SCOTTS VALLEY WATER DISTRICT
GROUNDWATER MANAGEMENT PROGRAM

2003 - 2004
ANNUAL REPORT

Prepared For:

Scotts Valley Water District
Two Civic Center Drive
Scotts Valley, California 95066

Prepared By:

ETIC Engineering, Inc.
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Oakland, California 94612

June 2005

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EXECUTIVE SUMMARY

INTRODUCTION

This report summarizes the Scotts Valley Water District (SVWD) Groundwater Management Program (GWM Program) and related management activities for the 2003-2004 Water Year, which covers the period from October 2003 to September 2004. This report provides a comprehensive review of water resource conditions and groundwater management activities in the Scotts Valley area to assist the SVWD in future decision-making and management of the basin.

A water year runs from October through September of the following year for the purpose of grouping the typically higher precipitation months of October through April. Therefore, the 2003–2004 Water Year covers the period from October 2003 through September 2004. For this report, the 2003–2004 Water Year will be referred to as WY2004. Similarly, historical data that are referred to by water year will also use a similar designation.

GROUNDWATER MANAGEMENT PLAN

In 1994, the Scotts Valley Groundwater Management Plan (GWM Plan) was adopted by the SVWD in accordance with Assembly Bill 3030 (AB3030) groundwater management planning legislation, now included in water code sections 10753-10753.10 (Todd Engineers 1994). The SVWD GWM Plan was the third AB3030 plan recorded by the California Department of Water Resources (DWR). The AB3030 plan was intended to encourage groundwater management by local water agencies in non-adjudicated groundwater basins. The 1994 SVWD GWM Plan focused on two major goals:

- Management of groundwater supplies to meet present and future demands and to provide for downstream water rights and instream uses, and
- Protection of water quality and remediation of existing groundwater contamination.

The SVWD has actively managed groundwater since 1984. Management efforts have included monitoring of climatic, surface water, and groundwater conditions in the basin. Annual reports provide a source of reference for public and agency input, as well as establishing monitoring and reporting procedures. This is the eleventh annual report of the SVWD GWM Program under the 1994 SVWD GWM Plan.

Regular interaction and cooperation among local agencies is concentrated within the Santa Margarita Groundwater Basin Advisory Committee. This committee was established in June 1995 by means of a Memorandum of Understanding (Member Agencies 1995) among SVWD, San Lorenzo Valley Water District (SLVWD), Lompico County Water District, City of Scotts Valley, and County of Santa Cruz.

The groundwater management planning statutes require that the local agency make available to the public a written statement describing the manner in which interested parties may participate. The SVWD encouraged public participation primarily through its recommendations for annual reporting of water resource conditions and for meetings with local groundwater producers. In addition, summaries are provided in the agenda for the SVWD Board, SVWD committees, and the Santa Margarita Groundwater Basin Advisory Committee, which are posted locally. All meetings of the SVWD Board of Directors are open to the public and are publicly noticed in either the Scotts Valley Banner or the Santa Cruz Sentinel. The SVWD General Manager also provides an annual presentation on the state of the groundwater supply to the Scotts Valley City Council at one of its televised public meetings in the spring.

GROUNDWATER MANAGEMENT ACTIONS

A key indication of the commitment to the GWM Plan by the SVWD and the City of Scotts Valley is the Water Recycling Program. The program is a cooperative effort between the City of Scotts Valley and the SVWD to enhance the existing water resources for Scotts Valley. The Water Recycling Program is the first of its kind to operate in Santa Cruz County and a proactive step in addressing the water conservation objectives established by AB3030. The program began in 2002 and provides additional water supplies for use mainly for irrigation.

Importantly, water usage by the SVWD decreased in WY2004. Water supply augmentation measures, such as the Water Recycling Project, can be credited with at least a portion of this decrease. Continued efforts to expand the use of recycled water are continuing where appropriate to reduce the demand on groundwater for irrigation and landscaping uses.

In July 2004, the SVWD was awarded with a $225,000 Local Groundwater Assistance Program (AB303) grant from DWR to update the existing numerical, basin-wide, groundwater flow model. The AB303 numerical model update includes a re-evaluation of the hydrogeological conceptual model of the basin via a thorough analysis of the available geologic and hydrogeologic data. This updated hydrogeological conceptual model will be incorporated into an updated and recalibrated numerical model that can proactively and efficiently support groundwater management. The types of issues that this model will address include:

- Assessing the available aquifer storage volume;
- Defining the perennial yield for the aquifer, including effects of water quality; and
- Providing input regarding the impacts of land use decisions on water supply.

The grant is being administered by the SVWD, with a Technical Advisory Committee (TAC) comprised of members from the SVWD, SLVWD, and Santa Cruz County.

HYDROGEOLOGY

Scotts Valley is situated on the southwestern slope of the central Santa Cruz Mountains in Santa Cruz County (USGS 1998). For this report, the study area covers the portion of the Santa Margarita Groundwater Basin that most directly affects the SVWD. Specifically, the Scotts Valley study area is defined as the portion of the Santa Margarita Groundwater Basin that is south and east of Bean Creek.

The primary aquifers in the Scotts Valley area are the Santa Margarita Sandstone, the Lompico Sandstone, and the Butano Formation. The Santa Margarita and Lompico Sandstones have long been recognized as primary aquifers in the Scotts Valley area. The Santa Margarita Sandstone unit has a long history of groundwater production with several large production wells (Muir 1981). The Lompico Sandstone is currently the primary groundwater producing horizon in the Scotts Valley area, with several large production wells completed in this unit.

The sediments in the basin have been folded during geologic deformation associated with the development of the Coast Range (Clark 1981). The complex geology resulting from this geologic deformation is important in understanding the hydrogeologic characteristics in the Scotts Valley area. As part of the AB303 numerical model update, a comprehensive review of the hydrogeological data is being conducted to update the conceptual model, or hydrogeological understanding, of the area. As a result of this review, the SVWD Wells #3B and #7A have been reinterpreted as being completed all or mostly within the lower sandstone member of the Butano Formation (Figure 3-4). The production history of these wells indicates that the Butano Formation is capable of producing significant volumes of groundwater.

GROUNDWATER SUPPLY MONITORING

In an effort to identify and evaluate the dynamic water supply conditions in Scotts Valley, the SVWD began collecting basic hydrologic data for the region in 1983. The groundwater supply monitoring program includes collection of a variety of data such as:

- Operations data, including groundwater pumping by the SVWD and neighboring water users, and water use for the SVWD Water Recycling Program;
- Climate related data, including rainfall, evaporation, and evapotranspiration in the Scotts Valley area;
- Surface water data, including measurements of stream flow spring discharge;
- Groundwater level data, including groundwater elevation measurements collected by SVWD, other local agencies, private entities, and consultants; and
- Water quality data, including analysis of chemical composition of groundwater by the SVWD, other local agencies, private entities, and consultants.

GROUNDWATER SUPPLY ASSESSMENT

Groundwater Pumping

In WY2004, SVWD groundwater production was from six wells: SVWD Wells #3B, #7A, #11A, and #11B in the North Scotts Valley area, and SVWD Wells #9 and #10 in the South Scotts Valley area – Camp Evers subarea. SVWD Wells #7A and #11B accounted for over 60 percent of the total SVWD metered pumping in both WY2003 and WY2004; however, the combined pumping was decreased in these two wells by approximately 102 acre-feet in WY2004. Groundwater pumping was increased in Wells #3B and #11A by 114 acre-feet from WY2003 to WY2004. Overall, total metered groundwater pumping by SVWD was decreased by 96 acre-feet from WY2003 to WY2004. SVWD groundwater pumping has increased steadily from 470 acre-feet in WY1976 to approximately 2,000 acre-feet per year since WY2000 (Figure 5-2). This trend corresponds to increases in the population of the City of Scotts Valley from 3,621 in 1970, to 11,385 in 2000. Although population increased approximately at a rate of 253% groundwater pumping by SVWD increased at a rate of 426% during the same time period. The increase in water consumption is significantly higher than the increase in population over the same period. This discrepancy is related to the effort to switch existing Scotts Valley residents from private wells to SVWD provided water and encourage new development to tap into the SVWD distribution system. It can also be attributed to the change in development patterns in the area from rural lots with limited need for landscaping irrigation to the development of more suburban subdivisions requiring landscaping irrigation for non-native landscapes.

The total groundwater pumping by other users in the Scotts Valley area has also increased significantly. Based on available data, total groundwater pumping has risen from approximately 1,400 acre-feet in WY1976 to over 3,500 acre-feet in WY2000. Groundwater pumping by other water suppliers (SLVWD, Mt. Hermon Association, Mañana Woods Mutual Water Company) has increased from 927 acre-feet in 1976 to a maximum of 1,581 acre-feet in 2001.

Precipitation

The most significant source of groundwater recharge for the Scotts Valley area is precipitation. The WY2004 rainfall amounts at the Scotts Valley El Pueblo Yard and the Scotts Valley Wastewater Treatment Facility (WWTP) station were 37.04 and 40.15 inches, respectively. This was approximately 5 inches below the average annual precipitation of 42.2 and 44.7 inches, respectively, based on the historical records available for each station.

One method to evaluate the cumulative effect of the variations in rainfall over time is a departure analysis. For this analysis, the difference between the measured and average rainfall for each year is summed over the interval of interest. By assuming that after WY1983 the basin was nearly full, evaluating the departure since WY1983 provides an analysis of current conditions. Using this assumption, the Scotts Valley area remains in a rainfall deficit of approximately 60 inches since WY1983. Therefore, it will require several years of above-average rainfall for the Scotts Valley area to make up the deficit produced by the 1984 through 1994 drought period.

The impact on groundwater supply is that the area is still lacking the rainfall necessary to recharge the aquifers to build up groundwater levels to pre-drought conditions. It should be noted that the recovery of groundwater levels is not only hindered by deficiencies in precipitation but also as a result of increased pumping within the basin.

Surface Water

Carbonera Creek shows a close correlation between stream flow and precipitation, with the highest flows showing little to no delay after the main precipitation events. Further, the stream flow declined in March 2004 in response to low late-season precipitation resulting in a decrease in stream flow approximately one month earlier than average. In WY2004 Bean Creek stream flow closely matched average stream flow. The highest stream flows were measured in February 2004 rather than December 2003. Moreover the decline in stream flow from March 2004 through May 2004 was slightly below normal.

Groundwater Levels

Santa Margarita Sandstone

Groundwater flow in the Santa Margarita Sandstone is characterized as compartmentalized, where groundwater flows from a local recharge area toward a local discharge point. Groundwater recharge is primarily from precipitation falling on Santa Margarita Sandstone outcrops or infiltration along a portion of Carbonera Creek. Bean Creek also acts as a recharge point for the Santa Margarita Sandstone in the North Scotts Valley area. This is evident intermittently when reaches of Bean Creek become dry in summer months when all the upstream flow percolates into the Santa Margarita sandstone. Groundwater outflow is typically through discharge at a spring or stream. Bean Creek is a major discharge point for the Santa Margarita Sandstone in the South Scotts Valley area. Groundwater outflow also occurs where the Santa Margarita and Lompico Sandstones are in direct contact.

In the South Scotts Valley area – Camp Evers subarea, groundwater elevations have declined by 100 to 150 feet compared to the WY1983 levels. Water levels in the South Scotts Valley area indicate that groundwater elevations in the Lompico and Santa Margarita Sandstones are closely related. This is primarily the result of groundwater flow between the Lompico and Santa Margarita Sandstones through a contact point where the Monterey Formation is absent. North of this "window", the intervening Monterey Formation effectively eliminated groundwater flow between the Lompico and Santa Margarita Sandstones. To the south of this "window.", the Lompico Sandstone is absent. These conditions allowed water levels in the Santa Margarita Sandstone to remain more stable in areas farther away from the "window".

In WY2004 groundwater pumping from the Santa Margarita Sandstone was estimated at 311 acre-feet, up from 284 acre-feet in WY2003. Only a minor portion of the WY2004 pumping was for water supply as both the water supply wells, SVWD Well #9, and Mañana Woods #2, obtain a significant portion of their production from deeper zones. Importantly, over 50% of this production was for environmental remediation of contaminant plumes. The remainder is for irrigation and landscaping purposes by private users. The Santa Margarita Sandstone/Monterey Formation accounts for only about 2% of the total production by SVWD.

Lompico Sandstone

Groundwater flow in the Lompico Sandstone is primarily controlled by the large pumping wells completed within this geologic unit. Historically, groundwater elevations from the Lompico Sandstone reflect the presence of a depression along the eastern margin of the basin at these pumping centers. Groundwater inflow is primarily from flow through the Lompico Sandstone from the north near the center of the Santa Margarita Groundwater Basin. In the Scotts Valley area, groundwater recharge to the Lompico Sandstone is primarily from the Santa Margarita Sandstone. Other recharge areas are limited to surface exposures of the Lompico Sandstone along the northern and western margins of the Santa Margarita Sandstone; either directly by precipitation or infiltration from streams.

Few natural points of groundwater discharge are noted for the Lompico Sandstone in the Scotts Valley area. Historically, groundwater from the Lompico Sandstone may have recharged the Santa Margarita Sandstone through the area of direct contact in the Camp Evers area. Groundwater outflow from the Lompico Sandstone is primarily through groundwater pumping wells. Groundwater pumping from the Lompico Sandstone was estimated at 2,086 acre-feet in WY2004, down from 2,303 acre-feet in WY2003. Nearly all (over 97%) of the WY2004 Lompico Sandstone production pumping was for water supply purposes. The Lompico Sandstone accounts for approximately 68% of the total production by SVWD; only a minor portion of the total pumping amount was used by private users for irrigation and landscaping.

Butano Formation

The hydrogeologic significance of the Butano Formation has only recently been identified during the hydrogeologic characterization for the AB303 numerical model update. Groundwater recharge is inferred to come primarily from the infiltration of precipitation or stream flow occurring on Butano Formation outcrops or north of Scotts Valley. Groundwater outflow is not clearly understood at this point. The AB303 numerical model input should provide some insight into groundwater flow within the Butano Formation.

Groundwater pumping from the Butano Formation was estimated at 588 acre-feet in WY2004 up from 535 acre-feet in WY2003. The Butano Formation accounts for approximately 30% of the total production by SVWD. Almost all of the WY2004 Butano Formation production pumping comes from the SVWD Wells #3B and #7A and was used for water supply purposes with the exception of private domestic pumping in the region.

WATER QUALITY ASSESSMENT

Water Quality

Water quality in SVWD Well #9 has declined in recent years, with a rise in total dissolved solids (TDS) due primarily to a rise in sulfates. This is attributed to a higher percentage of the production being derived from the Monterey Formation, as groundwater levels have declined over 160 feet over the past 20 years in the Santa Margarita Sandstone near SVWD Well #9.

The Santa Margarita Sandstone has been impacted by several contaminant plumes including the Watkins-Johnson site, the Camp Evers methyl-tert-butyl ether (MtBE) plume, and the Scotts Valley Dry Cleaners. Groundwater from SVWD Well #9 is treated using granular activated carbon (GAC) to remove any low levels of chlorinated solvents and gasoline-derived chemicals. Benzene, 1,2-dichloroethane (1,2-DCA), trichloroethene (TCE), and 1,2-dichloroethylene (1,2-DCE) have historically been detected in this well but the source has yet to be determined.

Water quality in wells pumping from the Lompico Sandstone has declined in recent years, with a rise in TDS, iron, and manganese concentrations. This is likely due to the inflow of groundwater from the north, where groundwater is inferred to have had a higher residence time in the aquifer allowing it to become more mineralized. Arsenic concentrations in Wells #11A and #11B are highly variable and have sporadically exceeded the newly revised maximum concentration level (MCL) for arsenic. Tetrachloroethene (PCE) has been noted in monitoring wells at the Scotts Valley Dry Cleaners site near to SVWD Well #10.

Water quality in wells pumping from the Butano Formation has varied in recent years. TDS concentrations have risen above secondary MCLs, whereas iron concentrations have declined below secondary MCLs. Manganese occasionally exceeds secondary MCLs. Secondary MCL s are based on aesthetic quality of water rather than public health concerns. Importantly, water quality parameters are well within drinking water standards. Of note, arsenic and nitrate have never been detected in the Butano Formation wells.

Environmental Compliance

The SVWD actively monitors sites where groundwater quality has been compromised by pollution or chemical spills. The SVWD retains and exercises its opportunity to comment on environmental compliance reports, actions, or other documents involving these sites. The relevant groundwater contamination issues within the SVWD area include:

- Scotts Valley Dry Cleaners – PCE Plume
- Watkins-Johnson Site – PCE/TCE Plume
- Camp Evers – MtBE Plume
- Scotts Valley Drive - Chlorobenzene Plume
- Hidden Oaks Well and SVWD Well #9 - Benzene Plume
- Hacienda Drive Shell - Petroleum Hydrocarbon Plume

PCE contamination in groundwater resulting from the Scotts Valley Dry Cleaners could potentially impact SVWD Well #10; although PCE has not been detected in SVWD Well #10 to date, the data from surrounding monitoring wells demonstrates PCE migration in the general direction of this water supply well. The site has thus far been insufficiently characterized and therefore the contaminant plume has not been adequately delineated.

