Facilities for Groundwater Conjunctive Use
Santa Cruz County Conjunctive Water Use and
Enhanced Aquifer Recharge Study
K/J 0864005

## 1 Introduction

Kennedy/Jenks Consultants (Kennedy/Jenks) is pleased to provide the Santa Cruz County Health Services Agency (County) with the Draft Technical Memorandum No. 3 (TM3) in support of the Conjunctive Use and Enhanced Aquifer Recharge Project (Conjunctive Use Project). The Conjunctive Use Project is one of 16 projects funded by a Proposition 50 Water Bond Grant from the State Water Resources Control Board to the Regional Water Management Foundation, a subsidiary of the Community Foundation of Santa Cruz County. The Conjunctive Use Project is Project 3 of the grant and is being administered by the County.

The structure of TM3 is as follows:

1. Introduction
2. Background
3. Overview of Potential Source Waters
4. Inventory of Existing Infrastructure
5. Overview of Conceptual Infrastructure Requirements
6. Planning level Cost-estimating Approach

Depending on the source of the water, treatment and end use needs, a combination of the facilities described in Section 5 will be used to achieve the project goals.

## 2 Background

### Scope

The objective of the Conjunctive Use Project is to assess the most appropriate approaches for coordinating water projects and increasing groundwater storage to provide reliable drinking water to the lower San Lorenzo River Watershed (Watershed), mitigate declines in groundwater levels, and increase stream baseflow. This portion of the Conjunctive Use Project will provide an


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overview of the engineered facilities necessary to implement opportunities such as water exchanges, winter streamflow diversion, active and in-lieu recharge, and/or reclaimed wastewater to replenish groundwater storage in the Santa Margarita Groundwater Basin (SMGB).

# 3 Overview of Potential Source Waters

As described in more detail in Draft Technical Memorandum No. 2A Water Rights Evaluation and Draft Technical Memorandum No. 2B Availability of Water Sources for a Conjunctive Use Framework Approach to Water Resource in the San Lorenzo Creek Watershed, Santa Cruz County, there is a range of supply sources of varying quantities and qualities that can be used conjunctively within the SMGB. These sources are summarized in the table that follows and are described in detail in the following sections.

## 3.1 Surface Water Quantity and Quality

The groundwater could be supplemented with the surface water sources within the SMGB as summarized above. From a water rights and hydrologic perspective, Bean Creek and Carbonera Creek appear to be the most feasible because they appear to be largely unappropriated as described in Draft Technical Memorandum 2A and have ample winter supply in most years as described in Draft Technical Memorandum No. 2B. In addition, Zayante Creek has a filing of 17,000 AF on behalf of North Santa Cruz County which could also be accessed. Exchange/transfer of existing water rights on the San Lorenzo River held by Santa Cruz Water Department or San Lorenzo Valley Water District are also potential sources of surface water. (See Technical Memorandum 2A for Task 2.2 for more information regarding water rights.)

However, recent regulatory activities with respect to the draft Coho Recovery Plan and draft Habitat Conservation Plan, will require reevaluation of surface water availability on a broader basis outside of strictly water rights and hydrologic availability.

The water quality of surface waters are likely to be high in suspended sediments, especially during large storm events. Most of the flow in Carbonera Creek is stormwater from urban runoff as evidenced in the high wintertime peak flows and low dry season base flows as discussed in Technical Memorandum 2B.


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# Memorandum

Mr. Mike Cloud and Mr. John Ricker
November 2010
0864005
Page 3

Table 1: Overview of Potential Source Waters

| Source | Quantity | | Quality | Notes |
|---|---|---|---|---|
| Surface Water | Ave. Stream Flow[1] (AFY) | Ave. Yield[1] (AFY) | | |
| Bean Creek | 8,000 | 520 | Some sediments; may be controllable through erosion control | |
| Carbonera Creek | 4,000 | 480 | Suspended sediments from eroded creek bed and first flush urban runoff contaminants[2] | Highly urbanized watershed resulting in highly erosive peak flows. |
| Newell Creek | 11,000 □ 12,000 (est)[3] | | | Loch Lomond Reservoir not specifically evaluated |
| San Lorenzo River | 96,100 | 1,643 | Suspended sediments likely (70 □ 1,700 tons/day during wet season) | Flow estimate from Big Trees Gauge, approximately 90 □ of total watershed; cumulative flows including upstream tributaries (e.g. Newell Creek) |
| Zayante Creek | 8,000 | 500 | Suspended Sediments likely (8,000 tons of sediment/yr) | |
| Stormwater | 300 □ 500 AFY from urban runoff in Scotts Valley[4] | | First flush urban runoff contaminants[2] | Not all available stormwater is likely to be captured and recharged. |
| Recycled Water for groundwater recharge | Up to 400 AFY based on 0.877 MGD of future wastewater flow for 5 month winter season | | Treated to Title 22 Tertiary unrestricted use level; emerging contaminants such as personal care products | Demand for recycled water for dry season urban reuse exceeds supply regionally. Likely wintertime availability. |
| In-lieu Exchange | Likely to be accommodated within existing excess wet season surface water supplies | | Treated potable water | Potential exchange partners include Santa Cruz Water Department, San Lorenzo Valley Water District, Scotts Valley Water District |

[1] Average stream flow in acre-feet per year (AFY) is the average of the period of record available for the flow gage. The Average yield is a calculated value that accounts for a flow sufficient for environmental uses, then assumes an additional diversion for conjunctive use during the wet season. More detailed explanation is found in Technical Memorandum No. 2B for this Conjunctive Use Project (Balance Hydrologics, 2009).
[2] Urban runoff contaminants include nutrients from fertilizers, bacteria, zinc, copper, lead, and some oils and greases.
[3] Estimated based on rainfall-runoff relationship for Eastern Santa Cruz Mountains (Balance Hydrologics, 2009) and mean annual precipitation at Newell Creek of 45 □ 46 inches.
[4] Based on estimated impervious area along Scotts Valley Drive and Mt Hermon Drive of approximately 300 Acres and average annual rainfall of 42 inches (3.5 ft).


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## 3.2 Stormwater Quantity and Quality

As water supplies become more limited, stormwater increases in its potential to contribute to overall water supplies. In some areas, such as Scotts Valley, urbanization that has produced increased quantities of stormwater, also has resulted in reduced groundwater recharge. Capture and recharge of stormwater in Scotts Valley could have multiple benefits such as increased aquifer storage, increased summer base flows to Bean and Carbonera Creeks, as well as reduced erosion and downcutting of Carbonera Creek.

### Quantity

As summarized above, most of the stormwater in the SMGB is generated within Scotts Valley along Scotts Valley Drive and Mount Hermon Road. Much of it is discharged to Carbonera Creek while a small portion flows northwest toward Bean Creek. An initial estimate of impervious area within Scotts Valley is approximately 300 acres as distributed in the table below and shown on Figure 1 that follows.

Table 2: Impervious Area Estimates in Scotts Valley

| Impervious Area Type | Estimated Area |
|---|---|
| Roadway | 29.8 Acres |
| Parking Lot | 199.4 Acres |
| Building/Structure | 62.25 Acres |
| Total | 291.45 Acres |

However, the impervious area also includes landscape and unpaved areas. An estimate of 15 of the 291 acres may be landscaped and/or unpaved areas for a net impervious area of about 250 acres.

The average annual rainfall in Scotts Valley is 42 inches, which is equivalent to 3.5 feet. If all of the stormwater is captured, that is over 1,000 AFY. However, the estimated impervious area is likely to be less than estimated in Figure 1 and the actual rain fall that is likely to be captured and recharged is less than 100 of the average annual rainfall. Therefore, a more likely estimate is in the 300 500 AFY range.

The discussion below provides an overview evaluation of water quality issues from urban stormwater runoff that including the potential constituents such as sediment and contaminants.


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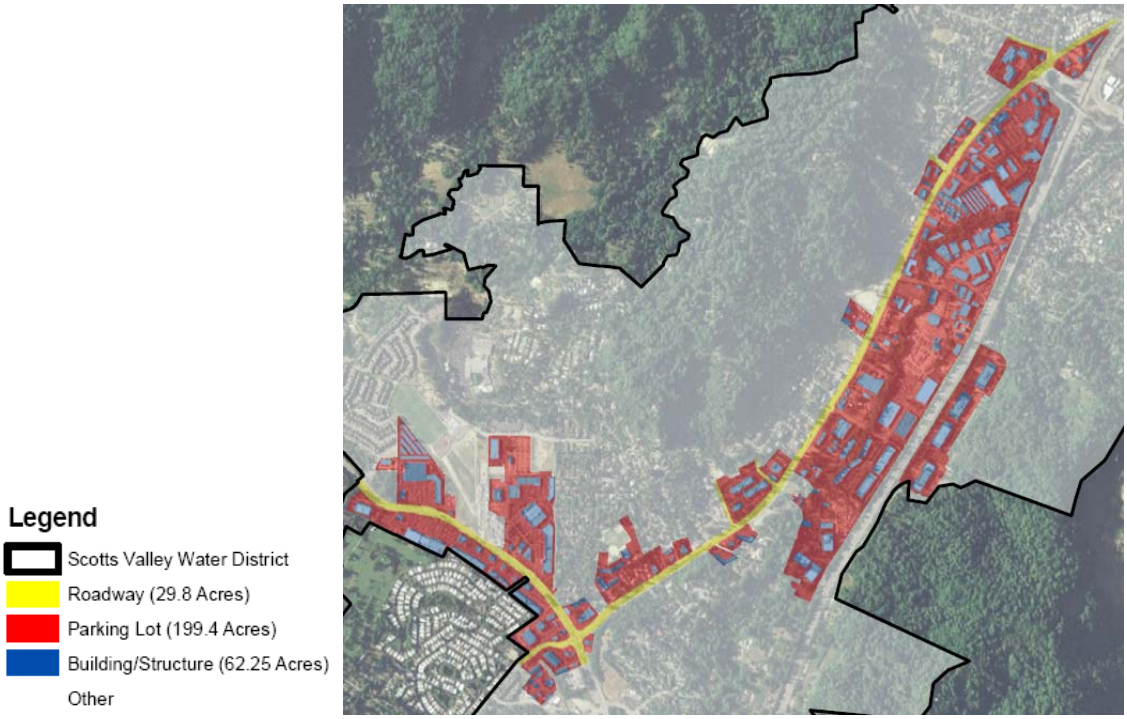


Figure 1: Estimated Areas of Impervious Coverage in Scotts Valley

## General Water Quality Characteristics of Urban Stormwater Runoff

Unlike the non-point source runoff from pre development conditions, runoff from urbanized areas contains various pollutants associated with human activities. It is now well understood that urban runoff is a significant source of water pollution resulting in impacts to water resources. When discussing urban runoff it is important to understand that urban runoff is composed of all flows that conveyed from urban land uses including both wet weather flows (runoff associated with storm events) and dry weather flows (i.e. runoff from other typical urban sources, landscape irrigation, residential wash down waters, hydrant flushing, etc). Some studies have indicated that nearly one-half of the discharge from an urbanized area could be dry weather flows. However, in the Scotts Valley area, it is likely that wet weather flows will be a higher proportion of stormwater than in other urbanized areas.

The urban activities of most concern can be categorized into municipal activities (corporation/maintenance yards, facilities, street maintenance, etc), industrial/commercial activities, construction activities, and residential activities (pets, car washing, fertilizer and pesticide application).

Examples of typical urban elements and activities that generate pollutants include the following.


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- Parking lots
- Atmospheric deposition
- Pavement maintenance
- Building exteriors
- Animal waste
- Waste handling/disposal
- Vehicle fueling, operation and maintenance
- Materials handling and storage
- Construction activities
- Fertilizer and pesticide application
- Cleaning activities
- Illicit connections
- Illegal dumping

The pollutants may generally include the following:

- Sediment
- Metals
- Organics
- Pesticides
- Bacteria
- Pathogens
- Nutrients
- Poly chlorinated biphenyls (PCBs)
- Poly aromatic hydrocarbons (PAHs)
- Plasticizers
- Oil and Grease

Vector control resulting from standing water is also a potential concern when managing urban stormwater runoff.


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In an effort to better control urban runoff, USEPA has promulgated storm water regulations, in the form of NPDES Permits, for large and small municipalities, industrial facilities, and construction activities. The focus of these regulations and the programs developed under the permit requirements has been on the use of Best Management Practices (BMPs) to control and reduce the pollutants. The regulations generally require municipalities to reduce the discharge of pollutants to the maximum extent practicable (MEP). To date, the BMPs developed have been largely source-control in nature, but, increasingly permitees are required to implement treatment type controls, a trend that will likely increase in future years.

### Water Quality of Urban Stormwater Runoff near Scotts Valley

As part of the USEPA storm water regulations for small municipalities, the City of Scotts Valley (City) is regulated under the California Small Municipal Separate Storm Sewer System (MS4) General Permit. In the 2008 Scotts Valley Storm Water Management Plan (SWMP), the City identified impairments by sediment and fecal indicator bacteria in both Carbonera and Camp Evers Creeks in accordance with the listings of the Regional Water Quality Control Board (Regional Board). Total Mass Daily Load (TMDLs) allocations have been developed for sediment and pathogens by the Regional Board. As part of TMDL development the following were identified as controllable sources.

- Storm drain discharge
- Pet waste
- Homeless encampments
- Septic systems
- Domesticated animals
- City sanitary sewer collection system leaks
- Private laterals

The City s SWMP contains BMPs to address these sources. The water quality of urban stormwater runoff can be improved prior to recharge by implementation of low impact development (LID) measures that treat and infiltrate runoff from streets, roofs and parking lots. LID measures are described in greater detail in Section 5.3.

Other discussions related to the regulatory requirements of stormwater can be found in Technical Memorandum No. 4 Regional Water Demand.


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## 3.3 Recycled Water Quantity and Quality

Title 22 tertiary treated, unrestricted use recycled water is already being used in the Scotts Valley area for irrigation during the summer period. It is estimated that at build-out, there may be a wastewater influent of 0.877 MGD which could be fully used for irrigation during the dry season. Excess recycled water is available in the wet season (estimated at up to 400 AFY based on 5 month availability) when irrigation demands are low and could potentially be used for recharge. However, there is currently more dry season recycled water demand identified than supply, and permitting a wintertime groundwater recharge facility using recycled water will require additional dilution water and may have significant challenges. Additional discussion regarding recycled water quantities can be found in Technical Memorandum No.4.

## 3.4 In-lieu Exchange Quantity and Quality

In the SMGB, the concept of an in-lieu exchange is to obtain other potable water through exchange such that the groundwater basin is not pumped. The alternative water supply, which could be wet season surface water, is used in-lieu of groundwater pumping allowing water in storage to accumulate. Some of the exchange concepts are discussed below.

At present, there is a 2-inch diameter meter connecting a 6-inch pipeline of the Scotts Valley Water District (SVWD) with a 4-inch diameter pipeline in a satellite, groundwater-only system of the San Lorenzo Valley Water District (SLVWD). Limitations in the quantity and elevation of water storage restrict the water that can be be exchanged between the two systems. There is more storage within the SVWD system than in the SLVWD satellite system so SLVWD may derivee greater benefit from this intertie. Therefore, this intertie is only of benefit during short-duration emergencies and presents no long-term quantity or water quality benefits since both the SVWD and SLVWD wells draw from the same groundwater basin.

SLVWD is considering interties between the various portions of the SLVWD including the northern portion served largely by surface water; the recently acquired Felton surface water system, and the two groundwater-only systems, Probation Wells and Manana Woods, in Scotts Valley. However, there may be water rights and other issues that prevent movement of water between the various SLVWD systems. If constructed, an intertie between the northern or Felton system and the groundwater-only systems of SLVWD could be continued to SVWD to allow water from SLVWD's surface supply to be accessible to SVWD. Surface water quality from the northern systems may vary from the groundwater quality but can be blended to minimize impacts.

The SVWD is also in the process of evaluating an intertie with the Santa Cruz Water Department (SCWD). A likely route is to continue north along Sims Road to La Madrona Road and into the SVWD system. A small booster pump station would be needed to provide adequate pressure to SVWD's system. The intertie would deliver potable water treated at the


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SCWD s Graham Hill Water Treatment Plant (WTP) to SVWD in the wintertime. It could also be used during an emergency in the summer time. Similar to the SLVWD, surface water quality from SCWD could vary from the groundwater served in SVWD; however, these differences can be minimized through blending. Some studies have been initiated to further evaluate this option.

SLVWD also has 313 AFY (102 MGY) raw surface water stored in Loch Lomond reservoir that could be used to offset groundwater pumping. The mostly likely mechanism for SLVWD to use Loch Lomond Reservoir water is to exchange raw water for treated Loch Lomond Water from the SCWD, through a proposed intertie. There should be essentially no difference in water quality between Loch Lomond and the San Lorenzo River; any differences between the surface sources and groundwater can be minimized through blending. A study to evaluate alternative delivery mechanisms for Loch Lomond water to SLVWD is currently underway and expected to be completed in summer 2010.

# 4 Inventory of Existing Infrastructure

There is existing infrastructure that could be integrated into a conjunctive use project. This infrastructure could include surface water diversion facilities, pipelines, and recharge facilities. These facilities are described below and shown on Figure 2 that follows.

## 4.1 Existing Diversion Facilities

There are several existing diversion facilities that are owned and operated by the area water agencies as follows. The SCWD facilities that are potentially relevant to the SMGB are the Felton and Tait Street Diversions located on the San Lorenzo River and Loch Lomond Reservoir. It should be noted that from the June 1 October 31 period, the San Lorenzo River and its tributaries are fully appropriated from a water rights perspective. However, there are likely high winter flows that are available for diversion that will require consultation and negotiation with State and Federal fishery agencies.

The Felton Diversion is located just downstream of the confluence of Zayante Creek and the San Lorenzo River and is a diversion structure with an inflatable dam to divert flows into a screened intake sump that is typically used during the winter months of dry years. Water rights limitations at Felton include a 20 cfs/12.9 MGD year-round rate limit as well as instream flow requirements ranging from 10 cfs/8.4 MGD to 25 cfs/16.2 MGD depending on the time of year. Water from the Felton Diversion is pumped up to Loch Lomond Reservoir via the Newell Creek Pipeline or directly to the Graham Hill WTP. There are 3 pumps at the Felton Diversion as well as 6 pumps at the Felton Booster Station that can be used in various combinations to regulate the diversion rate.