Another site containing volatile organic compounds (VOCs), primarily TCE and PCE, is the Watkins-Johnson site. The site history shows that TCE and PCE concentrations have declined over time. TCE concentrations have declined from a maximum of 13,000 µg/L in 1986 to 22 µg/L in 2004. However, the ongoing remediation pumping of 143 acre-feet per year is likely contributing to reduced groundwater levels and production at SVWD Well #9.

Impacts from the other four aforementioned sites have been addressed through remediation or production well-head treatment and are discussed in detail in the water quality chapter of this document.

CONCLUSIONS

Santa Margarita Sandstone

- Declining groundwater levels continue to be an issue for the Santa Margarita Sandstone primarily in South Scotts Valley area – Camp Evers subarea.
- Groundwater flow in the Santa Margarita Sandstone is characterized as compartmentalized, where groundwater flows from a local recharge area towards a local discharge point.
- Groundwater pumping from the Santa Margarita Sandstone was estimated at 311 acre-feet in WY2004, up from 284 acre-feet in WY2003.

- Water quality in SVWD Well #9 has declined in recent years, with a rise in TDS that is mainly due to a rise in sulfates.
- The Santa Margarita Sandstone has been impacted by contaminant plumes including the Watkins-Johnson site, the Camp Evers MtBE plume, and the Scotts Valley Dry Cleaner.

Lompico Sandstone

- Groundwater flow in the Lompico Sandstone is primarily controlled by the large pumping wells completed within this geologic unit.
- Groundwater pumping from the Lompico Sandstone was estimated at 2,086 acre-feet in WY2004, down from 2,303 acre-feet in WY2003.
- In most areas, groundwater levels in the Lompico Sandstone have declined 150 to 200 feet over the past 20 years in the Scotts Valley area.
- Water quality in Lompico Sandstone has declined in recent years, with a rise primarily in TDS, iron, and manganese.
- The Lompico Sandstone has been less impacted by contaminant plumes. Low levels of chlorobenzene have impacted Wells #11A and #11B.

Butano Formation

- The hydrogeologic significance of the Butano Formation has only recently been identified during the hydrogeologic characterization for the AB303 numerical model update.
- All of the metered WY2004 Butano Formation production is for water supply purposes and is derived from SVWD Wells #3B and #7A. Groundwater pumping from the Butano Formation was estimated at 588 acre-feet in WY2004, up from 535 acre-feet in WY2003.
- The Butano Formation may hold the greatest potential and capacity for expansion of groundwater resources in the future; however, groundwater occurrence and movement in this geologic unit are not well understood at this point.
- Water quality in the Butano Formation has varied in recent years, although most water quality parameters are well within drinking water standards.

PROGRESS ON PREVIOUS RECOMMENDATIONS

Part of SVWD's accomplishments over the past year includes progress on the recommendations included in the 2002-2003 SVWD GWM Program Annual Report (Todd Engineers 2003).

- SVWD has continued the GWM Program through the publication of this document and its continued effort to monitor groundwater conditions throughout the Santa Margarita Groundwater Basin.

- In July 2004, SVWD was awarded a Local Groundwater Assistance Program grant from DWR to update the existing numerical model, evaluate groundwater storage, and evaluate stream flow/groundwater relationships.
- The water recycling program nearly doubled the volume delivered in the past year and continues to expand operations throughout the Scotts Valley area.

RECOMMENDATIONS

- The AB303 numerical model update should be applied to better quantify the water budget and changes in groundwater storage for the Scotts Valley area.
- Continued efforts to expand use of recycled water should be made where appropriate to reduce the demand on groundwater for irrigation and landscaping uses.
- As the Water Recycling Program continues to expand, the monitoring program should continue to be updated as well. In particular, additional shallow monitor wells should be identified that could be used to expand the water quality monitoring network.
- The SVWD should review its current groundwater elevation monitoring plan to ensure that groundwater elevations are collected from the specified wells on, at a minimum, a semi-annual basis.
- Groundwater level monitoring equipment with the SVWD production wells should be checked and calibrated periodically.
- SVWD should present the updated hydrogeological conceptual model to the USEPA and Watkins-Johnson and discuss the anticipated duration of the ongoing environmental restoration program. It may be appropriate to significantly reduce groundwater pumping for environmental remediation at the site.
- Impacted water beneath the Scotts Valley Dry Cleaners site has not been adequately characterized, with particular emphasis on potential impact to SVWD Well #10. Increases in contaminant concentrations in MW-9 between the release area and SVWD Well #10 suggest contaminant transport towards the water supply well. More multi-level well completions are necessary to characterize the complex hydrogeology in this area.
- Investigation of potential sites to augment groundwater recharge should continue.
- SVWD should coordinate with the City of Scotts Valley to implement incentives for residents and businesses to incorporate storm water conservation methods. Storm water can be captured from paved surfaces and roofs for the purpose of recharge into the underlying aquifers. Incentives should be made for new development and retrofit of existing developed areas.
- SVWD should continue its education efforts associated with water conservation and investigate other incentives to reduce consumption by its customers by updating its water conservations practices to reflect efforts by other water purveyors in Santa Cruz County.

- The installation of a climate monitoring station in Scotts Valley would benefit the SVWD GWM Program by providing an accurate and easily accessible record of precipitation, evaporation, and evapotranspiration, among others.

CHAPTER 1 – INTRODUCTION

PURPOSE AND SCOPE

This report summarizes the Scotts Valley Water District (SVWD) Groundwater Management (GWM) Program and related management efforts for the 2003–2004 Water Year (October 2003 to September 2004). This report provides a comprehensive review of water resource conditions and groundwater management activities in the Scotts Valley area to assist the SVWD in future decision-making and management of the groundwater basin. This report covers:

- Groundwater management activities by the SVWD in Chapter 2,
- Hydrogeology of the Santa Margarita Groundwater Basin in Chapter 3,
- Summary of the groundwater and surface water monitoring activities in Chapter 4,
- An assessment of the groundwater supply in Chapter 5, and
- An assessment of water quality in Chapter 6.

For the purpose of groundwater management, data are collected from all relevant parties and organized in multiple databases used to track sustainable use conditions, water quality, and alternative water resource progress. The data are presented in a format to be used as a reference and interpreted to recognize important issues affecting the groundwater basin and the SVWD.

This is the eleventh annual report of the SVWD Groundwater Management Program, which fulfills the requirements of the amended groundwater management act. It is understood that SVWD will continue its groundwater management program within the structure of the revised groundwater management legislation.

WATER YEAR

The water year runs from October through September of the following year for the purpose of grouping the typically higher precipitation months of October through April. Therefore, the 2003–2004 Water Year covers the period from October 2003 through September 2004. For this report, the 2003–2004 Water Year will be referred to as WY2004. Similarly, historical data that are referred to by water year will also use a similar designation.

BACKGROUND

The SVWD serves water to most of the City of Scotts Valley and parts of the surrounding area (Figure 1-1). SVWD is a County Water District formed in 1961 in accordance with the County Water District Law, California Water Code Section 30,000, et seq.

The San Lorenzo Valley Water District (SLVWD) also serves water to part of the southwestern portion of the City of Scotts Valley and adjacent areas to the west. Two nearby areas outside the Scotts Valley city limits receive water through private water purveyors, the Mt. Hermon Association and Mañana Woods Subdivision. Figure 1-1 shows the jurisdiction of these water districts and private water purveyors considered in this document.

CHAPTER 2 – GROUNDWATER MANAGEMENT PLAN

GROUNDWATER MANAGEMENT LEGISLATION

The original Assembly Bill 3030 (AB3030) groundwater management planning legislation (codified in California Water Code Sections 10750, et seq.) was intended to encourage groundwater management by local water agencies in non-adjudicated groundwater basins. Water code section 10752-10753.10 directs local agencies to practice groundwater management and to develop recommendations whenever possible and requirements wherever needed. The original legislation emphasized public hearings, formal adoption of plans, and the availability of public funding. The act also required the adoption of ordinances or regulations to implement the Groundwater Management Plan (GWM Plan) and reflection of the potential impacts of such ordinances on business activities.

Passage of Senate Bill 1938 amended the groundwater management planning act as of January 2003. The revised statutes emphasize the importance of groundwater for California's water supply and encourage local agencies to work together to optimize local water supplies while protecting groundwater and surface water resources. The statutes define specific requirements for GWM plans and link compliance with eligibility for state funding of groundwater projects. Specifically the new California Water Code section 10753.7 recommends:

- Submittal of an AB3030 GWM Plan to California Department of Water Resources (DWR),
- Reproduction of the DWR groundwater basin map,
- Adoption of monitoring protocols,
- Inclusion of components for monitoring,
- Involvement with other public entities/water agencies whose service areas overlie the groundwater basin,
- Public participation in the planning process, and
- Definition of basin management objectives.

SVWD GROUNDWATER MANAGEMENT

AB3030 Groundwater Management Plan

In 1983, the SVWD instituted a Water Resources Management Plan to monitor and manage water resources in the Scotts Valley area. This effort resulted in establishment of an integrated climatic, surface water, and groundwater monitoring program. SVWD has conducted an active GWM Program since 1984 (Todd Engineers 1984). In addition, regular reporting of water conditions and a safe yield study were conducted at the beginning of basin-wide water management.

In 1994, the Scotts Valley AB3030 GWM Plan was adopted (Todd Engineers 1994). The SVWD GWM Plan was the third AB3030 plan recorded by the DWR. The AB3030 Planning

Act of 1993 and its subsequent revision in 2003 have provided additional organization to the SVWD management efforts. The intent is to optimize water supply, increase reliability, and protect local water resources in accordance with the AB3030 requirements. The 1994 SVWD GWM Plan focused on two major goals:

- Management of groundwater supplies to meet present and future demands and to provide for downstream water rights and instream uses, and
- Protection of water quality and remediation of existing groundwater contamination.

The above goals and objectives continue to guide the SVWD program, which continues to serve as the major means to manage groundwater in the Santa Margarita Groundwater Basin (Figure 1-1). Annual reports provide a source of reference for public and agency input, as well as establishing a monitoring and reporting procedure. Data evaluation offered in this report and directly by SVWD is done within industry standards and regionally accepted professional practices.

DWR Groundwater Basins

As required by AB3030, the public water districts in proximity to the DWR defined basins are shown on Figure 2-1. DWR Bulletin 118 (DWR 2003) identifies three basins in the vicinity of Scotts Valley. These include Basin 3-27, Scotts Valley; Basin 3-21, the Santa Cruz Purisima Formation; and Basin 3-50, the Felton Area. These basins are shown in relation to the SVWD, SLVWD, Lompico County Water District, and Soquel Creek Water District. The Santa Margarita Groundwater Basin covers a significantly larger area than those depicted in Bulletin 118 (Figure 2-1).

SVWD Monitoring Protocols

The groundwater planning statutes require the adoption of monitoring protocols to detect changes in groundwater levels, groundwater quality, subsidence, and surface water flows and quality. Chapter 4 provides a detailed description of SVWD's monitoring of climatic, groundwater level, stream flow, and water quality. Water quality data compiled by SVWD are collected using industry standards and methods approved by local regulatory agencies. Water quality samples are analyzed by state certified professional laboratories and results are presented in reports. Data obtained by cooperation with other public agencies and private entities are not necessarily subject to SVWD's monitoring protocols.

Components for Monitoring and Management

Based on Senate Bill 1938, the components relating to the monitoring and management include:

- groundwater levels,
- groundwater quality,
- inelastic land surface subsidence, and
- changes in surface flow and surface water quality that directly affect groundwater levels or quality, or are caused by groundwater pumping.

Groundwater monitoring and management activities are conducted throughout the year, with key monitoring activities taking place in the autumn and spring. SVWD regularly monitors groundwater levels and water quality in production wells, other wells, and surface water in the Scotts Valley area. In addition, the SVWD cooperates with other local agencies and private entities to collect additional groundwater level and water quality data in the area.

Land subsidence is the lowering of the natural ground surface, which can occur as a result of distinct subsurface processes including compaction of clays, oxidation of organic soils (peat), and dissolution of limestone (USGS 2000). Such subsidence is unlikely in the Scotts Valley area because it is underlain by cemented, semi-consolidated formations including sandstone and shale with no significant limestone formations.

The SVWD has maintained a surface water monitoring program in cooperation with the United States Geological Survey (USGS) and local organizations that includes stream gauges on each of the two major creeks, regular monitoring of local springs, and sampling of surface water as part of the water recycling program. The SVWD also measures stream flow rates in creeks and performs water quality sampling semi-annually at high and low flow periods. The SVWD has pursued a better understanding of groundwater/surface water interaction with the synoptic survey of the creeks (Todd Engineers 1997). Moreover, the SVWD also has engaged in investigation of alternatives to retain and recharge urban runoff to both increase groundwater supply and to mitigate adverse impacts on streams resulting from urbanization.

Management of the groundwater basin by SVWD is accomplished by monitoring basin groundwater conditions and documenting these results in annual reports. Chapters 4, 5, and 6 of this report document the results of this monitoring program.

Local Agency Cooperation and Involvement

The Planning Act (AB3030) requires that the local agency prepare a plan to involve other agencies in the groundwater basin to work cooperatively. To this end the SVWD GWM Plan (Todd Engineers 1994) recommended cooperation between local water agencies in the Scotts Valley area on hydrogeologic studies, monitoring, and potential development of replenishment and water recycling projects.

Regular interaction and cooperation among local agencies is concentrated within the Santa Margarita Groundwater Basin Advisory Committee. This committee was established in June 1995 by means of a Memorandum of Understanding (Member Agencies 1995) among SVWD, SLVWD, Lompico County Water District, City of Scotts Valley, and County of Santa Cruz. The Santa Margarita Groundwater Basin Advisory Committee operates under objectives which include:

- Making recommendations for cooperative management of the groundwater basin,
- Advising member agencies to promote conservation, reuse, reclamation, protection of recharge areas, mitigation measures for loss of recharge areas or increased water consumption, development of new water resources, and enhancement and maintenance of existing resources,
- Functioning as a clearing house and repository for related hydrologic data,
- Maintaining and updating the groundwater model,

- Developing a systematic approach to enhance understanding of the basin,
- Seeking and identifying potential environmental impacts associated with recommendations of the Advisory Committee for cooperative groundwater management,
- Providing for public input, and
- Preparing an annual report on basin-wide consumption, amount of augmented recharge, amount of in-lieu recharge, basin-wide perennial yield, and other related groundwater management matters.

The Advisory Committee is supportive of local agencies, with powers to receive donations, develop proposals for assistance and grants, and issue reports. In 2000, the Advisory Committee sponsored the preparation of a White Paper (Member Agencies 2000) which considered local groundwater issues, data gaps and methods to diminish them, and potential solutions to the imbalance of recharge and pumping, including replenishment through water conservation and management of pumping, water recycling, and conjunctive use. The White Paper also provided a definition of general boundaries for a special replenishment district, should such a district be considered.

The SVWD GWM Plan (Todd Engineers 1994) recommended cooperation with regulatory agencies on investigation and remediation of contamination sites and prevention of future contamination. The SVWD routinely works with federal and state regulatory agencies to ensure complete and timely investigation and remediation of contaminant problems in Scotts Valley.

Public Participation

The groundwater management planning statutes require that the local agency make available to the public a written statement describing the manner in which interested parties may participate in developing the plan. The SVWD GWM Plan (Todd Engineers 1994) encouraged public participation primarily through its recommendations for annual reporting of water resource conditions and for meetings with local groundwater producers to discuss pumping, water consumption, groundwater level declines, and mitigation measures. In addition, summaries are provided in the agenda for the SVWD Board, SVWD committees, and the Santa Margarita Groundwater Basin Advisory Committee, which are noticed by local postings and the associated meetings are all open to the public.

All meetings of the SVWD Board of Directors are open to the public, and the agendas (with meeting time and location) are posted at least 72 hours before a regular meeting and published in a local newspaper in accordance with SVWD Ordinance No. 119-96, Article 2. The agenda provides an opportunity for members of the public to address the Board on items of interest (SVWD 2003).

SVWD management plan activities also are discussed at the regular meetings of the Santa Margarita Groundwater Basin Advisory Committee. The SVWD General Manager also provides an annual presentation on the state of the groundwater supply to the Scotts Valley City Council at one of its televised public meetings in the spring.

SVWD encourages public participation in the development and revisions to its Groundwater Management Plan. The plan is an ongoing effort that is reviewed on an annual basis. The plan is summarized to the public through year-end reporting and presentations to the SVWD Board of

Directors (Board) at two of its regular meetings. Prior to these meetings, public notices are published in the local newspaper, the Scotts Valley Banner, or the Santa Cruz Sentinel.