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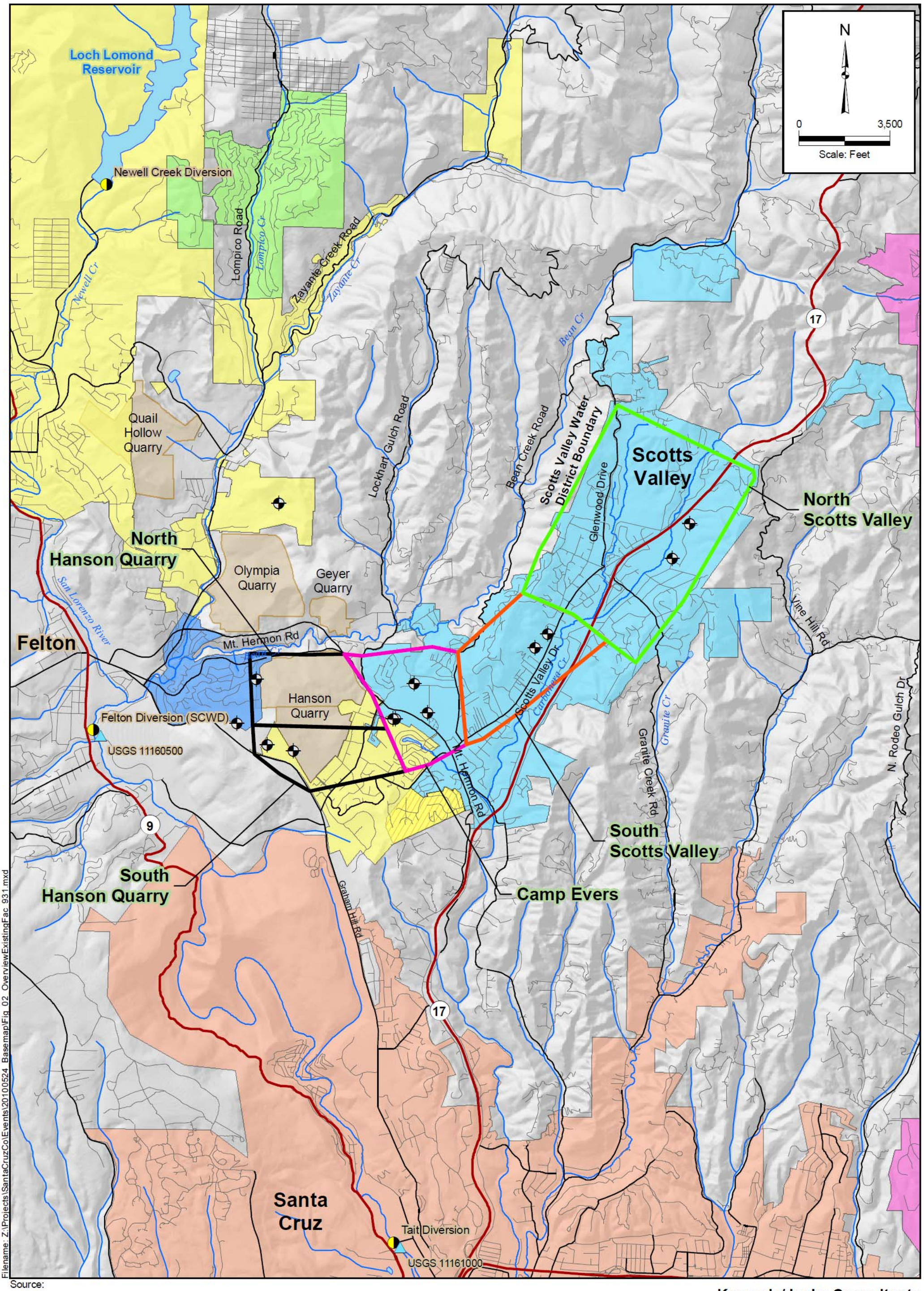


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Source:

- USGS Stream Gauge Location
- Santa Cruz Water Department Diversions
- Well Location
- Camp Evers
- North Scotts Valley
- South Scotts Valley
- Hanson Quarry
- Santa Cruz City Water Department
- Mt. Hermon Association
- Lompico County Water District
- Scotts Valley Water District
- Soquel Creek Water District
- San Lorenzo Valley Water District
- San Lorenzo Valley Water District - Manana Woods
- Mineral Resource Area (Quarry)

**Kennedy/Jenks Consultants**

Santa Cruz County Conjunctive Water Use and Enhanced Aquifer Recharge Study
Santa Cruz County, CA

**OVERVIEW OF EXISTING FACILITIES**

0864005
November 2010
**Figure 2**

The SCWD Tait Street Diversion is located just north of Highway 1 on the San Lorenzo River and is comprised of a surface water diversion as well as wells. There is a concrete check dam which directs flow to a screened intake sump. There are 3 vertical turbine pumps with a total capacity of 7.8 MGD to pump water to the Graham Hill WTP. This 7.8 MGD pumping rate compares to a wintertime SCWD demand of 11 MGD or less. Water rights specify that there is a 12.2 cfs/7.9 MGD maximum diversion rate year round at Tait Street. Near the Tait Street diversion are the Tait Well No.1 and Tait Well No. 4 that are 92 feet and 79 feet deep respectively. Each of these wells can produce 0.6 MGD. The well pumps discharge to the Tait Street diversion sump allowing a single set of pumps to pump surface diversion and/or groundwater flow to the Graham Hill WTP.

The Loch Lomond Reservoir on Newell Creek has 8,900 AF of storage and an estimated annual yield of 3,230 minus 742 AFY for instream releases or 2,500 AFY net annual yield. The SCWD is entitled to 2,187 AF of the annual yield while the SLVWD is entitled to 313 AF of the annual yield although SLVWD currently has no means to access this entitlement. The SCWD is currently applying to make changes to their water rights to maximize water to storage such that up to 5,600 AFY from Newell Creek is allowed to flow to storage in Newell Creek Reservoir/Loch Lomond and to allow up to 3,000 AFY of the City's Felton water right to flow to storage.

To supply its northern service area, SLVWD obtains surface water from diversions at seven surface streams in the Ben Lomond Mountain watershed. These seven diversions supply approximately 900 AFY on average. In addition, as a result of the acquisition of the Felton water system, SLVWD also acquired water rights and facilities for water from the Fall Creek watershed to be diverted at Felton and treated at the existing SLVWD Felton Water Treatment Plant. In the wintertime, there may be excess surface water in SLVWD's northern service area, Felton, and/or in Loch Lomond that could, with new intertie facilities, be piped to the SLVWD southern service area which is currently served exclusively with groundwater, thus providing in-lieu conjunctive use in the SMGB.


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## 4.2 Existing and Abandoned Pipelines

During discussions with the TAC and others knowledgeable in Santa Cruz County, a few pipelines were identified that could be used to operate groundwater conjunctively with surface water or other waters. In Scotts Valley, there is an existing pipeline currently used to deliver recycled water, that runs from the Scotts Valley Wastewater Plant (WWTP) located northwest of the junction of Mount Hermon Road and Scotts Valley Road to the Hanson Quarry. The pipeline was originally used to convey treated secondary wastewater to the quarry area for disposal. The 8-inch diameter pipeline was constructed of fused poly vinyl chloride (PVC) with a maximum pressure rating of 70 pounds per square inch (psi) and is scheduled for replacement as a recycled water pipeline because of its poor condition and low pressure rating. The segment to Hanson Quarry is currently unused, but may be limited in its pressure rating.

In addition, there is a secondary effluent disposal pipeline from the Scotts Valley WWTP to the Santa Cruz WWTP's ocean outfall pipeline. Scotts Valley WWTP discharges to this pipeline when recycled water demand is low, mostly in the wintertime. At present, this effluent disposal pipeline is under consideration to deliver secondary effluent to the Pasatiempo Golf Course so that the Golf Course can provide additional treatment and replace potable water with recycled water for part of their irrigation demand.

As discussed earlier, there are several emergency intertie pipelines. Given the small diameter of the existing pipelines, they would be of limited utility in the transfer of larger quantities of water. However, projects are currently under consideration to construct new pipelines of larger diameter and to construct pump stations in order to increase their usability for transfer of water regionally.

## 4.3 Recharge Facilities (e.g. quarries)

As discussed earlier, the three quarries in the SMGB are potentially viable recharge facilities as shown on Figure 2. In fact, Hanson Quarry was one of the original disposal sites for treated secondary wastewater. The Hanson Quarry is about 100 Acres of which about 30 acres is the southern portion of the quarry which is hydrogeologically distinct from the northern 70 acres of the quarry. The Olympia Quarry is about 50 Acres, and the Geyer Quarry is about 5 Acres. Since the Geyer Quarry has been turned over to a non-profit land conservancy and is quite small compared to the other two quarries, it is no longer considered as a feasible site for recharge activities.

Each quarry is geologically distinct and presents a range of advantages and disadvantages for use in direct recharge. These advantages and disadvantages are summarized in the table that follows.