The Groundwater Management Annual Report is distributed widely among local agencies and stakeholders and is made available to the public at SVWD offices. Public questions and comments regarding the management plan and the reports are welcome. The first AB3030 plan, prepared in 1994, generated considerable interest among local public agencies and citizens, who provided comments on the plan. These comments were addressed specifically in an addendum to the plan. Similarly, this report has been improved by the review and commentary of public agency representatives and interested citizens. Members of the public and press often attend the semi-annual Board meetings with the presentations of the annual and mid-annual report; comments and questions are welcomed and addressed specifically in the meeting.

Additionally, specific efforts are accompanied by public outreach. For example, during the hydrogeologic investigation conducted by SVWD a banner is posted at well drilling sites, an informational flier is released, press releases are provided to inform the public of the purpose and progress of the monitoring well program, and presentations are made of the draft report to the Technical Advisory Committee (TAC) and the final report at a regular SVWD Board meeting and/or a meeting of the Santa Margarita Groundwater Basin Advisory Committee.

Basin Management Objectives

The concept of Basin Management Objectives (Dudley 2001) was developed by DWR as a systematic process to support groundwater basin management. Originally developed for groundwater basins in the Sacramento Valley, the Basin Management Objectives have been adapted to Scotts Valley. The SVWD GWM Plan (Todd Engineers 1994) includes a series of objectives that include:

- Encouraging public participation through annual reporting at one or more public meetings,
- Coordinating with other local agencies for hydrogeologic studies, cooperative monitoring, potential development of replenishment and water recycling projects, investigation and remediation of contamination sites, and prevention of groundwater contamination,
- Continuing monitoring and evaluation of hydrogeology, climatic and surface water conditions, groundwater levels and storage, perennial yield, and groundwater pumping and use, and updating of the computer model,
- Implementing groundwater replenishment and water recycling,
- Developing management objectives for sub-basin with the regional groundwater basin, and
- Investigating groundwater quality and prevention of groundwater contamination.

SVWD GROUNDWATER MANAGEMENT ACTIONS

SVWD is also responsible for implementing significant management actions. These actions include the initiation of a cooperative water recycling program with the City of Scotts Valley, expansion of Water Recycling Program users, redistribution of pumping, drilling of monitor wells, development of additional deeper wells, exploration of artificial recharge options, and water conservation measures, including ordinances and regulations to prevent water waste and to conserve water during drought.

SVWD Water Recycling Program

A key component and indication of SVWD and the City of Scotts Valley's commitment to the groundwater management plan is the Water Recycling Program. The program began in 2002 and provides additional water supplies for use mainly for irrigation. The recycled water system is the first of its kind to operate in Santa Cruz County and a proactive step in addressing the water conservation objectives established by AB3030.

The program is a cooperative effort between the City of Scotts Valley and SVWD to enhance the existing water resources for Scotts Valley. The SVWD works closely with the City of Scotts Valley to encourage the use of recycled water for low-demand landscaping through the City's Planning Division. A major accomplishment of this team effort in the last water year was adoption of a city recycling ordinance. In 2004, ten new sites (Table 2-1) were approved. To date, fourteen permits have been issued for the Water Recycling Program (Figure 2-2). Nine of these permits are issued to public agencies including the City of Scotts Valley, SVWD, and Scotts Valley Unified School District. The remaining five permits have been issued to private users. An additional six permit applications have been submitted and are under review for addition to the program in 2005.

Table 2-1
New Water Recycling Program Sites Added in 2004

Site	Address	Estimated Demand Gallons (AFY)
Siltanen Park	Vine Hill School Rd.	3,890,000 (11.7 AFY)
Santa Cruz Medical Clinic	4663 Scotts Valley Dr.	180,000 (0.55 AFY)
Windward Company	Windward Place	176,680 (0.54 AFY)
Acorn Ct. Apartments	100 Acorn Ct.	485,700 (1.5 AFY)
Vineyards-Siltanen Booster	6020A Scotts Valley Drive	72,000 (0.22 AFY)
Scotts Valley High School	555 Glenwood Drive	2,330,000 (7.2 AFY)
SVWD Office	2 Civic Center Dr	40,000 (0.12 AFY)
Seagate	4627 Scotts Valley Drive	457,500 (1.4 AFY)
Scotts Valley Fire Dept.	251 Glenwood Dr	60,480 (0.19 AFY)
Enterprise Technology Centre	100 Enterprise Way	17,000,000 (52.3 AFY)

The city-operated Recycled Water Treatment Plant uses secondary effluent from the city's wastewater treatment facility and treats it to the tertiary level using direct filtration and ultraviolet (UV) radiation. This water is then provided to SVWD for distribution to recycled water customers. Figure 2-2 depicts the recycled water distribution system, current recycled water users, and potential users. SVWD operates a distribution system specifically for the recycled water, thus separating the resource from the potable water supply distribution system.

SVWD Water Conservation Efforts

The SVWD encourages water conservation in the City of Scotts Valley and surrounding areas through public education and monetary rebates to customers demonstrating individual conservation efforts. The most direct and successful effort has been through SVWD's metering program, which applies a tiered rate structure for water usage. This is a straightforward measure to implement given that all of SVWD's customers are metered users. SVWD also provides rebates for customers who incorporate low-flow units into existing plumbing and customers who identify and repair leaks in existing plumbing. These rebates in conjunction with free water conservation workshops and an enhanced effort to accomplish more outreach at the elementary school level demonstrate a continuing effort by SVWD to protect and conserve existing water supplies.

DWR Local Groundwater Assistance Grant

In July 2004, SVWD was awarded a $225,000 Local Groundwater Assistance Program (AB303) grant from DWR to update the existing groundwater model. The existing groundwater model was first developed in 1988 (Watkins-Johnson 1993) and is not up to current industry standards. Significant advances in modeling practices and capabilities have occurred during this time as well as rapid advances in computer software and hardware. The updated numerical model will provide a more comprehensive tool to quantitatively evaluate the issues surrounding groundwater resources in the Scotts Valley area. ETIC Engineering, Inc. and Todd Engineers were selected as the consultants to perform the AB303 numerical model update. Work on the grant project began in August 2004 and is anticipated to be completed during the summer of 2005.

The objective of the AB303 numerical model update includes a re-evaluation of the hydrogeological conceptual model of the basin with a thorough analysis of the available geologic and hydrogeologic data. This updated hydrogeological conceptual model will be incorporated into an updated numerical model that can proactively and efficiently support groundwater management. The types of issues that this model is intended to address include:

- Assessing the available aquifer storage volume,
- Defining the perennial yield for the aquifer, including effects of water quality, and
- Providing input regarding the impacts of land use decisions on water supply.

The grant is being administered by SVWD, although a Technical Advisory Committee composed of members from SVWD, SLVWD, DWR, and Santa Cruz County oversees the modeling work and adds input during regulary scheduled meetings. As a state-funded project, involvement by all the interested parties within the basin is considered a priority. The goal of the AB303 numerical model update is to improve the understanding of groundwater resources in the basin and develop an improved numerical groundwater model as a tool for groundwater management.

CHAPTER 3 – HYDROGEOLOGY

STUDY AREA

For this report, the study area covers the portion of the Santa Margarita Groundwater Basin that most directly affects the SVWD. The Santa Margarita Groundwater Basin is in the Santa Cruz Mountains north of the City of Santa Cruz. Scotts Valley and other municipalities overlie the basin along with unincorporated parts of Santa Cruz County. Specifically the Scotts Valley study area is defined as the portion of the Santa Margarita Groundwater Basin that is south and east of Bean Creek (Figure 3-1). Bean Creek is considered a natural flow-controlling feature in the Santa Margarita Formation where groundwater flows north and west of Bean Creek are considered independent from the Scotts Valley study area. The eastern boundary is defined as the edge of the groundwater basin. The Scotts Valley study area is subdivided into the North Scotts Valley area and the South Scotts Valley area. These subdivisions are based on both natural and operational conditions (Figure 3-1). The South Scotts Valley area has been further subdivided into the Camp Evers and Pasatiempo subareas for discussions of groundwater conditions in the Santa Margarita Sandstone.

PHYSICAL SETTING

Topography

Scotts Valley is situated on the southwestern slope of the central Santa Cruz Mountains in Santa Cruz County (USGS 1998). The Santa Cruz Mountains comprise a portion of the California Coast Ranges physiographic province (Clark 1966). The relief in the Scotts Valley area is moderately rugged, with elevations ranging from less than 300 feet along the San Lorenzo River to over 1,800 feet on Ben Lomond Mountain. Within Scotts Valley, which is situated along the Carbonera Creek, ground surface elevations range from 550 feet along Carbonera Creek to over 800 feet on the ridges north of the city, and over 1,000 feet on the ridges east of the city (USGS 1998).

The general topography of the area consists of north-south trending, elongated steep-sided ridges alternating with V-shaped valleys (Figure 3-1). One of the largest of these valleys is Scotts Valley. Scotts Valley is contiguous with Camp Evers, a broad bench on the south side of Scotts Valley that straddles the divide between the Carbonera and Bean Creek watersheds.

Climate

Scotts Valley has warm summers and mild winters. In inland areas that have a sunny exposure, the mean maximum daily temperature is often more than 80 degrees. The elevated inland areas are approximately 3 to 5 degrees cooler per 1,000-foot rise above sea level (USDA 1980). Precipitation varies across Santa Cruz County primarily due to the orographic effects of topography. Precipitation is heaviest in the mountains, such as Ben Lomond Mountain, where seasonal precipitation totals average 60 inches whereas mean annual precipitation along the coast is approximately 30 inches. In the driest years, which occur every 20 years on average, the Santa Cruz Mountains receive only 30 to 35 inches of precipitation. In the wettest years, precipitation totals more than 90 inches in parts of the Santa Cruz Mountains (USDA 1980).

Land Use

Within the City of Scotts Valley, much of the land has been developed for residential, commercial, and industrial uses. Much of the land along Scotts Valley Drive and Mt. Hermon Road, which form the primary corridors through the city, has been developed and covered with asphalt parking areas, roads, and buildings. A study based on satellite image analysis approximated that more than 60% of the City of Scotts Valley is covered with impervious areas (Basic 2001). Residential development has occurred over much of the City of Scotts Valley and several parts of the surrounding area. Undeveloped parts of the Scotts Valley area are typically covered by redwood or pine forests.

A large sand quarry was operated in the South Scotts Valley area northwest of the City of Scotts Valley. The quarry was operated by Hanson Aggregates. Operations at the quarry have been concluded and no further mining activity is anticipated at the site. The site is currently undergoing closure procedures. Similarly, nearby Olympia Quarry is also in the process of closing. Smaller, older closed quarries are also located throughout the area, including the Mandarino Development (former Bergstrom Pit) site. The locations of these quarries are shown on Figure 3-1.

GEOLOGY

Regional Setting

The geology of the Scotts Valley area has primarily been mapped by Clark (1966, 1981), Clark and others (1989), Brabb (1997), and McLaughlin and others (2001). The stratigraphic column for the study area consists of a crystalline basement rock overlain by a Tertiary-aged sedimentary sequence (Figure 3-2). The geologic map (Figure 3-3), from Brabb (1997), shows surface outcrop distribution of these units in the Scotts Valley area. Quaternary terrace and alluvium are mapped in portions of the major stream valleys. The stratigraphic column for the Santa Margarita Groundwater Basin (Figure 3-2) includes several geologic units in the Tertiary sedimentary sequence above the crystalline basement rock that range from Paleocene to Pliocene in age. The geologic units found within the Santa Margarita Groundwater Basin include:

- Locatelli Formation (oldest)
- Butano Formation
- Lompico Sandstone
- Monterey Formation
- Santa Margarita Sandstone
- Santa Cruz Mudstone
- Purisima Formation (youngest)

The hydrogeological conceptual model represents the understanding of geology, groundwater, and groundwater–surface water interactions based on an integrated analysis of the available data. As part of the AB303 numerical model update, a comprehensive review of the hydrogeological data is being conducted to update the conceptual model of the area. For this update, a series of hydrogeologic cross sections have been constructed across the basin to re-evaluate the geologic correlations within the Santa Margarita Groundwater Basin. The results of these updates will be presented more fully in the final report for the AB303 numerical model update. Figure 3-4 is representative of one of these cross sections that passes through most of the areas of interest for the Scotts Valley area. Below is a discussion of some of the updated data interpretations that have been derived to date of the hydrogeology that are pertinent to this report.

Geologic Units

The crystalline basement rock that underlies the Santa Margarita Groundwater Basin is primarily composed of granite and quartz diorite of Cretaceous age (Figure 3-2). This granitic rock is best exposed upon Ben Lomond Mountain, to the west of the study area, where it is primarily composed of granite. In the Scotts Valley area, the granitic rock is exposed along the lower portions of Carbonera Creek. Elsewhere, the depth to the granitic crystalline basement rock varies less than 30 feet in the southern parts of the study area to over 1,000 feet north of Scotts Valley near the SVWD Wells #3B and #7A (Figure 3-4).

The oldest sedimentary sequence consists of erosional remnants of the Locatelli Formation of Paleocene age (Figure 3-2). The Locatelli Formation is characteristically a gray, sandy siltstone with a basal sandstone bed typically found at the base of the unit. The Locatelli Formation lies nonconformably upon the crystalline basement rock. Within the study area, the Locatelli Formation is found only in the South Scotts Valley area where it outcrops in the hillside along Eagle Creek and the San Lorenzo River (Figure 3-3).

The Butano Formation consists largely of sandstone and interbeds of mudstone, shale, and siltstone of Eocene age (Figure 3-2). The Butano Formation consists of three members that include the lower sandstone member, the middle siltstone member, and the upper sandstone member. The total estimated thickness of the Butano Formation is about 5,000 feet. The lower sandstone member has been mapped as occurring in the Scotts Valley area (Clark 1981). The lower sandstone member consists of thick to very thick interbeds of conglomerate with clasts that range from well-rounded quartz pebbles to angular granitic boulders up to 8 feet across (Clark 1981).

The Lompico Sandstone is a thick sandstone unit that forms the base of the middle Miocene sequence (Figure 3-2). The lower third of the unit consists of thick beds of light-gray, medium-grained sandstone. The Lompico Sandstone is typically 200 to 300 feet thick. The upper two-thirds of the unit are composed of massive yellowish-gray, fine-grained sandstone beds (Clark 1981). The Lompico Sandstone is found throughout most of the basin; however, the unit outcrops along the basin margins (Figure 3-4).

The Monterey Formation is primarily composed of mudstone, shale, and siltstone of middle Miocene age (Figure 3-2). A few thick sandstone interbeds have been noted within the Monterey Formation. The rock is generally light gray or olive gray to white. Upon weathering, the rock becomes highly fractured and individual pieces remain hard and firm. The upper surface of the Monterey Formation has been eroded, and the Monterey Formation is missing along the southern and eastern margins of the groundwater basin (Figure 3-4). The Monterey Formation thickens towards the center of the basin to over 2,000 feet thick.

The Santa Margarita Sandstone generally consists of massive, fine-to-medium-grained sandstone of upper Miocene age (Figure 3-2). Laboratory analyses of this sandstone indicate that it is 85 to

90 percent sand, 7 to 8 percent silt, and 4 percent clay (USDA 1980). The Santa Margarita Sandstone occurs at the surface on the upland areas over a portion of the South Scotts Valley area. In the North Scotts Valley area the Santa Margarita Sandstone underlies most of the City of Scotts Valley, but is overlain by either the Quaternary alluvium or the Santa Cruz Mudstone.

The Santa Cruz Mudstone consists of organic mudstone beds of upper Miocene age that overlie the Santa Margarita Sandstone (Figure 3-2). The Santa Cruz Mudstone thickens westward from a featheredge along the eastern margin of the groundwater basin to more than 200 feet thick in the center of the basin. The Santa Cruz Mudstone conformably overlies the Santa Margarita Sandstone. In the Scotts Valley area, the Santa Cruz Mudstone underlies much of the northern portion of the City of Scotts Valley. To the south and west, this unit forms a capping mudstone found along the higher elevations (Figure 3-4).

The rock of the Purisima Formation consists mostly of fine-grained sandstone, mudstone, and siltstone of Pliocene age (Figure 3-2). The Purisima Formation forms a significant water producing horizon to the south in the Soquel area. In the Scotts Valley area, it is locally present on the higher elevations overlying the Santa Cruz Mudstone (Figure 3-4).

The Pleistocene and Holocene-aged alluvial deposits consist of unconsolidated sands and silts along the streambeds of Carbonera and Bean Creeks. Much of the City of Scotts Valley is directly underlain by these unconsolidated sediments. These sediments are typically less than 10 to 20 feet thick and are only partially saturated (Figure 3-4).