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Table 2: Summary of Quarries

| Quarry Name | Advantages | Disadvantages | Ownership/Status |
|---|---|---|---|
| North Hanson Quarry | - Proximity to Bean Creek<br><br>- Possible location for raw water sedimentation facilities prior to recharge and/or injection. | - Surface Recharge will be to Santa Margarita formation which will not reach the deeper Lompico (unless injected) because of Monterey shale that occurs between Lompico and Santa Margarita therefore will not have significant regional GW benefit, recharged water will quickly leak back to Bean Creek from Santa Margarita | Owned by Hanson Aggregates and in reclamation planning process; SVWD is exploring purchase of 1 acre in a location that coordinates with existing infrastructure for potential new well. |
| South Hanson Quarry | - At south end, Monterey formation pinches out, allowing Santa Margarita to be in direct contact with deeper Lompico formation which makes this site more attractive from a surface recharge perspective. | -Somewhat greater distance from Bean Creek<br><br>-Need to coordinate reclamation planning/development process | Owned by Hanson Aggregates and in reclamation planning process. |
| Olympia Quarry | -Proximity to Bean and Zayante Creeks<br><br>-Relatively low elevation gain from creeks<br><br>- Possible location for raw water sedimentation facilities prior to recharge. | -Same disadvantage as North Hanson Quarry | Owned by Lonestar Aggregates in reclamation planning process? |


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# 5 Overview of Conceptual Infrastructure Requirements of Potential Alternatives –

In addition to the existing infrastructure described in Section 4, the types of infrastructure necessary to deliver and/or recharge water directly or in-lieu have been identified and are described in summary as follows. The facility types include:

- Diversion Facilities for Surface Water
- Aquifer Recharge Facilities for Surface and Storm water
- Stormwater Recharge Approaches-Treatment and Low Impact Development (LID) Measures
- Treatment and Delivery of Surface Water for In-lieu Benefit Directly or in Exchange

## 5.1 Diversion Facilities for Surface Water

There are two options for obtaining surface water: surface diversion, and subsurface diversion. The facilities that would be used for these types of diversion are discussed below.

### 5.1.1 Surface Diversion Overview

A surface diversion would generally consist of the following major components each of which are described in greater detail below:

- Impoundment Structure: The impoundment structure is comprised of two components, a dam and a fish ladder, that need to function together as a unit.
    - Full or partial dam in the creek/river to back-up the water to allow it to be diverted. The dam could be a:
        - Concrete dam
        - Earthen/Rock dam (not common)
        - Inflatable rubber dam
        - Rock Weir Impoundment with Terraced Rock Pool Bypass Structure
    - Fish passage facilities such as fish ladders.


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- Diversion Structure: The diversion structure allows the water in the impoundment to be diverted to the use site and is also comprised of up to three components; a trash rack, a fish screen and an intake structure.
    - Trash rack to prevent large debris from being diverted
    - Fish screen to prevent entrainment of fish  this could also function to screen debris depending on the inlet structure.
    - Inlet structure to control rate of diversion
- Flow equalization and desilting basin, to remove large suspended solids.
- Pipeline and pump system, if required, at the basin to convey the water from the basin to where the water will be used/recharged.

#### 5.1.1.1 Impoundment Structure

Impoundment structures are used to create an area of ponded water such that the water can flow by gravity or be pumped for its ultimate use. One of the largest impediments to construction of impoundments is the need to allow fish passage past the structure. A range of impoundment structures and fish passage facilities are described below.

Concrete Dam: Concrete dams are commonly used to impound water. For small streams, they can be fairly simple structures, trapezoidal in cross-section using wooden weir boards that slide into steel tracks or steel sluice gates that raise and lower to impound water. Weir boards need to be easily removed and sluice gates need to be easily opened to increase capacity during high flow events. Operational and maintenance access across the dam is often provided in the form of an H-20 rated roadway.

As the waterway increases in size and flows increase, more complex concrete dam structures (e.g. buttress or arch dams), control structures (e.g. radial dam gates that open and close), and spillways are often constructed. Fish ladders, described in greater detail below, can be integrated into the concrete dam structure. As the size of the dam and the complexity of the dam gate controls increase, electricity, telemetry and control buildings are often required. For the relatively modest diversion quantities envisioned for this project, a concrete dam may be overly complex and difficult to obtain permits to construct.

Earthen/Rock Filled Dam: As with concrete dams, earthen/rock dams can be used for both small and large-scale applications. They are generally used for reservoir impoundments but not in an in-stream application such as is being considered in this project. The primary reason that they are generally unsuitable for in-stream applications is that flow control is generally either through a spillway or a release pipeline with valves through the base of the dam. Neither of these flow controls lend themselves to diversion of relatively modest flow quantities from a


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waterway. Earthen dams are constructed of layers of well compacted earth. Rock dams are constructed of compacted free draining earth with an impervious layer (either at the surface or inside the dam itself). Both types are often filled with a clay core to provide an impervious material. They are often more cost-effective than a concrete dam if suitable material is available near by. However, as with concrete dams, for the modest flows envisioned for diversion an earthern/rock-filled will be difficult to obtain permits for construction.

Rubber Dam: Rubber dams are made of inflatable rubber tubes that are anchored to a concrete foundation structure across the bottom of the water way. They can be inflated by either air or water and therefore require pumps, air/water inlet/exhaust lines, controls to inflate/deflate depending on in-stream flow conditions, electrical access, and structures to control operations. The dam base is often integrated with rip rap and boulders to create entry to fish passage facilities, as well as to protect the rubber dam structure. Integration of fish passage facilities, described below, is critical for rubber dams.

Rock Weir Impoundment with Terraced Rock Pool Bypass Structure: Rock weirs, or step-pools, can be effectively used to facilitate the diversion of streamflow for water resource reasons and yet still provide for conditions conducive to successful fish passage. The range of possible approaches in the use of rock weirs for such purposes depends in large part on the size of the river system, the magnitude of flows over which the structure must function, the geologic and geomorphic characteristics of the river corridor at point of use, and the diverse range of fish species which must be able to pass the weir structure(s). A variety of engineering solutions can also be integrated with the rock weir design to primarily manage for flow rates which are bypassed into an adjacent diversion channel, as well as to convey the associated volume of bedload carried by that flow. These types of structures and approaches have been implemented throughout the western United States with great success, including one local example within the lowermost reaches of San Vicente Creek.

Fish Passage Facilities: Fish passage facilities are critical facilities to any water impoundment/diversion scheme. In addition to a rock weir impoundment with terraced rock pool bypass structure which integrates fish passage with impoundment described previously, there are a range of fish passage options that include:

- concrete rectangular channels with concrete v-notch or rectangular weir structures that have graduated steps from the base to the top of the dam (with or without vertical slots to facilitate fish passage),
- use of multiple rubber dams, each with a drop passable by fish, at increasing elevations to provide impoundment as well as fish passage,
- fish elevators that collect fish with water in a tank-like facility and lift the tank to the higher elevation above the dam, and


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- the use of baffles in a natural or manmade channel to create areas of variable flow velocity that the fish can swim against (for an earthen dam, this could be constructed in a culvert that penetrates the dam base). These baffles can be constructed of metal, wood, rock, concrete and can be extended over a steep or shallow slope and can be engineered to be like a pool/riffle system of a natural waterway.

#### 5.1.1.2 Diversion Structure

Diversion structures are usually constructed in an embankment to divert water to a pipeline, open channel, or pump station wet well. As summarized earlier, there are a number of facilities associated with a diversion structure which are described further as follows:

- Trash rack to prevent large debris from being diverted. They are often constructed of bars or screens. Trash rack cleaning is a critical element to trash rack design and needs to occur to prevent overtopping of the turnout structure. Cleaning can be accomplished manually or mechanically.

- Fish screen to prevent entrainment of fish  this could also function to screen debris depending on the inlet structure. Similar to trash racks, fish screens to prevent entry of anadromous salmonids are critical to operation of turnout structures. As described in TM 2C- Fisheries, both the NOAA Fisheries and California Department of Fish and Game have fish screen criteria that describe placement of screens, approach velocities relative to fish size, screen area, sweeping velocity, screen face material and construction, bypass systems, and other technical information associated with fish screens.

- Inlet structure to control rate of diversion. The inlet structure connects to the open channel, pipeline, or pump station wet well and can be comprised of gated (with valve or weir) cast-in place concrete inlet or a cast-in place head wall for a pipeline.

#### 5.1.1.3 Flow Equalization and Desilting Basin

Flow equalization structures are used to capture large peak flows and meter them out to downstream facilities (e.g. pipelines and pump stations) so that downstream facilities can be sized for more constant, smaller flows and do not have to meet peak flow conditions. Desilting basins are used to settle out larger sediment particles, which will be particularly important to prevent recharge impoundment facilities from becoming clogged. It is expected that the high flows that are planned for diversion will carry a comparatively high sediment load so desilting basins are likely necessary prior to groundwater recharge. Depending on the rate of diversion, the largest challenge may be in finding sufficient space to locate flow equalization and desilting basin facilities.


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#### 5.1.1.4 Pipeline and Pump System

If the diverted water cannot be conveyed by gravity to its recharge or use site, a pump station will need to be constructed either at the turnout structure or at the flow equalization/desilting basin. The pump station discharge can be either to a pipeline, into an open channel, or into a combination pipeline/open channel depending on the destination of the diverted water. The use of flow equalization basins can reduce the size of a pump station and reduce overall capital and operations and maintenance costs.