Geologic Structure

As mapped by the USGS (1997), the Ben Lomond Fault trends north-northwest and forms the western boundary of the basin (Figure 3-3). Ben Lomond Mountain, which is primarily composed of granitic basement rock, is located west of the fault. The Zayante Fault forms the northern basin boundary. The area north of the Zayante Fault is composed of a sequence of Tertiary-aged sedimentary formations that are not present south of the Zayante Fault in the Scotts Valley Syncline (Figure 3-3).

Regional folding has produced a major syncline, or trough, termed the Scotts Valley Syncline, which crosses through the North Scotts Valley area (Figure 3-3). The axis of the syncline has a northwest-southeast trend (Clark 1981; Brabb 1997). The Scotts Valley Syncline was formed as a result of uplift along the Zayante Fault and, therefore, essentially parallels the fault (Figure 3-3).

The sediments in the basin have been folded during deformation associated with the development of the Coast Ranges (Clark 1981). A period of geologic deformation preceded the deposition of the Lompico Sandstone as evidenced by the Lompico unconformably overlying the crystalline basement, and Locatelli and Butano Formations in different portions of the basin. Subsequent geologic deformation has caused the Lompico Sandstone to be steeply dipping in the Scotts Valley area. This subsequent deformation has caused the Lompico Sandstone to be directly overlain by the Monterey Formation, Santa Margarita Sandstone, and Santa Cruz Mudstone. These complex relationships have significant impact on how groundwater flows into, out of, and through the Lompico Sandstone. Due to geologic deformation, the Santa Margarita Sandstone directly overlies, in different locations, the crystalline basement, and/or the Locatelli Formation, and/or Lompico Sandstone, and/or the Monterey Formation (Figure 3-4).

HYDROGEOLOGY

Santa Margarita Groundwater Basin

The Santa Margarita Groundwater Basin is formed by the sedimentary sequence found within the Scotts Valley Syncline. The basin forms a roughly triangular area that is bounded by the two regional faults, the Ben Lomond Fault to the west and the Zayante Fault to the north (Figure 3-3). To the southeast, the basin is bounded by the granitic crystalline rock which rises steeply in this area. The depth to the granite varies from an elevation of approximately 1,000 feet below sea level near SVWD #3B and #7A (Figure 3-4) to an elevation of approximately 500 feet above sea level over a distance of about one half mile. This marked change of the elevation of the top of the granite can be traced along the eastern side of Scotts Valley and marks the southeastern edge of the Santa Margarita Groundwater Basin.

Definition of Aquifers

The primary aquifers in the Scotts Valley area are the Santa Margarita Sandstone, the Lompico Sandstone, and the Butano Formation. The Santa Margarita and Lompico Sandstones have long been recognized as primary aquifers in the Scotts Valley area. The Santa Margarita Sandstone has a long groundwater production history, with several production wells completed within this unit within the Scotts Valley area (Muir 1981). Similarly, the Lompico Sandstone is currently the primary groundwater producing horizon in the Scotts Valley area, with several large production wells completed in this unit.

Prior to the current AB303 numerical model update, the role of the Butano Formation in providing water to SVWD had not been recognized. As a result of the AB303 numerical model update, the SVWD Wells #3B and #7A have been reinterpreted as being completed all or mostly within the lower sandstone member of the Butano Formation (Figure 3-4). The production history of these wells indicates that the Butano Formation is capable of producing significant volumes of groundwater.

The sandstone interbeds and the fractured siltstones in the Monterey Formation can locally produce groundwater; this is mostly used for domestic wells. The SVWD Well #9 is currently producing from the lower well screen that is completed within the Monterey Formation. A few wells in the South Scotts Valley area have also been completed within the basal sandstone layer in the Locatelli Formation. In addition, some local domestic wells, primarily south of Scotts Valley, are completed within fractures in the granitic, crystalline basement rock.

Because of its limited distribution, the Purisima Formation is not a significant water producing unit in the Scotts Valley area. The Purisima Formation is a significant groundwater producing horizon farther to the southeast.

The Quaternary alluvium located along Carbonera Creek is not considered a significant water producer in the Scotts Valley area because of its limited saturated thickness and lateral distribution.

Groundwater–Surface Water Interactions

Groundwater–surface water interactions with streams, such as Carbonera and Bean Creeks, are important hydraulic features that influence groundwater levels and flow. Depending on several factors, the groundwater–surface water interaction may result in one of the following:

- a stream may recharge the groundwater ("losing reach"),
- the groundwater may discharge to the stream ("gaining reach"), or
- the interaction may be restricted so that little interaction occurs.

The first two factors are primarily controlled by the relative difference between the stage, or elevation, of the water in the stream, and the elevation of the groundwater. If the stream stage is higher, then the stream will recharge the groundwater. If, however, the groundwater elevations are higher, then the groundwater will discharge to the stream either directly or as springs.

The third factor is controlled by the geologic unit the stream is traversing at a given location. If the stream flows across more permeable aquifer material, then the groundwater–surface water interactions will be more responsive. However, if the stream is flowing across less permeable material such as an intervening aquitard, then the groundwater–surface water interactions will be more restricted. Figure 3-6 provides a map that indicates the geologic unit, the stream, and the associated alluvial deposits where present. Areas of the streams underlain by the Santa Margarita or Lompico Sandstones would be in direct communication in the stream. In the areas underlain by the Monterey Formation or the Santa Cruz Mudstone, the groundwater–surface water interactions will be more restricted.

Groundwater recharge from Carbonera Creek occurs along the portion of the creek that is underlain by the Santa Margarita Sandstone (Figure 3-6). The presence of the Santa Cruz Mudstone near the surface in the vicinity of Wells #3B and #7A (Figure 3-4) limits groundwater recharge from Carbonera Creek.

For Bean Creek, this relationship is more varied due to the elevation change. Along upper Bean Creek and its tributaries, there are losing streams that recharge the groundwater. Bean Creek and its larger tributaries have eroded down to the Santa Margarita Sandstone throughout most of the watershed, and, therefore, streambed percolation would recharge the Santa Margarita Sandstone (Figure 3-6). The amount of this recharge is unknown and is influenced by the streambed conditions, slope of the stream, and other factors. Lower Bean Creek becomes a gaining stream where groundwater is discharged to the stream through springs either through the streambed or along the stream margins. Several springs are mapped along the lower contact of the Santa Margarita Sandstone and Monterey Formation along Lower Bean Creek. The AB303 numerical model update will be used to provide additional insight into the amount of stream recharge into the Santa Margarita Sandstone from these creeks.

HYDROGEOLOGICAL CONCEPTUAL MODEL

Santa Margarita Sandstone

The Santa Margarita Sandstone has widespread surface exposures primarily in the South Scotts Valley area and north of Bean Creek. Where the Santa Margarita Sandstone is exposed at the surface, higher infiltration rates of precipitation relative to runoff are anticipated due to the development of high-permeability sandy soils in these areas (USDA 1980). These areas will form significant groundwater recharge locations (Figure 3-3). In the South Scotts Valley area, the Santa Margarita Sandstone forms upland areas that are covered by over 300 feet of sandstone (Figure 3-4).

In the North Scotts Valley area, the Santa Margarita Sandstone is found at depth below the Santa Cruz Mudstone. Based on the available geologic log data from wells drilled in the area, the thickness of the Santa Margarita Sandstone diminishes to the north. Where the Santa Margarita Sandstone is overlain by the Santa Cruz Mudstone in the North Scotts Valley area, however, groundwater recharge will be significantly limited due to the low-permeability clayey soils that develop over the Santa Cruz Mudstone (USDA 1980).

Within the Santa Margarita Sandstone thin, dense, lower permeability layers have been identified that have formed perching horizons (R.L. Stollar 1988). The perched aquifer formed above this horizon has been noted to have a significantly higher groundwater elevation than the regional Santa Margarita Sandstone below it. However, these horizons are not considered to be continuous. Identification of these perching horizons is important for properly evaluating the impact of contamination to the regional aquifer, and properly understanding and mapping groundwater elevations within the Santa Margarita Sandstone.

Contact Between Santa Margarita and Lompico Sandstones

The thickness of the Monterey Formation varies widely across the area as a result of geologic deformation and erosion. The Monterey Formation is considered to act as an aquitard that significantly limits groundwater flow between the Santa Margarita and Lompico Sandstones. Along the eastern rim of the Santa Margarita Groundwater Basin, the Santa Margarita Sandstone directly overlies the Lompico Sandstone. In this area the Monterey Formation is absent, thus leaving the Santa Margarita and Lompico Sandstones in direct contact (Figure 3-4). The distribution of this contact forms a strip along the southern and eastern portions of the basin (Figure 3-5). This relationship is important in understanding the groundwater interactions between these two primary aquifers. Where present, the intervening Monterey Formation forms a significant aquitard that limits groundwater movement between the Santa Margarita and the Lompico. This area is considered to form an area of significant groundwater recharge to the Lompico Sandstone from the overlying Santa Margarita. The AB303 numerical model update will address these relationships to better quantify and understand the groundwater interaction at these locations.

Lompico Sandstone

In the Scotts Valley area, the Lompico Sandstone is primarily recharged from the Santa Margarita Sandstone. The limited amount of surface exposure of the Lompico Sandstone within the groundwater basin significantly limits the potential for groundwater recharge from surface sources such as precipitation and streambed percolation. The overlying low-permeability Monterey Formation also significantly limits groundwater recharge by vertical flow from overlying units. Therefore, a portion of the groundwater recharge for the Lompico Sandstone likely comes from the northern portion of the basin at a distance of several miles from the Scotts Valley area. Recharge can also occur where the Lompico is overlain directly by saturated Santa

Margarita Sandstone (discussed below). Groundwater outflow from the Lompico Sandstone is primarily from groundwater pumping. Due to the limited surface exposures of the Lompico Sandstone, it would appear that there are few natural discharge points within the Lompico Sandstone. Improving the understanding of groundwater inflow and outflow from the Lompico Sandstone will be addressed by the AB303 numerical model update.

The Lompico Sandstone is recharged by groundwater outflow from the Santa Margarita Sandstone where it is directly overlain by the Santa Margarita Sandstone (Figure 3-6). The amount of groundwater flow from the Santa Margarita to the Lompico Sandstone is considered to have increased as the result of decreasing groundwater levels in the Lompico Sandstone due to increased pumping. Unfortunately, portions of the Santa Margarita have also been dewatered. Groundwater pumping is another major component of groundwater outflow from the Santa Margarita Sandstone. Evapotranspiration, the uptake of groundwater by trees and vegetation, is considered to be locally significant where groundwater levels are shallow enough to be within the root zone, which is no longer as prevalent as it may have been in the 1970s.

Butano Formation

The Butano Formation forms a wedge along the northern portion of the basin (Clark 1981). Groundwater recharge is likely from infiltration of precipitation and from the streams that flow over the Butano Formation in these exposure areas north of Scotts Valley. Similarly, the Butano Formation appears to have few natural discharge points. Improving the understanding of groundwater inflow and outflow from the Butano Formation will also be addressed by the AB303 numerical model update.

The Butano Formation had been mapped in surface outcrop by Clark (1966, 1981), Brabb (1997), and McLaughlin and others (2001). These investigations had noted that the Butano Formation extended beneath a portion of the Scotts Valley area. By constructing cross sections that extended to these outcrop areas, the Butano was extended beneath the overlying layers. Through this analysis, it was recognized that SVWD production Well #3B was screened completely within the Butano Formation and Well #7A was screened across both the Lompico Sandstone and Butano Formation. Wells #3B and #7A have a total depth of 1,067 and 981 feet, respectively. These wells have a significantly thicker sequence of sedimentary rock than other wells in the vicinity. The correlation of the lower section encountered in these wells with the Butano Formation provides a more realistic geologic interpretation.

CHAPTER 4 – GROUNDWATER SUPPLY MONITORING

DATA COLLECTION

In an effort to identify and evaluate the dynamic water supply conditions in Scotts Valley, SVWD began collecting basic hydrology data for the region in 1983. The groundwater supply monitoring program includes collection of a variety of data that includes the following:

- Operations data which includes groundwater pumping by SVWD and neighboring water users, and water use for the SVWD Water Recycling Program. Data tables are provided in Appendix A.
- Climate data which includes rainfall, evaporation, and evapotranspiration in the Scotts Valley area. Data tables are provided in Appendix B.
- Surface water data which includes measurements of stream flow spring discharge. Data tables are provided in Appendix C.
- Groundwater level data which includes groundwater elevation measurements collected by SVWD, other local agencies, private entities, and consultants. Data tables are provided in Appendix D.
- Water quality data which includes analysis of chemical composition of the groundwater by SVWD, other local agencies, private entities, and consultants. Data tables are provided in Appendix E.

Chapter 4 provides an overview of the quantity and quality of data collected from the various data sources. These data are analyzed to assess the quantity and quality of the water supply for Scotts Valley. The assessment of the data is presented in Chapters 5 and 6.

OPERATIONS

Groundwater Pumping

Tracking groundwater pumping, or total volume of groundwater extracted, in the Scotts Valley area is an important component in assessing the groundwater supply. Historical groundwater pumping data are presented in Appendix A. The locations of known groundwater pumping with historical data are shown on Figure 4-1.

Groundwater pumping is metered and tracked for the major wells by the SVWD and others on a daily basis. Monthly summaries of metered groundwater pumping data from water supplies are provided by the San Lorenzo Valley Water District, Mount Hermon Association, and Mañana Woods Association. The primary industrial user is Hanson Aggregates, which also provides monthly summaries of metered groundwater pumping; however, operations at the quarry have ceased. Groundwater pumping is obtained by directly contacting these agencies. These agencies also maintain historical records of groundwater pumping.

Groundwater pumping at the two large environmental remediation sites, Watkins-Johnson and Camp Evers, is also metered. Quarterly summaries of groundwater pumping are obtained from regulatory reports. SVWD receives copies of these reports. WY2004 groundwater pumping data for Watkins-Johnson were obtained from a report by Arcadis (2005) and a report by Delta (2005) for the Camp Evers Site. Historical data have been compiled for these sites as well.

Unmetered pumping has to be estimated based on water use practices (Todd Engineers 1998). Included in the unmetered pumping estimate is pumping from wells for Valley Gardens Golf Course, Spring Lakes Mobile Home Park, Vista del Lago, Montevalle Mobile Home Park, and Interdesign. These wells are used for irrigation and landscaping purposes. Without more specific data on annual water usage, water usage for these users is assumed to be constant through time.

Water Recycling Program

Water recycling data are recorded in a cooperative effort between the City of Scotts Valley and SVWD. Recycled water is treated to the tertiary level at the Scotts Valley WWTP, as discussed previously, and is stored, distributed, and metered for use by SVWD customers. These data are compiled based on production numbers from the Scotts Valley WWTP and meters measuring individual usage by both public and private users (Appendix A). A discrepancy exists between the quantity of recycled water delivered to SVWD and metered sales because SVWD has the ability to augment storage with potable water when the tertiary plant is offline. Therefore, any winter recycled sales have historically been potable water. For instance, in WY2004, 2,113,500 gallons of potable water were added to the recycled system.

Although the Water Recycling Project was not initiated until May 2002, the surface water monitoring began in 1998 and shallow groundwater monitoring began in 1999 to establish baseline conditions in the Scotts Valley area. The locations of each of these sampling points are shown in Figure 4-2. All baseline data and current monitoring data are listed in Appendix E (Table E-2). The data include water quality parameters that are typically present in tertiary treated water effluent.

The surface water locations are located to verify whether any runoff of recycled water, or recycled water effluent, is reaching streams. There is a strict prohibition on any recycled water reaching any stream, and this prohibition is included in the permit for the City of Scotts Valley and SVWD to distribute recycled water. Surface water is monitored semi-annually at four stations along Bean Creek and three stations along Carbonera Creek. In-stream measurements are collected of temperature, electrical conductivity, turbidity, and flow. Water samples are collected and analyzed for TDS, general minerals, metals, general physical properties, ammonia, and nitrates.

Currently, three shallow wells are sampled semi-annually to monitor changes in groundwater quality near recycled water usage areas (Figure 4-2). Water samples are collected from these wells and analyzed for TDS, general minerals, metals, general physical properties, ammonia, and nitrates. In addition, the deep SVWD production wells also serve as deep monitoring wells in locations where no shallow wells occur or no other data are available. For example, SVWD Well #9 is in close proximity to a recycled irrigation water user and is relatively shallow for a production well. Therefore, the data provided by the usual monitoring of raw water are useful to identify undesirable impacts of the recycled water program. The construction of shallower monitoring wells or monitoring of existing shallow wells in these areas would provide a more comprehensive evaluation of the recycled water program's impact to the SVWD water supply.

CLIMATE

Precipitation

Precipitation is the primary source of groundwater recharge within the basin. A precipitation gauge located at the El Pueblo Yard facility has maintained records since 1981. Earlier records (dating back to 1947) were maintained at Blair ranch on the outskirts of Scotts Valley. The City of Scotts Valley has also maintained a precipitation gauge at the Scotts Valley WWTP since 1987. The locations of these rainfall gauges are shown on Figure 4-3. Historical groundwater pumping data for these gauges are presented in Appendix B.

Other precipitation gauges in Santa Cruz County were also included in this evaluation. San Lorenzo Valley Water District maintains a precipitation gauge at its offices in Boulder Creek. The County of Santa Cruz maintains a precipitation gauge at its offices at the Ben Lomond Landfill near the town of Ben Lomond. Data for these gauges were obtained by contacting the appropriate agency. The City of Santa Cruz and the DWR also maintain a precipitation gauge. Data for this gauge are recorded and made available through the California Irrigation Management Information System (CIMIS) database.

Evaporation and Evapotranspiration

Evaporation and evapotranspiration are considered losses to the water budget. These natural phenomena affect two major components of the major supply sources to the groundwater basin: groundwater recharge and stream flow. These losses can be quantified using evaporation pan data and evapotranspiration data. SVWD has maintained an evaporation pan since 1985 at the El Pueblo Yard (Figure 4-3).

Evapotranspiration data are provided by the De Laveaga Golf Course weather station in Santa Cruz. The De Laveaga Golf Course weather station has been operated by the DWR since 1990 and reports to the CIMIS database. These data serve as a reference for SVWD evaporation pan data and are available on the web at http://wwwcimis.water.ca.gov/cimis/welcome.jsp. Historical evaporation and evapotranspiration data are provided in Appendix B.

SURFACE WATER

Stream Flow

Stream flow in Bean and Carbonera Creeks is monitored by the SVWD in cooperation with the USGS. The USGS operates two stream flow gauges, funded by SVWD, which are positioned upstream of where Bean and Carbonera Creeks effectively exit the groundwater basin. The locations of these gauges are shown in Figure 4-3. Historical stream flow data as well as real-time flow data are made available on the web at www.USGS.gov for both Carbonera and Bean Creek. These data are tracked by SVWD and can be used to determine the outflow of surface water from the basin. Flow measurements are also measured twice annually during monitoring for the Water Recycling Project from seven locations in the groundwater basin.

Springs

The Scotts Valley area contains numerous natural springs and seeps throughout the groundwater basin. The USGS stream gauges do not account for the springs which discharge into lower Bean or Carbonera Creek because they are located downstream of the gauging stations. There are two major springs that are measured annually and one that is measured semiannually; they are Ferndell Spring, Redwood Springs, and Eagle Creek and their locations are shown on Figure 4-3. These springs generally yield consistent numbers relative to previous years; however seasonal monitoring of these springs could yield valuable information on the hydro-cycle and discharge from the aquifers.

Redwood Springs and Ferndell Spring are located on the grounds of Mt. Hermon Conference Center. The Mt. Hermon Association measures the flow of these springs on an annual basis. Eagle Creek is comprised of multiple springs and seeps in a small watershed that drains into the San Lorenzo River. The flows at Eagle Creek are included in the SVWD groundwater management program and are measured semiannually. The historical flows for all three springs are presented in Appendix C.

GROUNDWATER LEVEL

Groundwater elevation data are collected from a number of different sources. SVWD maintains a groundwater elevation database of historical groundwater elevations that have been collected over time. These data extend from 1968 to 2004. The amount of data can be quite variable for each well. Fifty-five wells from this database were used for the groundwater analysis.

Groundwater elevation data are also obtained from other agencies and sources to supplement this SVWD database. Other water districts and private users that provide groundwater elevations include the San Lorenzo Valley Water District, the Mount Hermon Association, Mañana Woods, and Hanson Aggregates. Groundwater elevation data are obtained by directly contacting these agencies. These agencies also maintain historical records of groundwater pumping. The large environmental remediation sites also collect extensive groundwater elevation data. Regulatory reports for the Camp Evers Site (Delta 2005) and the Watkins-Johnson site (Watkins-Johnson 1991, Arcadis 2005) provide both WY2004 and historical groundwater elevation data.

The locations and geologic units for the wells where groundwater elevation data are available are shown on Figure 4-4. Information about these wells is provided in Appendix D. Table 4-1 provides a summary of the number of wells used for the Scotts Valley groundwater assessment by source of the data.

Table 4-1
Scotts Valley Area Groundwater Elevation Data Sources

	Groundwater Level Data	Number of Wells
Measured (metered)	SVWD	55
	SLVWD	11
	Mt. Hermon Association	2
	Mañana Woods	2
	Hanson Aggregates West	4
	Watkins-Johnson Site	34
	Camp Evers Remediation Site	44
	Others	7

Assignment of the geologic unit for each groundwater elevation location was based on the assessment by the source of the data. This geologic unit assignment was then re-evaluated during the AB303 numerical model update. The distribution of groundwater elevation data by geologic unit is provided in Table 4-2.

Table 4-2
Scotts Valley Area Groundwater Elevation Data Availability by Geologic Unit

	Groundwater Level Data	Number of Wells
Measured (metered)	Santa Margarita Sandstone	102
	Monterey Formation	10
	Lompico Sandstone	38
	Butano Formation	2
	Locatelli Formation	5
	Granite	2

WATER QUALITY

Water Supply

SVWD monitors the active groundwater producing wells for a number of constituents with a frequency that complies with the Safe Drinking Water Act requirements as outlined in the California Code of Regulations, Title 22 requirements. SVWD has also proactively incorporated new constituents into the monitoring program as a result of new regulatory action or trends in the water quality industry. All water quality results are reported to the California Department of Health Services (DHS), Division of Drinking Water and Environmental Management.

SVWD's monitoring program consists of sampling both the raw and treated water from production wells, compiling water quality data from other water purveyors in the region, monitoring of shallow groundwater, and monitoring of surface water in the region. Water quality data are recorded and are posted on the web for SVWD staff record-keeping by MWH Laboratories at the WaterTrax website (WaterTrax 2005). The website is password protected and allows data to be accessed by staff according to sampling location, date, or individual water quality constituent. SVWD also samples for a list of general minerals, physical characteristics, select metals, and organic chemicals often associated with industrial or commercial sites. These data are presented in Appendix E.

Environmental Compliance Sites

SVWD also is actively monitoring sites where groundwater quality has been compromised by pollution or chemical spills. These sites are subject to regulation by public health and water resource agencies once the responsible party is identified.

SVWD retains and exercises its opportunity to comment on environmental compliance reports, actions, or other documents involving these noteworthy sites. The district also is included on the distribution list for environmental investigation reports, remedial reports, and correspondence between regulators and potentially responsible parties (PRPs). This allows the district to comment and provide recommendations as appropriate.

Table 4-3 provides a list of the known environmental compliance sites where groundwater has been impacted in the Scotts Valley area, the chemical(s) of concern, and the regulatory agency responsible for oversight. A data summary for some of these sites is presented in Appendix E.

Table 4-3
Active Environmental Compliance Sites in the Scotts Valley Area

Site	Source of Data	Regulatory Agency
Scotts Valley Dry Cleaners	Secor International Inc.	RWQCB
Scotts Valley Drive Chlorobenzene Plume	SVWD	SVWD, previously DTSC
Camp Evers Plume	Delta Environmental Consultants Inc.	RWQCB
Watkins-Johnson Site	Arcadis	USEPA
Hidden Oaks Well and SVWD Well #9	SVWD/Delta	DHS
Hacienda Drive Shell	Delta Environmental Consultants Inc.	RWQCB

CHAPTER 5 – GROUNDWATER SUPPLY ASSESSMENT

The groundwater supply assessment for Scotts Valley is divided into the North Scotts Valley area and the South Scotts Valley area. These subdivisions are based on both natural and operational conditions (Figure 3-1). For discussions on groundwater conditions in the Santa Margarita Sandstone, the South Scotts Valley area has been further subdivided into the Camp Evers and Pasatiempo subareas (Figure 3-1).

GROUNDWATER PUMPING

Scotts Valley Water District WY2004 Pumping

In WY2004, SVWD groundwater production was from six wells: SVWD Wells #3B, #7A, #11A, and #11B in the North Scotts Valley area, and SVWD Wells #9 and #10 in the South Scotts Valley area – Camp Evers subarea. SVWD Wells #7A and #11B accounted for over 60% of the total SVWD metered pumping in both WY2003 and WY2004; however, the combined pumping was decreased in these two wells by approximately 102 acre-feet in WY2004. Groundwater pumping was increased in Wells #3B and #11A by 114 acre-feet from WY2003 to WY2004. Overall, total metered groundwater pumping by SVWD was decreased by 96 acre-feet from WY2003 to WY2004 (Table 5-1).

Table 5-1
Scotts Valley Water District Pumping by Well (in acre-feet)

SVWD Production Well	WY2003 Total	WY2004 Total
Well #3B	219	286
Well #9	85	44
Well #10	400	332
Well #11A	55	102
Well #11B	682	607*
Well #7A	632	605
Total	**2,072**	**1,976***

* Lower volume may be partially due to change in flow meter.

However, it should be noted that the 6 inch Water Specialties™ Propeller Meter flow meter for SVWD Well #11B was replaced by a 6 inch Badger® Magnetoflow® Mag Meter in July 2003 Flows measured by the new meter were about 25% less than those measured by the older meter that was replaced. This may account for much of the decline in groundwater production by SVWD Well #11B. If the 75 acre-foot decrease in production in SVWD Well #11B is due to a faulty meter, then the total groundwater production would be 2,051 acre feet for WY2004 for a 21 acre-foot decrease in groundwater production compared to WY2003.

The SVWD Water Recycling Program is designed to replace groundwater pumping that is used for irrigation and landscaping with highly treated recycled water that is suitable for unrestricted irrigation reuse. Reclaimed water usage nearly doubled from 18.8 acre-feet in WY2003 to 38.5 acre-feet in WY2004, for nearly a 20 acre-foot increase in recycled water usage. The recycled water usage is considered to have replaced extracted groundwater, and has contributed to the overall decrease in groundwater pumping during WY2004.

Other WY2004 Pumping

Additional groundwater pumping in the Scotts Valley area is attributed to several users. The locations of the primary groundwater extraction wells in the Scotts Valley area, and their associated WY2004 pumping, are shown on Figure 5-1.

Table 5-2 provides a summary of the distribution of pumping by groundwater user for water years WY2003 and WY2004 and per basin subarea. Overall, groundwater pumping decreased in WY2004 by approximately 177 acre-feet, which accounted for a 5% decrease in total pumping in the Scotts Valley area. This may have been at least partially caused by the relatively cool summer in 2004.

The total pumping was divided nearly evenly between the North Scotts Valley and the South Scotts Valley areas in WY2003. However, the total pumping decreased in the South Scotts Valley area by approximately 190 acre-feet but increased by only 13 acre-feet in the North Scotts Valley area in WY2004. This is partially due to SVWD operational decisions to rest the South Scotts Valley Wells as much as possible (i.e., SVWD Well #9 was only pumped 82 days of the year and most of this was during the winter to facilitate upgrades to the Orchard Run Water Treatment facility, which required a shut down of both SWVD Wells #3B and #7A). Groundwater pumping in the North Scotts Valley area is almost exclusively by SVWD whereas pumping is distributed among several users in the South Scotts Valley area. The decrease in WY2004 pumping is primarily the result of a 96 acre-foot reduction by SVWD relative to WY2003, and the cessation of operations by Hanson Aggregates that also resulted in a 96 acre-foot decrease in total pumping.

Table 5-2
Scotts Valley Area Estimated Groundwater Pumping by User (in acre-feet)

	WY2003			WY2004		
Groundwater User	**South Scotts Valley**	**North Scotts Valley**	**WY2003 Total**	**South Scotts Valley**	**North Scotts Valley**	**WY2004 Total**
SVWD	485	1,587	2,072	376	1,600	1,976
SLVWD	436	0	436	428	0	428
Mt. Hermon	206	0	206	202	0	202
Mañana Woods	66	0	66	66	0	66
Industrial Users	96	0	96	0	0	0
Remediation Users	133	0	133	160	0	160
Estimated Private Users	235	11	246	235	11	246
Total	**1,657**	**1,598**	**3,255**	**1,467**	**1,611**	**3,078**

Other water providers in the South Scotts Valley area include the SLVWD, the Mt. Hermon Association, and Mañana Woods Mutual Water Company. SLVWD produced 428 acre-feet of groundwater from wells Pasatiempo #6 and #7 (Figure 5-3). The Mount Hermon Association produced 202 acre-feet of groundwater from well Mt. Hermon #2, and Mañana Woods Mutual Water Company has produced 66 acre-feet of groundwater from well Mañana Woods #2 (Figure 5-3). Production by these groundwater users indicated only minor variations in pumping between WY2003 and WY2004 (Table 5-2).

The major industrial user, Hanson Aggregates Quarry, has ceased operations and is pumping only small amounts of groundwater at the site until re-vegetation is completed. In WY2003, Hanson Aggregates estimated a total pumping of 96 acre-feet. Hanson Aggregates Quarry is currently undergoing closure activities and no significant pumping is anticipated at the site in the future.

Groundwater extraction increased at the contaminant remediation sites by approximately 27 acre-feet in WY2004. The Watkins-Johnson site pumps groundwater primarily from remediation well RA-2. Total pumping increased from 112 to 143 acre-feet from WY2003 to WY2004. This increase is primarily attributed to the groundwater extraction system being offline for maintenance during part of WY2003. The Camp Evers site pumps groundwater for remediation of an methyl-tert-butyl ether (MtBE) and gasoline hydrocarbon plume from well CEEW-1 (Figure 5-1). Pumping at Camp Evers declined slightly between WY2003 and WY2004, from 21 to 17 acre-feet.

The estimated groundwater pumping for private users is based primarily on previous estimates from the 1998 Water Balance (Todd Engineers 1998), and is assumed to be approximately the same from year to year. These wells are not metered; therefore, year to year changes cannot be obtained. However, they are included here to provide a reasonable estimate of the total water usage in the Scotts Valley area using GIS parcel data. Parcels not identified as SVWD customers are assigned an average pumping value based on the the assumption of one well per residential parcel, unless otherwise specified. The wells included under the "Estimated Private Users" category include Vista del Lago #2, Spring Lakes #5, Valley Gardens Golf Course, Montevalle Mobile Home Park, and Interdesign in addition to numerous small domestic wells. The groundwater produced from these wells is currently used for irrigation and landscaping purposes only.

Historical Groundwater Pumping

SVWD groundwater pumping has increased steadily from 470 acre-feet in WY1976 to approximately 2,000 acre-feet per year since WY2000 (Figure 5-2). This essentially correlates to increases in the population of the City of Scotts Valley from 3,621 in 1970 to 11,385 in 2000 (California State Department of Finance 2005). In evaluating the historical change by user, the primary change has been the increase by SVWD and the other water suppliers (SLVWD, Mt. Hermon Association, and Mañana Woods Mutual Water Company) due to the increasing population of the area. Water use by private and industrial entities has declined, as these users have connected to the water supply systems of either SVWD or SLVWD during this period. The remaining major private wells are used for irrigation and landscaping purposes and are not metered (Todd Engineers 1998).

The maximum metered groundwater pumping by SVWD occurred in WY1997 with 2,101 acre-feet. From WY1976 to WY1980, SVWD groundwater pumping was exclusively from the North Scotts Valley area with pumping from Wells #3, #3A, #6, and #7 in the El Pueblo Yard location (Figure 5-2). From WY1981 to WY1993, groundwater pumping increasingly shifted to the South Scotts Valley area with the operation of SVWD Wells #9 and #10. These South Scotts Valley area wells accounted for approximately 50% to 60% of SVWD's total pumping during this period (Figure 5-2). Starting in WY1994, with the introduction of its GWM Program, SVWD began shifting operations back to the North Scotts Valley area with increasing pumping from wells #7A, #3B, and #11B (Figure 5-2). These North Scotts Valley area wells now account for approximately 70% to 80% of SVWD's total recent pumping. From WY1996 to WY1999, Well #7A alone accounted for approximately half of the SVWD total pumping.

The total groundwater pumping by other users in the Scotts Valley area has also increased significantly. Based on the available data, total groundwater pumping has risen from approximately 1,400 acre-feet in WY1976 to over 3,500 acre-feet in WY2000 (Figure 5-3). The maximum total pumping occurred in WY1997 with an estimated 3,637 acre-feet pumped from the Scotts Valley area. The overall pumping has declined in each year since WY2001, with an estimated 3,078 acre-feet in WY2004. Groundwater pumping by other water suppliers (SLVWD, Mt. Hermon Association, Mañana Woods Mutual Water Company) has increased from 927 acre-feet in 1976 to a maximum of 1,581 acre-feet in WY2001. This pumping is primarily in the South Scotts Valley area (Figure 5-1).

Much of the increase that occurred in WY1986 is due to the initiation of groundwater remediation operations at the Watkins-Johnson site. Groundwater pumping by Watkins-Johnson associated with its cleanup of a solvent plume has slowly declined, from a maximum of 464 acre-feet in WY1986 to 143 acre-feet in WY2004.