### 5.1.2 Subsurface Diversion

Subsurface diversions are constructed in the alluvial material adjacent to a surface water body. A subsurface diversion would generally consist of the following major components:

- Vertical or horizontal well(s), located adjacent to the creek/river, with screened openings. Vertical wells are similar to groundwater wells while horizontal wells are described in greater detail below.

- Well pump to pump the water from the basin to where the water will be used.

A horizontal collector well consists of a concrete caisson (approximately 16- feet in diameter) which extends to a depth appropriate for the site conditions, sometimes to bedrock, and lateral well screens extending radially from the caisson. This type of horizontal well is often called a Ranney Collector after the inventor. A lateral may be up to 175 feet long. There may be one to ten or more laterals at multiple elevations. The high pumping rate of a horizontal collector well lowers groundwater levels under the surface water, causing surface water to flow into the aquifer in a process known as induced infiltration. Induced infiltration is a significant portion of the available yield for a horizontal collector well. The elevation of the lateral well screens, slot size, and number of linear feet of well screen is dependent on aquifer properties. Horizontal collector wells are constructed using a natural gravel pack design with an entrance velocity less than 2 feet per minute. (Riegert, 1999)

## 5.2 Aquifer Recharge Facilities for Surface Water, Stormwater, or Recycled Water

A variety of facilities may be considered for aquifer recharge purposes. Larger recharge rates may require larger facilities such as percolation ponds, recharge/infiltration basins and injection wells. For smaller recharge rates, aquifer recharge facilities could include gravity recharge wells, infiltration galleries, or pressurized leachfields. Both the larger recharge and smaller recharge rates facilities are described in greater detail as follows. Regardless of the method of recharge, monitoring of groundwater would be a prudent measure to determine the impact of the recharge operation. Draft Department of Public Health regulations for groundwater


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recharge with recycled water indicates that significant monitoring will be required if recycled water is considered for recharge.

### 5.2.1 Percolation Ponds (large shallow ponds)

Percolation ponds are shallow basins enclosed by dikes or levees. The pond bottom is situated above the water table (the upper boundary of the saturation zone in a groundwater system). The discharge flow percolates through the unsaturated soils in the pond to reach groundwater. Thus, the ponds have no direct connection to underlying groundwater. The actual discharge capacity will depend on the site-specific soil and aquifer characteristics.

### 5.2.2 Recharge/Infiltration Basin (deep ponds)

The second aquifer recharge method considered is the infiltration basin. Infiltration basins are similar to percolation ponds, except that they are much deeper, containing no unsaturated zone, and they are in direct contact with the groundwater. The basins are typically excavated deep below the water table  as deep as 50 to 100 feet  to allow infiltration directly into the groundwater aquifer.

An infiltration basin facility would be significantly more costly than a percolation pond facility, because of the extent of excavation activities. However, the costs would be expected to be significantly lower if the quarries near the SMGB were to be used for percolation. Other considerations such as the quarry restoration plans may preclude the use of deep ponds for recharge.

Recharge/infiltration basins would generally consist of the following major components:

- A graded area surrounded by berms to hold the water in place during percolation.
- One to two feet of sand at the bottom of the basin, to promote percolation. As debris began to accumulate on top of the sand, the debris along with the top few inches of sand would be removed and disposed of. Additional sand would then be provided to replace the sand removed.
- An overflow structure (e.g., spillway, vertical pipe) to handle excess water in the basin.
- An influent distribution system, such as manifolded pipe.


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### 5.2.3 Injection Wells

The injection well option consists of a series of wells drilled into transmissive zones of the aquifer. Water is pumped under low pressures into these wells and allowed to flow into the aquifer. The wells discharge water directly to the saturated zone and bypass the unsaturated zone; therefore, the injection well option would produce the water-quality benefits from flow through the aquifer, but not the benefits from flow through the unsaturated soils (Kennedy/Jenks 2008).

The operation of injection wells include facilities that allow water to be injected into the well through a drop pipe equipped with a submerged hydraulic restriction. The restriction ensures that back pressure can be maintained on the drop pipe during operation to prevent the introduction of air (Kennedy/Jenks, 2008). A minimum pressure of 5 pounds per square inch (psi) is required to avoid air entrainment in the well, which would seriously impact performance. Typically, it is assumed that pump maintenance and other operational contingencies may arise that require some number of wells to be out of service at any time. This may be less of a consideration in the SMGB because recharge operations are most likely to occur in the wet season providing a 5 □7 month window for maintenance during the dry season.

In the well casing, the buildup of the water level is a function of the flow rate of water into the well and the transmissivity of the aquifer. Transmissivity is a parameter that defines the ability of the aquifer to transmit water. The greater the transmissivity, the greater the flow of water that the aquifer is capable of accepting. Injection rates vary with water levels (Kennedy/Jenks, 2008).

Wells can be very sensitive to clogging. Clogging occurs when sediment, buildup, biological fouling, or chemical precipitation occurs, thus reducing the open area of the well screen and thereby reducing the flow of water into the aquifer. To allow monitoring for the effects of clogging, each well would require automated level controls and shut-off valves. Level controls would be necessary to shut down the well in case of such a problem. Clogging could be minimized by injection of treated potable water. For raw surface water or stormwater, sedimentation basins or other settling and/or treatment will likely be required prior to injection.

Maintenance of injection wells typically constitutes periodic □backwashing□of each well to remove the buildup of sediments and organic materials. To facilitate this activity, each well would be equipped with a submersible pump at the bottom of the well casing to provide suction pressure and thus clean out any accumulated obstructions in the well screens. Well backwashing is expected to take place at a frequency between daily and weekly. More intensive maintenance activities, such as chemical cleaning or well redevelopment, may be necessary when a well demonstrates further deterioration in performance. Chemical cleaning would entail the application of hydrogen peroxide solution or the equivalent to remove organic buildup on the well screen. Well redevelopment would entail using a drilling rig to mechanically swab the well


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screen to break up heavy buildups or mineral precipitates that resist other forms of maintenance. As with any well, ongoing maintenance and replacement of pumps and valves also would be required.

### 5.2.4 Gravity Recharge Wells

Gravity recharge wells are similar to injection wells with the exception that recharge occurs through gravity, not pressure. Therefore, many of the considerations discussed in the prior section on injection wells apply. The main advantage of the gravity recharge well over an injection well is simplicity of operation. However, site selection for transmissivity is critical for a gravity recharge well. The rates of recharge are likely to be lower with gravity recharge than with injection wells and storage of recharge waters may become a critical factor in optimizing recharge quantities. A gravity recharge well would generally consist of the following major components:

- One or more vertical wells with screened openings, gravel packing, and housekeeping slab around the well.
- Pipelines and valves connecting the walls to the main pipeline providing the recharge water

If necessary, recharge wells can be pumped. However, this option is not considered at this time because of additional cost and complexity. It is expected that existing water agency production wells will be used to recover the recharged water.

### 5.2.5 Infiltration Trench/Gallery

An infiltration gallery is assumed to be similar to a recharge well, but where the perforated pipe/slotted well screen is oriented horizontally in a gravel-lined trench, similar to a leachline for a septic system. Recharge water will flow by gravity through the perforated pipe which makes this a relatively simple option when compared to a pressurized leachfield described in the section that follows. As with a gravity recharge well, site selection for transmissivity is critical for optimizing recharge quantities.

### 5.2.6 Pressurized Leachfield

A pressurized leach field utilizes a system of perforated pipes installed in a series of shallow trenches backfilled with highly permeable material to disperse the discharge flow. The pipes and trenches are situated above the water table and recharge water is pumped into the perforated pipe/slotted well screen. A pressurized leach field uses the same principle as a percolation pond, namely percolation of discharge water through the unsaturated zone. The discharge flow percolates through the unsaturated soils to reach groundwater; thus, the trenches have no


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direct connection to underlying groundwater. Actual recharge capacity would depend upon the site-specific soil and aquifer characteristics.

## 5.3 Stormwater Recharge Approaches

There are several approaches for diversion of stormwater to be used for groundwater recharge. As described earlier, stormwater could be collected and diverted in gravity and/or pressurized facilities such as those described in Section 5.2. These approaches will likely require additional infrastructure as described in Section 5.3.1. and may require treatment as described in Section 5.3.2. An alternative approach is to implement Low Impact Development (LID) techniques as described in Section 5.3.3. LID is intended to treat smaller quantities of water so may need to be supplemented with additional storage in order to be able to recharge the larger quantities of rainwater that are available in the SMGB.

### 5.3.1 Storm drain diversion to dedicated aquifer recharge facilities

As summarized earlier, diversion of storm drain facilities may require infrastructure, especially, if it is to be directed to dedicated aquifer recharge facilities as described in Section 5.2. The infrastructure may include pipelines, or open channels, flow equalization and/or wet well structures, especially if the stormwater will have to be pumped. As discussed in Section 5.3.2, depending on the type, location, and flow to be diverted, settling and/or other treatment may be required prior to recharge.

If the diversion is coming from an urbanized, piped system, it may be easier to intercept and have higher flows, but may also have a higher pollutant load that will likely require treatment. Identifying the optimal location for interception to minimize pumping and treatment will be critical to using this type of runoff for recharge. If the diversion is for rural runoff from drainage ditches or local small, ephemeral streams, the treatment need may reduce because the water quality is likely better. However, the flow may also be reduced. These considerations should be evaluated during a feasibility study.

Stormwater collection or diversion would generally consist of the following major components:

- Pipeline or series of pipelines connected to existing stormwater discharge points or manholes upstream of the discharge points.
- Storage tank or wet well to collect and equalize the stormwater prior to pumping, if necessary.
- Pump system at the tank/wet well to pump the water from the tank/wet well to where the water will be treated and/or recharged. Recharge facilities are addressed Section 5.2.


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It should be noted that sizing of stormwater collection, diversion, and storage needs to be carefully evaluated because flows occur relatively infrequently and can be highly variable. Sizing is especially critical in pumping facilities whereby the highest flow rates occur infrequently and large pumping capacities are therefore infrequently used.

### 5.3.2 Potential Stormwater Treatment Measures

Depending on the recharge facility that will be used, stormwater treatment may be necessary prior to recharge. Treatment of urban runoff is challenging because of the need to improve water quality while managing for a wide range of flow conditions. Stormwater quality issues were previously discussed in Section 3.2. Most technologies to date have focused on passive treatment with no mechanical systems or active treatment. Some agencies with combined sanitary sewer/storm sewer systems provide active treatment such as activated sludge and other chemical/biological treatment processes. Additionally, a more recent focus is developing in the area of active treatment technologies using flocculants. Active treatment is not considered further for this study.

The typical passive treatment technologies currently in use include both public domain and propriatey devices. As defined by the California Stormwater Quality Association (CASQA), public domain devices can be designed and constructed without purchase of patented equipment while proprietary devices are purchased from vendors and cannot be re-created without potentially violating patents.

| Public Domain | Proprietary Devices |
|---|---|
| Constructed Wetlands | Vortex Separators |
| Wet Basins | Oil/Water Separators |
| Dry Basins | Media Filtration |
| Vegetated Swales and Buffer Strips | Drain Inlet Devices |
| Infiltration Systems | |

There are unique challenges associated with storm water treatment that must be considered in designing systems. As in stormwater pumping facilities, a key challenge is in sizing stormwater treatment to handle the variability associated with storm events and the uncontrolled large volume of water generated over a short period of time.

In implementing these storm water treatment technologies, various implementation strategies can be considered as follows.

- Distributed vs centralized systems
- Low impact development (LID) strategies to be discussed in Section 5.3.3


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- Storage and reuse strategies
- Hydromodification control strategies
- First flush capture strategies
- Hot spot capture strategies
- Treatment train strategies

Treatment selection decisions need to be driven by the storm water quality characteristics and the treatment objective to be attained. The types of pollutants, sources, dissolved fraction, particle size distributions, settling velocity, sediment chemistry all need to be considered along with the available technologies. These parameters are discharge specific and adequate characterization of the discharge must be completed.

In addition to the selection and design considerations to meet the treatment objectives, other considerations need to be addressed when implementing structural treatment devices in an urbanized setting. Examples of other considerations include.

- Maintenance requirements and cost
- Asthetics
- Ownership and responsibility
- Ordinances
- Other watershed, air, soil, and groundwater impacts

These measures would have to be coordinated with the stormwater management activities of the City of Scotts Valley, or other local jurisdictions.

### 5.3.3 Onsite Recharge of Runoff using LID techniques

An alternative to dedicated multi-use aquifer recharge facilities are smaller, more distributed treatment/runoff measures that can be implemented at individual sites using LID techniques. These measures, which include public domain measures summarized in Section 5.3.2 above, provide both water quality treatment and the potential for stormwater recharge. In the SMGB and the Carbonera Creek and Bean Creak Watersheds, LID measures have added benefits of reduced downstream hydromodification which is stream erosion from high peak flows and volumes which can result in reduced fish passage and habitat. LID measures are highly encouraged in stormwater management permits and appear to have available funding for implementation.


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**5.3.3.1 Low Impact Development**

As described earlier LID measures can be used to improve water quality and to allow first flush quantities of stormwater to recharge directly into the groundwater at multiple, disperse locations. If the facilities are sized to capture larger storm events than are typically used for treatment, recharge quantities can be increased. At a minimum, the LID measures would be installed with new development, as this tends to be more cost effective and is consistent with the City of Scotts Valley's Stormwater Management Plan. However, some large surfaces, such as parking lots or rooftops, could be retrofitted with LID measures such as:

- Pervious Pavement: Porous asphalt over geotextile over gravel base, plastic grid with trays filled with grass, or open grid paver blocks with the area between blocks filled with a porous medium. Subsurface storage can be enhanced with deeper gravel bases.

- Bioretention/Vegetated Facilities

    - Rain Gardens: Curb and gutter or other type of containment, planted topsoil, gravel layer, and weep holes or underdrain to drain excess water during high flow storm conditions.

    - Vegetated Swales and Buffer Strips: Depressed channel with native soil, compost and plants. An underdrain may be required if the swale does not discharge to another storm water conveyance system or has soils with low infiltration rates.

Other measures that could be applied for stormwater recharge have been discussed earlier in Section 5.2 and include:

- Infiltration Trench/Gallery

- Infiltration/detention basins. Water quality treatment requirements dictate that infiltration/detention facilities are generally sized for approximately 2-year return interval storm events. These could be oversized if sufficient flow exists to enhance additional recharge.

Some of the issues related to stormwater treatment using Infiltration Trenches and Infiltration/Detention Basins are described below:

- Operation and Maintenance
    - More difficult to establish vegetation on 2:1 slopes
    - Observe the drain time for several storm events to make sure it is consistent with calculations to prevent vector issues and is providing sufficient treatment
    - Maintenance check after major storms and at start and end of the wet season


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  - Sediment removal is typically at 10□ year intervals

- Expected Stormwater Treatment Performance
  - Interception of constituents from surface water is 100□ for the water quality volume infiltrated
  - Soluble constituents (TDS, Nitrate, some organic compounds) may contaminate groundwater
  - Not recommended in industrial areas or where groundwater contamination could be a problem from spills or dumping

A summary of the more technical aspects of the pervious pavement, bioretention, and vegetated swales and buffer strips are discussed in greater detail in the following sections. A more detailed discussion of the planning aspects that support LID implementation is provided in Appendix A.

Some of the specific considerations for implementation of LID in the SMGB are:

- Location is very important because the subsurface geology is such that there are some places that have nominal deep groundwater recharge benefit from recharge at the ground surface. The geology is such that the recharged water cannot easily flow to the aquifer which has the most storage capacity.

- Similarly, a close understanding of the storm drain system and the receiving creeks is important to removing flows that have greatest hydromodification benefit.

**5.3.3.2 Pervious Pavement and Interlocking Concrete Pavers**

Pervious concrete and pervious asphalt can be typically be used interchangeably to reduce runoff from paved areas. Pervious asphalt is typically cheaper than pervious concrete, although both are more expensive than traditional concrete and asphalt. In addition to reducing runoff, pervious paving can also reduce surface heat. In area with high traffic, conventional paving should be used. The pervious surface may eliminate the need for catch basins and a drainage system for the area in which it is used. This has two benefits, cost and the ability to have a flat surface.

*Pervious Pavement Source: Clear Creek Solutions; LID Hydrology and Hydraulics Presentation*


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Interlocking concrete pavers are available as both permeable and impermeable, although generally impermeable are used. Water is allowed to infiltrate between the pavers. Permeable pavers are able to handle heavy loads if properly designed. Pavers can be easily removed and replaced if settling occurs.

In either instance, the gravel base can range in thickness between 6-inches minimum by up to 3 feet or more, depending on the desired stormwater retention capacity of the pavement system. The subgrade should be evaluated by a geotechnical engineer. The subgrade should be un-compacted if possible, or should be compacted the minimum amount necessary to provide structural support for the pavement above, but not overly compacted to prevent infiltration.

*Interlocking Pavers- Source: Clear Creek Solutions; LID Hydrology and Hydraulics Presentation and Kennedy/Jenks Consultants Installation at Castaic Lake Water Agency*

**5.3.3.3 Elements of Bioretention**

Bioretention is the filtering of stormwater runoff through a terrestrial aerobic plant/soil/microbe complex to remove pollutants through a variety of physical, chemical, and biological processes. The word bioretention was derived from the fact that the biomass of the plant/microbe (flora and fauna) complex retains or uptakes many of the pollutants of concern such as nitrogen, phosphorus, and heavy metals. Plant matter traps oils and greases and allows it to degrade through ultraviolet exposure and/or biological processes. It is the optimization and combination of bioretention, biodegradation, physical and chemical, that makes this system the most efficient of all Best Management Practices for providing stormwater treatment. Types of bioretention include rain gardens, vegetated swales, and buffer strips. Infiltration and detention basins if designed appropriately can provide treatment and have been discussed in prior sections.