The variation in historical pumping by the various groundwater users is also reflected in the distribution of pumping by area (Figure 5-3). Pumping has historically been highest in the South Scotts Valley area, which produced from 60% to 80% until WY1995. After WY1995, SVWD has shifted more pumping to the North Scotts Valley area until the distribution between the North and South Scotts Valley areas is about 50% since WY2000.

Groundwater Pumping by Geologic Unit

The distribution of pumping by all groundwater users in the Scotts Valley area by geologic unit shows that groundwater pumped from the Lompico Sandstone accounts for about 70% of the total pumping (Table 5-3). The decrease in production from the Lompico Sandstone from WY2003 to WY2004 is due primarily to reduced pumping by SVWD and the cessation of operations at the Hanson Aggregates Quarry. The Santa Margarita Sandstone accounts for about 10% of the total pumping. This is due, in no small part, to the dewatering of large portions of the Santa Margarita. A quantitative estimate of recharge of these de-watered sections of the Santa Margarita can be defined by utilizing the updated Santa Margarita Groundwater Basin Numerical Water. The Monterey Formation and other units account for only a minor percentage of the total pumping in the South Scotts Valley area (Table 5-3).

The Butano Formation is the next largest groundwater producing unit, accounting for slightly less than 20% of total pumping (Table 5-3). Prior to the recently revised hydrogeologic correlations associated with the current AB303 grant, the Butano Formation had not been recognized as a producer of groundwater in the area. It should also be noted that SVWD Well #7A, the largest producing single well in the area, is completed in both the Lompico Sandstone and Butano Formation (Figure 3-4). For this analysis, it is assumed that the total production from wells #3B and #7A is distributed evenly between the Lompico Sandstone and Butano Formation.

Table 5-3
Scotts Valley Area Estimated Groundwater Pumping by Geologic Unit (in acre-feet)

	WY2003			WY2004		
Geologic Unit	**South Scotts Valley**	**North Scotts Valley**	**WY2003 Total**	**South Scotts Valley**	**North Scotts Valley**	**WY2004 Total**
Santa Margarita Sandstone	284	0	284	311	0	311
Monterey Formation	85	0	85	44	0	44
Lompico Sandstone	1,250	1,052	2,303	1,074	1,012	2,086
Butano Formation	0	535	535	0	588	588
Other Units	38	11	49	38	11	49
Total	**1,657**	**1,598**	**3,255**	**1,467**	**1,611**	**3,078**

The distribution of total groundwater production by geologic unit has also shifted over time (Figure 5-4). From WY1976 to WY1988, total groundwater pumping from the Santa Margarita Sandstone increased from 734 to 1,482 acre-feet per year. During this time, pumping from the Santa Margarita Sandstone accounted for over 50% of the total pumping in the area. Subsequently, groundwater pumping from the Santa Margarita Sandstone has steadily declined, from 1,361 acre-feet in WY1989 to 311 acre-feet in WY2004. In WY2004, over 50% of the groundwater pumping from the Santa Margarita Sandstone was for environmental remediation of contaminant plumes. The reduced water supply pumping is a result of declining groundwater levels in the Santa Margarita Sandstone and the installation of deeper wells to replace this lost production capacity.

From WY1976 to WY1985, groundwater pumping in the Lompico Sandstone ranged from 500 to 700 acre-feet per year. In WY1986, this increased to 1,150 acre-feet primarily due to increased pumping from SVWD Well #10 and Kaiser Well #4 at the Hanson Aggregates Quarry. The percentage of the total groundwater pumping from the Lompico Sandstone increased from 40% in WY1986 to about 70% in WY2004. Total groundwater pumping from the Lompico Sandstone increased from 1,147 to 2,303 acre-feet from WY1985-1986 to WY2004.

As mentioned above, the role of the Butano Formation in groundwater production in the area has recently been recognized. Currently, only two wells produce from the Butano Formation. These are SVWD Wells #3B and #7A. Production from the Butano Formation began in WY1994 with the operation of SVWD Well #7A. Groundwater pumping is estimated to range from 500 to 800 acre-feet per year over the period from WY1996 to WY2004. The Butano Formation accounts for approximately 20% of the total groundwater production during this period.

PRECIPITATION

WY2004 Rainfall

The most significant source of groundwater recharge for the Scotts Valley area is precipitation. The WY2004 rainfall amounts at the Scotts Valley El Pueblo Yard and the Scotts Valley WWTP were 37.04 and 40.15 inches, respectively. This was approximately 5 inches below the average annual precipitation of 42.2 and 44.7 inches based on the historical records available for each station. Other stations in Santa Cruz County also show that WY2004 was a below normal rainfall year. In WY2003, a near normal rainfall year, precipitation at the Santa Cruz County stations ranged from 1.5 inches above normal to 2 inches below normal.

Table 5-4
Santa Cruz County Precipitation Summary

Precipitation Station	WY2003 Total (inches)	WY2004 Total (inches)	Average Annual Precipitation (inches)
Scotts Valley El Pueblo Yard	42.46	37.04	42.2
Scotts Valley WWTP	46.27	40.15	44.7
Ben Lomond #4	49.01	44.06	48.3
SLVWD Office Boulder Creek	47.10	45.22	49.7
Santa Cruz	29.14	24.48	30.4

On a monthly basis, the distribution of rainfall in WY2004 was concentrated in December 2003, when nearly 18 inches of rainfall fell that month accounting for nearly 50% of the ultimate WY2004 rainfall (Figure 5-5). February 2004 was the second wettest month, with about 10 inches of rain accounting for approximately 25% of the WY2004 rainfall. March, April, and May 2004 were significantly below average in monthly rainfall. This distribution of rainfall has several potential impacts on the groundwater supply. Concentration of rainfall into short duration can result in a higher percentage of the rain going to surface runoff rather than to groundwater recharge. Further, the lack of late season rain can both limit groundwater recharge and result in earlier groundwater pumping for irrigation and landscaping. Despite the lower rainfall, the overall groundwater pumping for WY2004 was less than WY2003.

Historical Rainfall

Annual rainfall records have been available at the Scotts Valley El Pueblo Yard since WY1982. Since this time, the maximum rainfall has been 86.25 inches in WY1983 and the lowest has been 19.89 inches in WY1976 (Figure 5-5). The average rainfall over that time has been 42.3 inches per year; however, the median rainfall is 40.5 inches per year, indicating a slight shift in the average due to a few extremely wet years. There have been 25 years with rainfall less than WY2004 and 32 years with higher rainfall.

One method to evaluate the cumulative effect of the variations in rainfall over time is a departure analysis. For this analysis, the difference between the measured and average rainfall for each year is summed over the interval of interest. Therefore, the cumulative impact of a series of drought years or wet years can be evaluated. A departure curve for the Scotts Valley El Pueblo station is presented in Figure 5-6. From this curve, after a drought in the late 1940s, the Scotts Valley area enjoyed a net surplus of rainfall during the 1950s through the mid-1970s. The drought years of WY1976 and WY1977 brought a net rainfall deficit that was not fully recovered until the wet years of WY1982 and WY1983. From WY1984 through WY1994, the Scotts Valley area experienced a period of extended drought where rainfall was below normal for 9 of 11 years. This extended drought resulted in a cumulative rainfall deficit of nearly 100 inches over this period. A series of wet years from WY1995 to WY2000 produced a 53 inch surplus in rainfall. The past four years of WY2001 to WY2002 have been slightly below normal, adding a deficit of 13 inches (Figure 5-6).

The departure analysis (Figure 5-6) indicates that the extremely wet years of WY1982 and WY1983 built up a large surplus of rainfall. However, if we assume that after WY1983 the basin was nearly full, then looking at the departure since WY1983 provides an analysis of current conditions. Using this assumption, the Scotts Valley area is still in nearly a 60 inch rainfall deficit since WY1983 (Figure 5-6). Therefore, it will still require several years of above average rainfall for the Scotts Valley area to make up the deficit produced by the 1984 through 1994 drought period. The impact on groundwater supply is that the area is still lacking the rainfall necessary to recharge the aquifers to build up groundwater levels to pre-drought conditions. Furthermore, groundwater pumping also increased significantly during this period, from an estimated 1,948 acre-feet in WY1984 to 3,116 acre-feet in WY1994 (Appendix A). This 60% increase in groundwater pumping has further compounded the situation created by the drought.

SURFACE WATER

Stream Flow

Stream flow in both Bean and Carbonera Creeks is monitored by the SVWD in cooperation with the USGS. The USGS operates two stream flow gauges funded by SVWD, which are positioned upstream of where Bean and Carbonera Creeks effectively exit the groundwater basin (Figure 4-3).

Figure 5-7 displays the average daily stream flow by month for WY2004 relative to the average daily stream flow of the historical record for both Bean and Carbonera Creeks along with the monthly WY2004 precipitation data. Carbonera Creek shows a close correlation of stream flow to precipitation. The high rainfall months of December and February resulted in the highest flows with little to no delay in increased stream flow after the main precipitation events. Further, the stream flow declined quickly in March in response to low late-season precipitation. This resulted in a decrease in stream flow about one month earlier than average.

The Bean Creek WY2004 stream flow more closely matches the average stream flow. The highest stream flows were measured in February rather than December. The decline in stream flow from March through May was slightly below normal. This indicates a slower response by Bean Creek to the rainfall event in December 2003. This likely reflects the larger watershed area and lower level of development in the watershed area drained by Bean Creek and its tributaries compared to Carbonera Creek’s smaller and more urbanized watershed. Also, the Bean Creek watershed contains large areas of Santa Margarita Sandstone at the surface where higher initial infiltration rates of precipitation over runoff are anticipated. This would result in a delayed and extended response to high precipitation events.

Groundwater–surface water interactions in the Carbonera and Bean Creek watersheds are primarily controlled by the relative difference between the stage, or elevation, of the water in the stream, and the elevation of the groundwater. If the stream stage is higher, then the stream will recharge the groundwater. If, however, the groundwater elevations are higher, then the groundwater will discharge to the stream.

A portion of Carbonera Creek is underlain by the Santa Margarita Sandstone to form a potential groundwater recharge zone (Figure 3-6). In much of this area the Santa Margarita is covered by a 10 to 20 foot thick layer of alluvium that extends over much of the lowland area in Scotts Valley (Figure 3-3). The alluvium may serve an important role in groundwater recharge in this area. Surface water flows from Carbonera Creek would percolate into the alluvium, especially during high flow periods in the winter that will produce a higher stream stage. After the stream levels recede, a portion of the groundwater would drain back into Carbonera Creek, but another portion would infiltrate into the underlying Santa Margarita Sandstone. However, Carbonera Creek has eroded deeper into the alluvium. This downcutting is likely the result of the urban runoff effect produced by a large portion of the watershed being paved (Basic 2001). This downcutting by the creek lowered the hydraulic base level of the creek, causing a higher proportion of the high stream flow infiltration to drain back into Carbonera Creek. This would result in lower groundwater levels in the alluvium and thereby reduce the amount of water available to recharge the Santa Margarita Sandstone.

Springs

The Scotts Valley area contains numerous natural springs and seeps throughout the groundwater basin. The USGS stream gauges do not account for the springs which discharge into lower Bean or Carbonera Creek because they are located downstream of the gauging stations. There are two major springs that are measured annually and one that is measured semiannually; they are Ferndell Spring, Redwood Springs, and Eagle Creek and their locations are shown on Figure 4-3. Redwood Springs and Ferndell Spring are located on the grounds of Mt. Hermon Conference Center. Flows from Ferndell and Redwood Springs were 0.27 cubic feet per second (cfs) and 0.17 cfs, respectively, in April 2004. In January 2005, Ferndell Spring had increased to 0.33 cfs whereas Redwood Springs remained at 0.17 cfs. Eagle Creek is comprised of multiple springs and seeps in a small watershed that drains into the San Lorenzo River. In November 2004, Eagle Creek was measured at a discharge of 0.42 cfs whereas in March 2004 it was at 0.66 cfs. The historical flows of these three springs are presented in Appendix C. Eagle Creek does show some seasonal variations. Redwood and Ferndell Springs, measured in late winter and early spring, have sustained consistent flow rates since 1998.

These three springs all drain from the Santa Margarita Sandstone in the South Scotts Valley area. Based on these data, these three springs are estimated to have resulted in groundwater outflow from the Santa Margarita Sandstone of approximately 730 acre-feet. This represents an outflow that is more than double the total groundwater pumping from the Santa Margarita Sandstone in WY2004. Several more springs exist that have not been measured, such as those along Camp Evers Creek and Dufour Springs; therefore, substantially more discharge by springs is present.

Springs form at hydraulic low points, typically the base of the Santa Margarita Sandstone overlying a lower permeability geologic unit such as the Monterey Formation, the Locatelli Formation, or granite. Therefore, spring discharge will tend to remain relatively stable until the groundwater source feeding the spring is depleted.

SANTA MARGARITA SANDSTONE GROUNDWATER LEVELS

Trend Analysis

SVWD Well #9 produces groundwater from both the Santa Margarita Sandstone and a sandstone interbed within the Monterey Formation. The declines in groundwater levels in SVWD Well #9 over the past 20 years have resulted in a higher proportion of the groundwater production coming from the Monterey Formation. Groundwater elevations have declined from about 490 feet above mean sea level (amsl) in WY1983 to a low of 315 feet amsl in WY1999 (Figure 5-8). This steady decline in groundwater elevations averaged nearly 11 feet per year during this period. In WY2004, groundwater elevations had risen to approximately 330 feet amsl for an average 3 foot per year rise since 1999 (Figure 5-8).

Groundwater elevations in SVWD Well #9 in WY2004 are still 160 feet below the WY1983 levels. From April 1994 to September 2000, groundwater elevations in SVWD Well #9 were below the base of the Santa Margarita Sandstone, indicating that the water production was primarily from the Monterey Formation. The saturated thickness of the Santa Margarita Sandstone at SVWD Well #9 has been reduced by 95%, from 161 feet in 1983 to about 5 feet in WY2004.

In the South Scotts Valley area – Camp Evers subarea, groundwater elevations over time for other wells completed in the Santa Margarita Sandstone show a similar trend to that observed in SVWD Well #9. Both the SVWD #9 Monitoring Well and Montevalle #3 show changes in groundwater elevations over time with a similar pattern as observed in SVWD Well #9 (Figure 5-8) where groundwater elevations have declined over 100 feet compared to the WY1983 levels. The locations of the wells used for the Santa Margarita Sandstone groundwater trend analysis are shown on Figure 5-9.

The Hidden Oaks Well shows less of a change over time, but still indicates a 90-foot decline in water levels over time (Figure 5-8). The Hidden Oaks well is located farther from the primary pumping wells in the area of SVWD Well #9, Mañana Woods #2, and the Watkins-Johnson wells. The Hidden Oaks Well is also located closer to potential groundwater recharge areas that include the surface exposure of Santa Margarita Sandstone to the east and Carbonera Creek. CEMW-9 (Camp Evers) shows a similar pattern to the Hidden Oaks Well (Figure 5-8). The recent decline in water levels in CEMW-9 and Hidden Oaks is attributed to the groundwater remediation activities at Camp Evers. In contrast, the more upgradient well, SV Rockery, maintains a more consistent groundwater elevation over time. This may be the result of this well being located farther from the major pumping centers in the Camp Evers subarea and to the recharge area along Carbonera Creek.

Two representative Watkins-Johnson monitoring wells, WJ-11 and WJ-37A, are included on Figure 5-8. Data for WJ-11 show that groundwater elevations declined about 20 feet in response to the pumping associated with the groundwater remediation at Watkins-Johnson. Data for WJ-37A show that groundwater elevations have increased by 8 to 10 feet since WY1988, thereby recovering nearly 50% of the initial groundwater decline. The groundwater elevation difference between wells at the Watkins-Johnson site (WJ-11) and the other Santa Margarita wells (SVWD #9 Monitor and Montevalle #3) has changed dramatically over time. This difference was about 120 feet in WY1985. During the period of rapid groundwater elevation declines, the change was much less notable at the Watkins-Johnson wells. By WY1998, the groundwater elevation difference between these wells was nearly zero, and has increased to only about 12 feet in recent years (Figure 5-8).

In the South Scotts Valley area – Pasatiempo subarea, groundwater level trends in the Santa Margarita Sandstone show less variation over time than those observed in the Camp Evers subarea. In the Pasatiempo subarea, there was not the sustained decline in groundwater levels from WY1983 to WY1999 (Figure 5-10). Most of the pumping in the Pasatiempo subarea is from the Lompico Sandstone. Therefore, these trends in water level likely indicate a lesser degree of groundwater interaction between the Santa Margarita and Lompico Sandstones than what occurs in the Camp Evers subarea. Rather, the variations in groundwater elevations of approximately 10 to 20 feet over this time show a pattern that more closely corresponds to the WY1984 to WY1994 drought period. This is followed by a recovery in groundwater levels during the higher rainfall years since WY1995.