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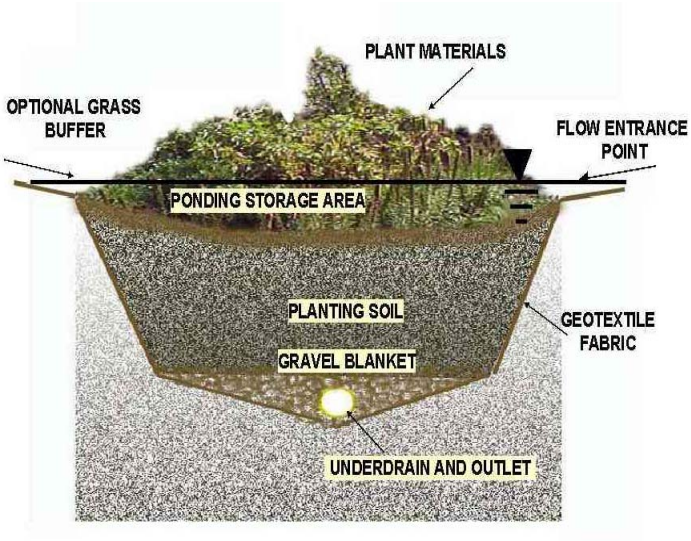
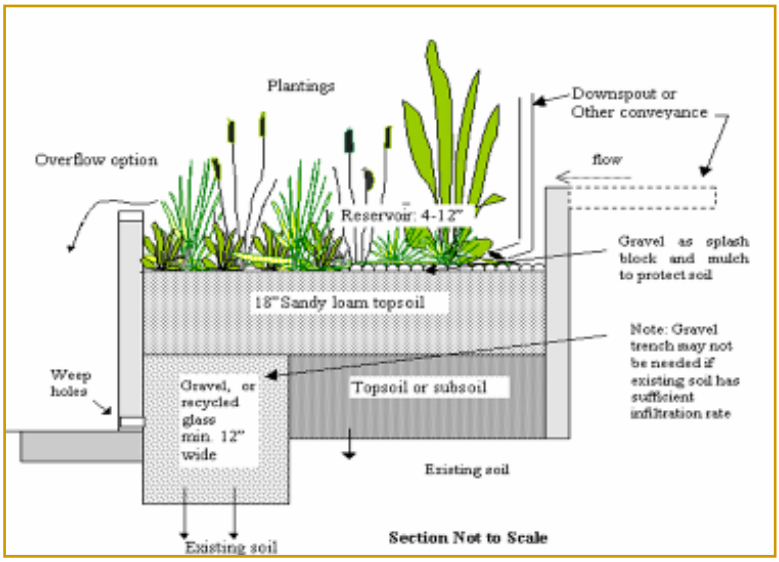
Bioretention measures are typically sized to provided stormwater treatment. They can be oversized to provide enhanced groundwater recharge. The example that follows shows a type of facility that could be used adjacent to a parking or road facility. The underdrain provides overflow protection should there be excessive flows to the facility beyond the infiltration capacity.




*Source: Larry Coffman, ACEC, Bioretention Rain Gardens Overview Presentation*

5.3.3.3.1 Rain Gardens

A rain gardens is a planted depression that is designed to absorb rainwater runoff from impervious urban areas like roofs, driveways, walkways, and compacted lawn areas and provide treatment of the runoff. There are several commercial and residential applications of rain gardens, some of them are shown in the figures below:




The example that is adjacent could be used adjacent to a building to capture and treat rooftop runoff from a residential or commercial building. Attention needs to be paid to protect the building foundation from water. .

*Source: Cunningham Engineering, Low Impact Development Site Planning Techniques Presentation*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The examples that follow show applications of stormwater treatment bioretention/rain gardens for parking lots, larger commercial buildings, as well as for road runoff in a residential area

*Source: Larry Coffman, ACEC, Bioretention Rain Gardens Overview Presentation*


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Filterra offers proprietary, compact, bioretention catch basin treatment units as shown below.

*Rain Gardens Overview Presentation (Urban Applications)*

*Source: Larry Coffman, ACEC, Bioretention*

The system components and features of Filterra treatment units include:

- Mulch
- Engineered media consisting of coarse sand, organics, and other soil components
- Plants

The units remove pollutants through a combination of sedimentation, filtration, adsorption, absorption, cation exchange capacity, polar/non-polar sorption, microbial action (aerobic and anaerobic), plant uptake, cycling of nutrients/carbon/metals, biomass retention and evaporation/volatilization. The biological treatment is provided in pore spaces, and on soil surfaces that create microbes/biofilm to remove contaminants

#### 5.3.3.3.2 Vegetated Controls: Vegetated Swales and Buffer Strips

Some relatively simple examples of the use of vegetation to cleanse stormwater are vegetated swales and buffer strips which are planted areas adjacent to impervious surfaces that provided filtration and treatment for small, frequent storm events.

##### Vegetated Swales

Vegetated swales are designed to convey concentrated flow. The swales are generally a flat bottomed channel (as shown in the graphic that follows) and can treat up to about 10 tributary acres.


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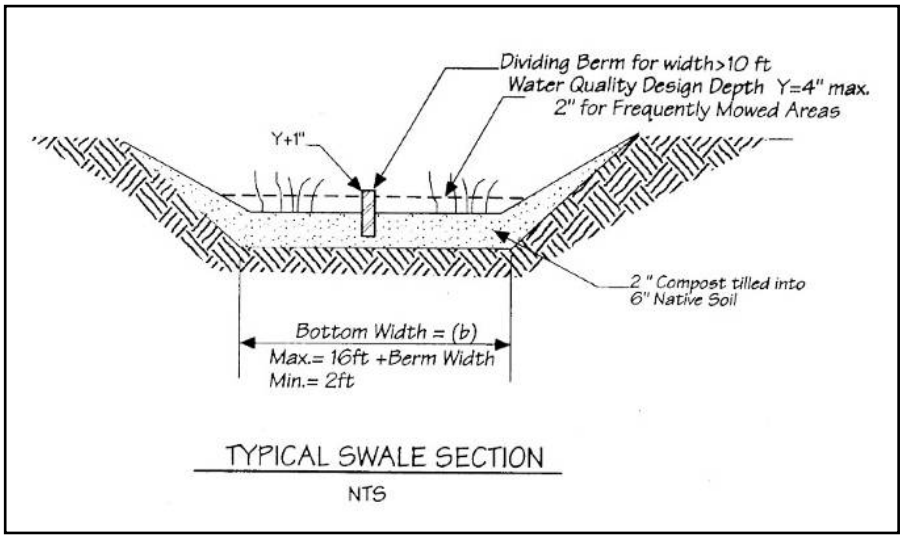
Design considerations for vegetated swales include

- 1 to 2 □ slope in the direction of flow
- 6□ maximum slope
- Hydraulic residence time □5 minutes
- Velocity □1 feet per second
- Vegetate with fine, turf-forming grass
- Mowing grass is optional

(Reference: WEF Urban Runoff Quality Management)




*Source: RBF Consulting, Vegetated Controls Presentation*

Swale Performance

- Removes gross pollutants, coarse and medium sized particulates
- Some dissolved removal depending on quantity of infiltration
- Tend to export total and fecal coliform
- About 30□ and 60□ TPH oil and diesel removal respectively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## Examples of Vegetated Swales

*RBF Consulting, Vegetated Controls Presentation (King County and Orlando Swale)*

*RBF Consulting, Vegetated Controls Presentation (Baltimore Swale)*

## Buffer Strips

Buffer strips are used to diffuse shallow sheet flow across a vegetated surface adjacent to roadways and parking areas. The buffer strips generally have a maximum tributary area of 100 square-foot per foot of buffer strip. Since buffer strips typically offer treatment of low,


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frequent flows, stormwater management for high flows needs to be considered adjacent to buffer strip areas.

### Example of a Buffer Strip

*RBF Consulting, Vegetated Controls Presentation*

Advantages of Vegetated Swales and Buffer Strips:

- Viewed as landscape
- Inexpensive
- Urban development or roadway drainage conveyance
- Minimal Maintenance
- Significant water quality benefit

Limitations to Vegetated Swales and Buffer Strips:

- Cannot treat a very large drainage area (□10Ac)
- May not have significant attenuation of the Volume and Rate of Runoff during intense rain events
- Dissolved constituents removal only through infiltration
- Channelization may occur
- Require surface area


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## 5.4 Treatment and Delivery of Surface Water for In-lieu Benefit Directly or in Exchange

As discussed earlier in Section 3.4, there are several options for in-lieu recharge by providing an alternative potable supply that is not groundwater. The delivered water can be used for direct potable reuse and/or for groundwater recharge. The first option is to use available wintertime capacity in existing diversion and treatment facilities and building infrastructure to deliver the treated water which is being called an exchange option. Another option is to use an existing or new diversion from one of the surface water bodies and treating it in a new surface water filtration plant and conveying the treated water to end users which is being called a direct delivery option. Both options are described as follows.

Exchange

Treated water could be transferred from an adjacent agency, such as the SCWD's Graham Hill Water Treatment Plant, and would generally consist of the following components:

- Connection to the adjacent agency's closest pipeline via a tee and valves.
- A meter station, consisting of a flow meter, bypass line, and valves. A pressure reducing valve may also be required depending upon the pressures in the sending and receiving systems.
- A pipeline and possibly pump station, between the adjacent water supplier and the receiving agency's distribution system and/or the recharge area.
- A discharge to a groundwater recharge basin, which would likely consist of a concrete box with overflows or pipe connections; or a tee with valves connecting to the receiving agency's distribution system.

As described earlier, SVWD is already in discussions with SCWD to evaluate the feasibility of an exchange between the two agencies. In addition, an intertie to allow an exchange between the various SLVWD systems is also being evaluated. The exchange option may provide the simplest, most cost-effective means of providing in-lieu benefit to the SMGB.