In the North Scotts Valley area, groundwater levels have been even more stable over time (Figure 5-10), with variations generally ranging from 5 to 10 feet. Similarly, the observed variations in groundwater levels correspond to the climate pattern. Similar to the Pasatiempo subarea, groundwater pumping in the North Scotts Valley area is primarily from below the Santa Margarita Sandstone. Therefore, these trends in water level also indicate a lesser degree of groundwater interaction between the Santa Margarita and Lompico Sandstones than what occurs in the Camp Evers subarea.

The presence of a perched or upper Santa Margarita zone has been noted during the more detailed environmental investigations at the Watkins-Johnson, Camp Evers, Scotts Valley Dry Cleaners, and Hacienda Shell sites. Figure 5-11 shows the relative difference in groundwater elevations between these two zones for closely spaced wells. Groundwater elevations were about 25 feet higher in the perched zone at Watkins-Johnson (WJ-16 and WJ-26) and range between 5 to 30 feet higher at Camp Evers (CEMW-1 and CEMW-9). The hydrographs show that the lower, regional Santa Margarita aquifer responds to remediation pumping activities with declines in water levels of about 15 feet at WJ-26 in WY1986 and 25 feet at CEMW-9 in WY2002. A detailed characterization of the perched zone was conducted at the Watkins-Johnson site (R.L. Stollar 1988) which found that the perched zone was developed above a thin, moderately-cemented conglomerate within the Santa Margarita. The perched zone was noted as having holes that allowed for leakage between the perched zone and the regional Santa Margarita aquifer. The perched zone does not appear to have a significant impact on the groundwater supply, but it is locally important in influencing transport of contaminant plumes.

Groundwater Elevation Maps

From the available groundwater elevation data, a series of groundwater elevations maps was developed for the Santa Margarita Sandstone for WY1985, WY1995, WY2003, and WY2004

(Figures 5-10 through 5-13). In general, groundwater flow is directed from these groundwater-elevation highs, which represent recharge areas, towards the lower groundwater elevations, which represent points of groundwater discharge including creeks and springs. In this manner, groundwater flow within the Santa Margarita Sandstone is generally compartmentalized with groundwater flow directed to the nearest local discharge point as shown (Figures 5-10 through 5-13) by the groundwater flow direction arrows.

In the South Scotts Valley area – Camp Evers subarea, the lowest groundwater elevations are found near the confluence of Lockhart Gulch and Ruins Creek with Bean Creek, which forms the primary groundwater discharge for the Santa Margarita Sandstone (Figures 5-10 through 5-13). Groundwater is discharged through springs in the streambed where the streams have cut into the Santa Margarita, to the point that the groundwater elevations are higher than the stream stage. Springs are also located along the sides of the streams where the base of the Santa Margarita Sandstone is exposed. Groundwater recharge is from precipitation percolating into the sandy soil developed on surface exposures of the Santa Margarita Sandstone. A less prominent groundwater elevation high occurs along Carbonera Creek in Scotts Valley. This location corresponds to where the Carbonera Creek and its associated alluvium directly overlie the Santa Margarita Sandstone, forming a groundwater recharge area.

In the South Scotts Valley area – Pasatiempo subarea, the general pattern shows that the highest groundwater elevations occur south and southwest of Scotts Valley where the Santa Margarita Sandstone caps these upland areas. Groundwater recharge is primarily from precipitation percolating into the sandy soil developed on the Santa Margarita Sandstone. Groundwater discharge occurs along the sides of Bean Creek, Eagle Creek, and Camp Evers Creek where numerous springs, including Ferndell and Redwood Springs, have also been mapped. The water discharged by these springs is sourced from the upland area adjacent to the springs (Figures 5-10 through 5-13).

In the North Scotts Valley area, the highest groundwater elevations are located in the north and northeast part of the area. This would suggest that groundwater recharge is related to precipitation and streambed percolation within the Santa Margarita exposures at the surface in these areas. Groundwater flow is also directed toward the low groundwater elevations near the confluence of Lockhart Gulch and Ruins Creek with Bean Creek. The area west of Bean Creek shows a much wider spacing of the groundwater elevation contours, indicating a lower groundwater gradient. This is inferred to represent reduced groundwater recharge in the areas where the Santa Cruz Mudstone is present.

As seen on the hydrographs, groundwater levels have declined in the South Scotts Valley area – Camp Evers subarea. This change is primarily observed by comparing WY1985 to WY1995 groundwater elevation maps, where the 350 and 400 foot contours are mapped over a half mile farther to the south near Camp Evers in the WY1995 map (Figure 5-12 and Figure 5-13). Other areas show only minor changes. This indicates that the over 100 foot decline in groundwater elevations is concentrated in the area from Bean Creek near the Watkins-Johnson site southward toward Camp Evers. This area also includes a portion of the area where the Santa Margarita Sandstone directly overlies the Lompico Sandstone, which lies between the primary recharge areas to the south. Declines in groundwater levels in the Lompico Sandstone may be inducing a higher percentage of Santa Margarita groundwater into the Lompico. This would result in less recharge reaching the areas north of this contact and contribute to declining groundwater levels in the Santa Margarita.

LOMPICO SANDSTONE GROUNDWATER LEVELS

Trend Analysis

Of the total groundwater production by SVWD in WY2004, approximately 68% was produced from the Lompico Sandstone. Therefore, the long-term trends of groundwater elevations in the Lompico Sandstone are of particular interest to SVWD. Groundwater production is primarily from SVWD Well #10 in the South Scotts Valley area, and wells #11A, #11B in the North Scotts Valley area (Figure 5-16). Well #7A is completed in both the Lompico Sandstone and Butano Formation; however, the actual distribution between these formations is unknown.

Groundwater elevations in SVWD Well #10, in the South Scotts Valley area, have declined from about 490 feet amsl in WY1985 to a low of 350 feet amsl in WY1995 (Figure 5-17). SVWD Well #10 is primarily screened in the Lompico Sandstone; however, the upper screen is also in the Santa Margarita Sandstone. Water levels in SVWD Well #10 are considered representative of the Lompico Sandstone. This steady decline in groundwater elevations averaged nearly 13 feet per year during this period. From WY1995 to WY2004, groundwater elevations had declined to about 320 feet amsl for an average three foot per year decline since WY1995 (Figure 5-17). Declines in groundwater levels in other Lompico wells in the South Scotts Valley area have ranged from 100 to 200 feet over the past 20 years (Figure 5-17).

The groundwater elevations for Wells #11, #11A, and #11B in the North Scotts Valley area have declined from a high of about 450 feet amsl in WY1985 to a low of 300 feet amsl in WY1994 (Figure 5-18). This steady decline in groundwater elevations averaged nearly 15 feet per year during this period. By WY1999, groundwater elevations increased to about 360 feet amsl for an average 12 foot per year rise since WY1995 (Figure 5-18). This rise is primarily the result of decreased pumping from Well #11. Wells #11A and #11B are relatively new in the El Pueblo well field. These wells were constructed in 1997 and 1999, respectively. Although the use of these wells increased pumping in the region, the highest totals production from the well field occurred in 1993 and most likely was a major contributing factor to the initial groundwater elevations decline. Importantly, since SVWD Well #11A and #11B were put online, groundwater elevations have declined to approximately 300 feet amsl for a 12 foot per year decline since WY1999 in response to increased pumping primarily in Well #11B. Historical groundwater elevation data indicate that groundwater elevations in the El Pueblo Yard area were about 485 feet amsl in WY1968. These data also show that groundwater elevations recovered from 385 to 430 feet amsl during WY1982 through WY1985 in response to reduced pumping.

Groundwater Interaction between Santa Margarita and Lompico Sandstones

In the South Scotts Valley area, groundwater elevations in the Santa Margarita Sandstone and the Lompico Sandstone were similar in the early 1980s (Figure 5-19). In response to increased pumping, groundwater levels in the Lompico Sandstone have dropped 100 to 200 feet across both the North and South Scotts Valley areas.

Water levels in wells completed in the Santa Margarita Sandstone in the South Scotts Valley area - Camp Evers subarea have shown similar decreases to those observed in the Lompico Sandstone. As shown on Figure 5-20, groundwater elevations in SVWD Well #10, considered to represent Lompico Sandstone water levels, were similar to those in the Hidden Oaks Well, a well completed in the Santa Margarita Sandstone, prior to WY1985. After WY1985, groundwater elevations in SVWD Well #10 have declined to between 300 and 350 feet amsl, whereas groundwater elevations in the Hidden Oaks well have ranged from 400 to 425 feet amsl. A similar relationship is observed by the closely spaced wells CEMW-5 and CEMW-9, screened in the Lompico and Santa Margarita Sandstones, respectively (Figure 5-20).

In contrast, groundwater levels in the Santa Margarita Sandstone have been relatively constant. This is true for the SLVWD monitoring wells Pasatiempo MW-2 (Santa Margarita Sandstone) and MW-1 (Lompico Sandstone) in the South Scotts Valley area and SVWD TH-18 (Santa Margarita Sandstone) and TH-19 (Lompico Sandstone) in the North Scotts Valley area (Figure 5-19).

Based on this analysis, groundwater elevations in the Lompico and Santa Margarita Sandstones are closely related in the South Scotts Valley area – Camp Evers subarea. This is primarily the result of groundwater flow between the Lompico and Santa Margarita Sandstones through a "window" where the Monterey Formation is absent (Figure 3-5). North of this "window", the intervening Monterey Formation effectively eliminated groundwater flow between the Lompico and Santa Margarita Sandstones. To the south of this "window", the Lompico Sandstone is absent. These conditions allowed water levels in the Santa Margarita Sandstone to remain more stable in areas farther away from the "window".

The decline in water levels in the South Scotts Valley area – Camp Evers subarea is also more pronounced because the base of the Santa Margarita Sandstone is at a lower elevation than elsewhere in Scotts Valley due to the geologic folding in the basin (Figure 3-4). Historically, water levels have been near the surface in the Camp Evers subarea. The saturated thickness of the Santa Margarita Sandstone tends to be less in the South Scotts Valley area – Pasatiempo subarea and in the North Scotts Valley area. These physical conditions resulted in a thicker saturated section in the Camp Evers subarea that allowed for the development of larger production wells. The concentration of pumping wells in the Camp Evers subarea has also contributed to the water level declines observed in this area.

There is some indication that prior to significant pumping in the Lompico Sandstone, groundwater levels were nearly the same and perhaps even higher in the Lompico Sandstone than in the Santa Margarita Sandstone in parts of the South Scotts Valley area (Figures 5-19 and 5-20). However, the data are sparse from this period and do not come from closely spaced wells. Conceptually, however, this may indicate that at times in the past the Santa Margarita – Lompico Sandstone contact may have been the discharge point for groundwater in the Lompico Sandstone prior to significant groundwater pumping. This would account for the high groundwater levels in this area, and explain the significant drop in groundwater elevations in this area when other areas in the Santa Margarita Sandstone were relatively unaffected. The groundwater levels also dropped to the level observed near the Watkins-Johnson site where the intervening Monterey Formation is present.

With groundwater flow between the Santa Margarita and Lompico Sandstones now directed downward because of the lowered water levels, this further impacts groundwater recharge in the

Camp Evers region. Groundwater recharge flowing from the Hidden Glen and Carbonera Creek areas is now intercepted by the window to the Lompico Sandstone and significantly less of this flow reaches the Camp Evers area. This would result in lower groundwater elevations in the Camp Evers area. Other factors that may be contributing to these lower groundwater levels include paving of much of the area underlain by alluvium, which has cut off groundwater recharge from precipitation. Another factor may be downcutting by Carbonera Creek that has lowered the hydraulic base level along the creek, which may result in draining the overlying alluvium into the creek rather than allowing it to recharge the underlying Santa Margarita Sandstone.

Groundwater Elevation Maps

Groundwater elevation data for the Lompico Sandstone are limited. Wells completed in the Lompico Sandstone tend to be concentrated along the southern and eastern margins of the groundwater basin where the depths to the Lompico are 500 feet or less. The Lompico Sandstone becomes significantly deeper to the north in the center of the groundwater basin, where the depths to the Lompico Sandstone are anticipated to be over 1,000 feet. No wells have been completed to this depth in these areas. Because of this fact, the groundwater elevation map for the Lompico Sandstone is limited to a narrow strip but does cover most of the City of Scotts Valley out to the Mt. Hermon area.

In contrast with the Santa Margarita Sandstone, the groundwater elevation maps for the Lompico Sandstone are interpreted to show a more regional decline in groundwater elevations throughout this area. This interpretation is based on the trend analysis of hydrographs from wells completed within the Lompico Sandstone. In WY1985, pumping in the Lompico Sandstone was primarily from the SVWD wells near the El Pueblo Yard area and near Spring Lakes. Groundwater elevations ranged from about 450 to 550 feet amsl (Figure 5-20). By WY1995, groundwater elevations had declined by 100 to 200 feet across the area based on the available data. Groundwater production had expanded in the South Scotts Valley area. Regional groundwater elevations were about 400 feet amsl in WY1995 (Figure 5-21). By WY2003, groundwater elevations had continued to decline regionally but at a slower rate than from WY1985 to WY1995. Increased pumping from SVWD #7A, which is completed in both the Lompico Sandstone and Butano Formation, is also impacting the Lompico Sandstone. Regional groundwater elevations were between 350 and 400 feet amsl in WY2003 (Figure 5-22). In WY2004, the main trend is the expansion of the groundwater depression centered on SVWD #7A as shown by the decline of about 10 feet in groundwater elevations in Monitoring Well TH-19.

The highest groundwater elevations are found both to the north and south of the main pumping centers. The higher groundwater elevations to the south are interpreted to represent recharge from the Santa Margarita Sandstone. To the north, the higher groundwater elevations are interpreted to represent groundwater flow from the center of the basin. The source of this recharge is assumed to be derived from outcrops of the Lompico Sandstone in the northern portion of the basin. The recharge sources are anticipated to be from surface streams that overflow the Lompico Sandstone and from the percolation of precipitation. The groundwater model update that is currently underway will help to provide more insight into the ultimate source of the water that is currently being pumped from the Lompico Sandstone in the Scotts Valley area.

BUTANO FORMATION GROUNDWATER LEVELS

The role of the Butano Formation as a water-producing horizon has recently been recognized during the re-evaluation of the conceptual model for the ongoing numerical model update. The Butano Formation has been mapped by the USGS (Brabb 1989; Clark 1981) at the surface along the northern margin of the groundwater basin (Figure 3-3); however, the Butano Formation had not previously been identified as being present at depth in the North Scotts Valley area. Based on the geologic logs for SVWD Wells #3B and #7A, the Butano Formation is interpreted to be present within a depth range of 900 to 1,800 feet below the ground surface (Figure 3-4).

The production history of SVWD Wells #3B and #7A indicates that the Butano Formation is capable of producing significant volumes of groundwater. Well #3B, which is completed solely within the Butano Formation, has averaged 255 acre-feet per year since WY1997. Annual pumping has ranged from 209 to 342 acre-feet. Well #7A, which is completed in both the Lompico Sandstone and the Butano Formation, has averaged 769 acre-feet per year since WY1994. Annual pumping has ranged from 605 to 1,032 acre-feet since WY1995.

Groundwater elevations measured in SVWD Well #7A varied within a narrow range of 430 to 435 feet amsl from WY1992 through WY1994 (Figure 5-25). It is unclear whether these groundwater elevations reflect conditions in the Lompico Sandstone or the Butano Formation. Once groundwater production from Well #7A began in March WY1994, groundwater elevations began to decline. Static groundwater elevations declined to a range between 235 and 265 feet amsl (Figure 5-25).

Similarly, groundwater elevations for Well #3B varied between 270 and 300 feet amsl from WY1994 to WY1997. During this time, Well #7A was operating; however, Well #3B was not. Once Wells #3B and #7A both became operational, static groundwater elevations declined to about 250 feet amsl, and pumping groundwater elevations were about 175 to 225 feet amsl (Figure 5-25). Since WY2000, groundwater levels for Well #3B have shown a rise to 250 to 300 feet amsl in WY2003. A single measurement in WY2004 indicated a static groundwater elevation of 369 feet amsl. This suggests that groundwater elevations in the Butano Formation have increased since WY2001 as groundwater production has decreased from over 1,190 acre-feet in WY2000 to 890 acre-feet in WY2004.

Since WY2002, groundwater elevation data from Well #7A have only been collected when the well is being actively pumped. Therefore, these data do not reflect static conditions. Also, in November 2004, it was determined that the electronic groundwater level monitoring device was no longer in calibration, and was, therefore, not producing reliable readings. Measures are currently underway to correct this problem. However, these issues make it difficult to evaluate the current conditions in the Butano Formation.

Groundwater production in Well #7A has decreased since WY2000. However, during that time, the groundwater elevation while the well is pumping has decreased about 100 feet. Although there are several factors that could account for this, this may suggest that the well efficiency in Well #7A has declined after several years of heavy pumping.