Direct Delivery

Direct delivery of surface water would require either the surface diversion facilities described in Section 5.1.1 or the subsurface diversion facilities described in Section 5.1.2. In addition to the diversion facilities, direct delivery would require conveyance pipelines and possibly pump stations to treatment and distribution facilities as well as treatment facilities to meet the surface water treatment rule. A subsurface diversion facility could reduce the required treatment level


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depending on whether the water is considered groundwater under the direct influence of surface water.

A surface water filtration plant can either be a conventional media filtration plant or a membrane filtration plant. A conventional media filtration plant or even a simple slow sand filtration system will likely have greater space requirements than a membrane (microfiltration or ultrafiltration) treatment plant. Disinfection facilities including feed systems and contact facilities will also be required to meet the surface water treatment rule. Operations and maintenance of a surface water treatment system to meet the surface water treatment rule will also require licensed treatment plant operators.

# 6 Planning-Level Cost estimating approach

The Conjunctive Use and Enhanced Aquifer Recharge Project is the first phase of a larger feasibility study to evaluate potential conjunctive use projects in the southern Santa Margarita Groundwater Basin (SMGB). These projects may have many alternatives, including new water sources, storm water recovery, and groundwater recharge. As part of this project, a set of these alternatives will be developed and evaluated to mitigate declines in groundwater levels. Part of the evaluation will be to prepare a planning level engineers opinion of probable construction costs (cost estimates) for up to three alternatives. This memo presents a general description of the assumptions that will be used in developing the cost estimates. Where available for specific types of facilities (e.g. injection wells, recharge ponds, etc.), more specific estimates for an overall facility will be used in-lieu of creating an estimate from a unit cost basis.

## 6.1 Factors and Contingencies

The capital cost estimates will include the following:

- Unit Costs for construction items (described in following sections) which will be marked up with the following factors to arrive at a capital cost estimate
- Construction contingency: 25□
- Contractor overhead and profit: 15□
- Design, construction management, and administration: 25□

Based on the unit costs described below and factors and contingencies assumed above, the estimate of probable construction cost is a conceptual, order of magnitude estimate with an accuracy of □50□ to □30□ .


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For the three recommended alternatives, annual operation and maintenance (O□M) costs, will be estimated to be 10□ of the total capital costs for the pumps and 5□ for the other items. The capital and O□M costs will be converted to lifecycle costs, assuming a 20-year lifecycle and 5 percent interest rate.

## 6.2 Unit Capital Costs

Where required by the recommended alternative, the following types of construction will be used to develop the overall estimate for the alternative.

### 6.2.1 Pipeline Installation

The estimated costs for pipeline construction will be based on a unit cost of □20/lineal foot (lf) of pipeline / inch diameter. This unit cost includes sawcutting and pavement removal, excavation, shoring, bedding installation, pipeline installation, backfilling, compaction, and pavement restoration. Bore and jack costs for highway crossings are not included in this cost and will be estimated separately if necessary.

### 6.2.2 Concrete

The estimated costs for concrete installation will be based on a unit cost of □500 per cubic yard of concrete in place. This unit cost includes formwork, reinforcement, and concrete.

### 6.2.3 Earthwork

The estimated costs for excavation, such as for recharge basins, will be based on a unit cost of □5 per cubic yard. This unit cost includes excavation, on-site hauling, and on-site disposal.

One cubic yard equals 27 cubic feet equals 202 gallons. So, the unit cost per gallon would be about □0.025 per gallon.

### 6.2.4 Above Ground Storage Tank

The estimated costs for above ground steel storage tanks will be based on a unit cost of □1 per gallon stored. The unit cost includes site grading, foundation construction, tank installation, and on-site piping.

### 6.2.5 Wells

The estimated costs for well construction, assumes a 6-inch diameter well approximately 200 feet deep, will be based on a unit cost of □200 per foot of depth. The unit cost includes drilling, well screen and casing installation, well cap installation, and well development.


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### 6.2.6 Well Pumps

The estimated cost for a well pump, assumes a pumping rate of 250 gallons per minute (gpm), will be based on a lump sum cost of □85,000 per pump and motor. The unit cost includes connecting the pump to discharge piping and installing the pump with piping but does not include disinfection, treatment, electrical or SCADA instrumentation and controls.

### 6.2.7 Booster Pumps

The estimated costs for a booster pump and motor, assuming up to 2,500 gpm, will be based on a lump sum cost of □50,000. The cost includes installing the pump outside on a concrete slab but does not include electrical or SCADA instrumentation and controls.

### 6.2.8 Iron and Manganese Treatment

The estimated costs for iron and manganese treatment will be based on a unit cost of □500 per gallon per minute. The unit cost includes the treatment system installed outside on a concrete slab.

### 6.2.9 LID Construction Costs

In order to provide order of magnitude planning estimates for LID measures, the 2009 Water Environment Research Foundation (WERF) Whole Life Cost Spreadsheet model was used to develop estimated capital costs for the types of LID measures that enhance infiltration that may be used for new or retrofit construction. The estimates were prepared for a generic 0.5 acre site and are summarized in the table that follows. These estimates should be compared to the actual costs from the stormwater retrofit projects currently underway.


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| LID Type | Estimated 2010 Cost for 0.5 Acre Impervious Area | Notes |
|---|---|---|
| Pervious Pavement - Asphalt | □1.50/ft2 for new construction | Based on □1/ft2 installed cost; and 25□ design allowance and 20□ contingency. Estimated yield for 3 ft of rainfall/yr □ 1.5 AFY |
| Pervious Pavement - Concrete | □9.75/ft2 for new construction | Based on □6.50/ft2 installed cost; and 25□ design allowance and 20□ contingency. Estimated yield for 3 ft of rainfall/yr □ 1.5 AFY |
| Vegetated Swale | □0.40/ft2 of tributary drainage area for new construction | Based on construction cost of □0.32/ft2 tributary drainage area adjusted for small project plus 25□ for engineering and planning; Approx 870 ft2 of swale (based on 4□ of tributary area) for an estimated yield for 3 ft of rainfall/yr □0.06 AFY |
| Curb Contained Bio-retention | □1.10/ft2 for 1,300 ft2 of bioretention as retrofit | Based on construction cost of □0.97/ft2 of tributary drainage area plus 25□ engineering/planning and retrofit adjustment; 1,300 ft2 of bioretention area for an estimated yield for 3 ft of rainfall/yr □ 0.09 AFY |


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### 6.2.10 Facility Construction Estimates

Based on prior work Kennedy/Jenks has conducted, more specific cost estimates for treatment plants and recharge facilities have been developed. These costs are summarized in the table below and could be used to simplify cost estimating for alternatives.

| Facility Type | Estimated 2010 Cost for 1 MGD/1.6 cfs/560 AFY (over 6 months) Facility | Notes |
|---|---|---|
| Microfiltration Membrane Surface Water Treatment Plant | 2.1 million | Includes land acquisition |
| Percolation Pond | 3 million | Includes land acquisition |
| Recharge/Infiltration Basin | 15.8 Million | Includes land acquisition and full excavation costs |
| Pressurized Leach Line | 3.8 million | |
| Injection Well Facilities (linear) | 3 million | Assumes construction along roadway and includes sufficient wells to accommodate resting of wells |
| Injection Well Facilities (rectangular) | 4.1 million | Assumes construction within rectangular footprint, requiring more land and includes sufficient wells to accommodate resting of wells |


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# Appendix A


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Appendix A: Overview of LID Planning, Construction, and Inspection and Maintenance Topics

## LID Site Planning Principles

1. Site hydrology is fundamental to the plan
2. Address runoff at its source
3. Think small-scale
4. Keep it simple
5. Integrate the drainage solutions into a multi-functional landscape
    - Sandy play area
    - Swale in greenbelt corridor
    - Bioretention
    - Rainwater as a design element

## LID Site Planning Process

1. Research Regulatory context
    - Flexibility in zoning requirements
2. Perform initial site evaluation
    - Topography and drainage patterns
    - Soils and infiltration potential
    - Quantify pre-development hydrology
3. Define development envelope
    - Maintain natural features
    - Retain predevelopment drainage patterns
    - Impervious area on least pervious soils
    - Compact layout
4. Reduce impervious area (IA)
    - Reduce building footprints
    - Green roofs
    - Increase aspect ratio of lots
    - Cluster buildings
    - Reduce size of parking areas
    - Narrower streets
    - Pervious paving
5. Reduce directly-connected impervious area (DCIA)
    - Filter strips
    - Swales
    - Distributed small scale storage
    - Bioretention
    - Pervious pavement
6. Preliminary LID-integrated site layout


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7. Compute post-development site hydrology
8. Refine LID elements
9. Re-compute post-development hydrology  complete LID site plan

## Construction Considerations

- Preconstruction meeting with the contractor / owner / architect / engineer
- Geotechnical Report
- Ensure sediment control measures in place
- Sub grade soils and preparation.
- Presence of ground water
- Under drain and filter media installation.
- Soil certifications for back fill.
- Topsoil layers should be thoroughly wetted to achieve settlement.
- Plant placement / warrantee / type
- Proper site grading
- Site stabilization before planting.
- Location of underground utilities

## Inspection  Maintenance

- Require a long term maintenance plan
- Non Erosive Designs Inlet / Outlet / Flow- through
- Sediment build-up
- Annual inspection / plant care
- Excessive ponding (Longer than 8 hours)
- Use underdrains
- Right Vegetation
- Spills


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