Currently, SVWD Wells #3B and #7A are the only wells completed within the Butano Formation that have available groundwater elevation data. This lack of data precludes the ability to generate a groundwater elevation map for the Butano Formation. Additional data will be required to further evaluate the potential of future groundwater development. Groundwater recharge is likely from infiltration of precipitation and from the streams that flow over the Butano Formation in the exposure areas north of Scotts Valley, including Bean Creek, Zayante Creek, and the West Branch of Soquel Creek. As a first step, improving the understanding of groundwater inflow and outflow from the Butano Formation will also be addressed by the numerical model update.

GROUNDWATER SUPPLY ASSESSMENT

Change in Groundwater Elevations

In the Santa Margarita Sandstone, changes in groundwater elevations from WY2003 to WY2004 are primarily noted in the South Scotts Valley area where sufficient data are available for evaluation (Figure 5-27). Groundwater elevation declines are primarily noted in the South Scotts Valley area – Camp Evers subarea where they are associated with water supply and environmental remediation pumping centers. Water supply pumping by SVWD and Mañana Woods wells declined slightly from WY2003 to WY2004; however, environmental remediation pumping increased at both the Watkins-Johnson and Camp Evers sites. Smaller declines in water levels are noted in the centered around the Vista Del Lago #1 well near Spring Lakes and the New Probation well in the Pasatiempo subarea. A rise in groundwater elevations was noted near the Hanson Aggregates Quarry that is attributed to a decrease in pumping for quarry operations.

In the Lompico Sandstone, declines in groundwater elevations from WY2003 to WY2004 are noted in both the North and South Scotts Valley areas (Figure 5-28). A broad area of decline is noted in the North Scotts Valley area around the SVWD Wells #11A, #11B and #7A (SVWD Well #7A is screened across both the Lompico Sandstone and Butano Formation). In the South Scotts Valley area, declines are noted in the vicinity of Camp Evers, Spring Lakes, and the Pasatiempo wells. A slight rise is noted at SVWD Well #10 southeast of Camp Evers.

Change in Groundwater Storage

Groundwater storage change was calculated using the contours on Figures 5-27 and 5-28 and estimated storativity values. Storativity values are based on values used in previous estimates to maintain consistency (Todd Engineers 1997, 2003). A storativity value of 0.12 is used for the Santa Margarita Sandstone; 0.06 for the Lompico Sandstone, and 0.001 for the Butano Formation. Because only limited groundwater elevation data are available for the Butano Formation, the change in groundwater elevations was assumed to be similar to those in the Lompico Sandstone in the vicinity of SVWD Well #7A (Figure 5-28). Based on these parameters, the groundwater storage is estimated to have declined by approximately 210 acre-feet from WY2003 to WY2004. This estimate is consistent with previous estimates based on a comparison with annual precipitation (Table 5-5).

Evaluation of groundwater storage changes in previous years (Todd Engineers 1997, 2003) indicate that groundwater storage declined between 175 to 500 acre-feet during the late 1980s and early 1990s, reflecting both the drought and increasing groundwater pumping (Figure 5-29). Increases in groundwater storage have been estimated for the period WY1995 to WY2000 reflecting a period of above average rainfall. However, since WY2001, groundwater storage declines have been estimated for the area (Figure 5-29). It should be noted that this method of analysis is subject to a large margin of error resulting from the use of an outdated hydrogeologic conceptual model in pervious years. The estimates for previous years do not necessarily reflect actual values based on the current hydrogoelogic conceptual model, moreover the County of Santa Cruz staff calculated the storage decline to be significantly larger using the same method and the updated hydogeologic model .

Table 5-5
Comparison of Change in Groundwater Storage to Annual Precipitation for WY1989 through WY2004

Year	Annual Precipitation (inches)	Annual Change in Groundwater Storage (acre-feet)
WY1989	30.67	-465
WY1990	20.58	-398
WY1991	26.64	-461
WY1992	33.55	-238
WY1993	50.06	-175
WY1994	27.81	-498
WY1995	58.73	328
WY1996	47.08	53
WY1997	47.36	11
WY1998	63.74	255
WY1999	40.66	150
WY2000	49.41	31
WY2001	33.74	-221
WY2002	41.30	-34
WY2003	42.45	-117
WY2004	37.04	-210

Application of Numerical Model

Additional assessment of the groundwater supply will be conducted as part of the AB303 numerical model update. The updated numerical model will provide a quantitative tool that can evaluate the groundwater supply in the Scotts Valley area based on the revised hydrogeological conceptual model. The types of groundwater supply assessments that can be performed using the AB303 updated numerical model include:

- Calculating the available aquifer capacity and the annual change in groundwater storage by geologic unit,
- Providing insights into groundwater flow within and between geologic units,
- Developing a more comprehensive hydrologic budget for the groundwater basin including local hydrologic budgets for areas and geologic units,
- Determining the sustainable yield for the groundwater basin including areas and geologic units, and

- Evaluating future groundwater management scenarios to better manage pumping and identify potential future well locations.

The report for the AB303 numerical model update is planned for the summer of 2005. Calculations of change in groundwater storage will be deferred to this upcoming report where they can be evaluated more comprehensively.

CHAPTER 6 – WATER QUALITY ASSESSMENT

NATURAL GROUNDWATER QUALITY

Definition of Natural Water Quality Parameters of Concern

The parameters used to measure the natural groundwater quality associated with public health risks and aesthetic conditions of the water supply are defined in this section. The Safe Drinking Water Act authorizes the U.S. Environmental Protection Agency (USEPA) and the DHS to set primary and secondary MCLs for these parameters. Arsenic and nitrate are the only public health parameters included in this section that have primary MCLs. Primary MCLs are set at levels protective of public health for chronic and short-term exposure. Other constituents, including TDS, iron, manganese, and sulfate are of concern for taste, odor, and other aesthetic factors, and, therefore, have concentration limits governed by secondary MCLs, which regulate these aesthetic factors.

Arsenic is a naturally occurring element that occurs in groundwater as a result of the erosion and breakdown of naturally occurring deposits. Arsenic in groundwater can also be associated with contaminant plumes. Arsenic ingestion has been linked to skin damage, circulatory problems, and increased cancer risk. The USEPA has recently reduced the primary MCL for arsenic from 50 micrograms per liter (µg/L) to 10 µg/L with compliance required by 2006. In addition to this federal guideline the California DHS has set a public health goal (PHG) of 4 µg/l for arsenic, in April 2004. Low levels of arsenic, averaging approximately 1 µg/L, have been found in the groundwater of Santa Cruz County (USGS 2005).

The occurrence of nitrate in water supplies has been correlated to pollution from fertilizer runoff, sewage, and leaching from septic tanks, but it is also a naturally occurring inorganic constituent in groundwater. The USEPA has established a primary MCL of 10 milligrams per liter (mg/L) for nitrate measured as nitrogen. Nitrate is associated with blue-baby syndrome and shortness of breath in infants and elderly adults. Historically, low levels of nitrate (well below MCLs) have been detected in SVWD production wells. Since 1991, however, no detections of nitrate have been measured at any SVWD production wells with the exception of a single sample from SVWD Well #10 of 6.5 mg/L in 1999. Nitrate is not currently a significant concern for the SVWD water supply, although it is monitored as an important water quality parameter.

TDS represents the ionic concentration of minerals dissolved in groundwater that result from the dissolution of minerals in the aquifers. The USEPA has no primary MCL for TDS concentrations as it is not a significant health concern. TDS is significant because it is associated with objectionable aesthetic characteristics in water. Therefore, a secondary MCL range of 500 to 1,000 mg/L, including a short-term limit of 1,500 mg/L, has been developed for TDS (California Code of Regulations Title 22, §64449).

Iron and manganese exist at elevated levels in the groundwater of the Scotts Valley region. These two constituents are naturally occurring and usually are the result of the dissolution of minerals contained within the geologic units. Although iron and manganese pose no significant health risk, they do possess undesirable characteristics including the discoloration of water, laundry, and fixtures, or cause the buildup of deposits in pipes and plumbing. These aesthetic concerns resulted in the creation of secondary MCLs of 300 µg/L for iron and 50 µg/L for manganese.

A study addressed the problem of fluctuating and elevated levels of iron and manganese in the Scotts Valley region (Todd 1996). The results of the investigation include:

- Iron and manganese concentrations exceeding the secondary MCL in raw groundwater are a common occurrence in the Scotts Valley area.
- Elevated iron and manganese concentrations occur in groundwater from all major aquifers in the area. Iron and manganese concentrations are generally lower in the wells that are screened in the Santa Margarita Sandstone.
- Iron and manganese concentrations are affected by the variations in pumping. A decrease in pumping from a well is correlated to an increase in iron and manganese concentrations. This is most likely a phenomenon involving geochemical changes occurring at the well/aquifer interface.
- Other factors potentially affecting the iron and manganese concentrations include the geochemistry of the geologic unit, the presence of iron bacteria, and sampling protocols.

Sulfate is another naturally occurring constituent that occurs in groundwater as a result of dissolution of minerals within the aquifer. There is no significant health risk associated with the presence of sulfate in drinking water (CDC 1999). However, the DHS has established a secondary MCL of 250 mg/L to account for the aesthetic characteristics of sulfate and its daughter product hydrogen sulfide. High levels of sulfate and hydrogen sulfide are usually associated with foul smell and taste in water. The odor of rotten eggs can often be attributed to the presence of dissolved hydrogen sulfide gas in water.

The natural water chemistry of the groundwater in the Scotts Valley area can be categorized by the geologic unit in which the water is produced.

Natural Water Quality in Butano Formation Wells

SVWD Wells #3B and #7A produce water from the Butano Formation. Figure 6-1 shows the historical trends for concentrations of iron, manganese, sulfate, and TDS in the Butano Formation production wells. SVWD Well #7A has been sampled regularly since its construction in 1991. Similarly, SVWD Well #3B has been sampled regularly since its construction in 1995. Importantly, arsenic and nitrate have never been detected in any water quality sample collected from SVWD Wells #3B and #7A. This history strongly indicates their absence from the Butano Formation in the vicinity of these wells.

Iron concentrations have historically been above the secondary MCL of 300 mg/L. However, the data show a steady declining trend over time, but with significant fluctuations. In WY2004, iron concentrations were below the secondary MCL. In SVWD Well #7A, manganese concentrations have been well below the secondary MCL of 50 mg/L. In contrast, manganese concentrations in SVWD Well #3B have fluctuated between 10 and 140 mg/L (Figure 6-1). These fluctuations are inversely proportional to pumping volumes for each correlating time period. At times when pumping rates are low the concentrations increase and at seasonal times when pumping rates are high the manganese concentrations drop significantly.

TDS concentrations in Wells #3B and #7A have fluctuated between 450 and 650 mg/L (Figure 6-1). TDS concentrations in SVWD Well #7A decreased from about 600 mg/L in 1991 to nearly 450 mg/L in 1997. Since 1997, TDS concentrations show a slight increasing trend to about 550 mg/L (Figure 6-1). TDS concentrations in SVWD Well #3B have fluctuated with no clear trend. In WY2004, TDS concentrations in both wells were above the secondary MCL.

The sulfate concentrations in Wells #3B and #7A have historically ranged between 69 mg/L and 170 mg/L (Figure 6-1), well below the secondary MCL of 250 mg/L. SVWD Well #7A shows a stable concentration trend over time with little variability whereas SVWD Well #3B also shows a steady, but fluctuating, concentration trend. In WY2004, sulfate remained low, with concentrations ranging from 72 to 85 mg/L.

Natural Water Quality in Lompico Sandstone Wells

SVWD Wells #10, #11A, and #11B are completed within the Lompico Sandstone. Figure 6-2 shows the historical trends for concentrations of arsenic, iron, manganese, sulfate, and TDS in the Lompico Sandstone production wells. Nitrate has not been detected in water quality samples collected from Wells #10, #11A, and #11B.

Iron concentrations in Wells #10, #11A, and #11B have historically been over the secondary MCL of 300 mg/L. The historical trend shows an overall increasing trend with significant fluctuations (Figure 6-2). Manganese concentrations show a similar historical trend with concentrations consistently above the secondary MCL of 50 mg/L. The manganese concentrations in SVWD Well #11A show a similar inversely proportional relationship to pumping volumes to those noted for SVWD Well #3B in the Butano Formation. However, the trend for manganese concentrations in Wells #11B and #10 has been relatively stable since 2000. In WY2004, iron concentrations ranged from a low of 780 mg/L in SVWD Well #10 to a high of 9,000 mg/L in SVWD Well #11B. Manganese concentrations in WY2004 ranged between 50 mg/L in SVWD Well #10 and 220 mg/L in SVWD Well #11A (Figure 6-2).

Historical data from SVWD Well #10 in the South Scotts Valley area indicate that TDS concentrations have historically been well below the secondary MCL of 500 mg/L although a slight increasing trend is noted. TDS concentrations have increased from about 100 mg/L in WY1983 to about 200 mg/L in WY2004 (Figure 6-2). Wells #11A and #11B in the North Scotts Valley area have higher TDS concentrations. TDS has generally been below the secondary MCL in SVWD Well #11B and slightly above the secondary MCL in SVWD Well #11A. In WY2004, TDS concentrations in SVWD Well #11A have ranged from 540 mg/L to 570 mg/L, just above the lower limit of the secondary MCL range. TDS concentrations in SVWD Well #11A have been above the secondary MCL since 2000. The historical trend shows a slight increasing trend in Wells #11A and #11B of about 100 mg/L (Figure 6-2).

Sulfate concentrations in Wells #10, #11A, and #11B are below the 250 mg/L secondary MCL and historically range between 26 mg/L and 219 mg/L. For WY2004 these concentrations remained between 47 mg/L and 190 mg/L. A slight increasing trend may be present in SVWD Well #11A, but it is not clear as a trend due to fluctuations in the sample history. Wells #11B and #10 have shown a generally stable trend over time.

Wells completed in the Lompico Sandstone are the only SVWD production wells that have consistently had arsenic detections. On a few occasions, arsenic concentrations have exceeded the revised primary MCL of 10 µg/L, which is set to go into effect in 2006. On multiple occasions levels have exceeded the California PHG of 4 µg/L. These detections have historically been more prevalent in Wells #11A and #11B in the North Scotts Valley area. Arsenic concentrations in SVWD Well #10, in the South Scotts Valley area, are below the 10 µg/L primary MCL and below the California PHG, in fact levels are generally less than 2 µg/L. The historical trend for arsenic has remained stable in SVWD Well #10. Since arsenic concentrations are present in SVWD production wells #10, #11A, and #11B it can be determined that arsenic exists in the geochemistry of the Lompico Sandstone.

Wells #11A and #11B have historically had arsenic concentrations between 1 µg/L and 12 µg/L. Arsenic concentrations show a considerable amount of fluctuation but not a clear trend. Arsenic concentrations in Wells #11A and #11B are notably higher than those in SVWD Well #10, which could be attributed to:

- Localized elevated arsenic concentrations due to natural variations in the groundwater geochemistry in the Lompico Sandstone;
- Historical groundwater drawdown in this area that allows greater arsenic concentrations to dissolve in a smaller volume of water;
- Possible dilution occurring in Well #10 resulting from Lompico water being mixed with Santa Margarita water, which contains no arsenic. This dilution would not occur in Well #11A and #11B because they are screened only in the Lompico Formation;
- Contaminant plumes, perhaps associated with the chlorobenzene plume that has been noted in the vicinity and is discussed later in this section.

SVWD submitted a grant pre-application to DWR in WY2004 to investigate the chlorobenzene plume and its impact on water quality in the vicinity of Wells #11A and #11B. In addition, SVWD submitted two grant pre-applications to add arsenic treatment at El Pueblo, should it be required to meet the anticipated California arsenic MCL.

Natural Water Quality in Santa Margarita Sandstone/Monterey Formation Wells

SVWD Well #9 is completed within the Santa Margarita Sandstone and Monterey Formation. Figure 6-3 shows the historical trends for concentrations of iron, manganese, sulfate, and TDS in Santa Margarita Sandstone and Monterey Formation production wells. Arsenic and nitrate have not been detected in any water quality sample collected from SVWD Well #9.

Iron and manganese concentrations in SVWD Well #9 have historically been below the secondary MCL of 300 mg/L for iron and 50 mg/L for manganese. Occasional spikes in concentrations have been noted in the past, but these appear to represent sample outliers rather than an overall trend in concentrations. In WY2004, iron and manganese concentrations remained below both secondary MCLs.

TDS concentrations in SVWD Well #9 do show an increasing trend over time (Figure 6-3). TDS concentrations prior to WY1999 were below the 500 mg/L secondary MCL. However, TDS concentrations show an overall increasing trend, with concentrations generally about 200 mg/L prior to WY1983. TDS concentrations rose to about 400 mg/L by WY1985, but then remained stable between 200 and 400 mg/L until WY1994. Beginning in WY1994, TDS concentrations began a steadily increasing trend to their current levels of about 600 mg/L in WY2004.

Concentration fluctuations have become more prominent as well, with TDS concentration spikes up to 1,000 mg/L (Figure 6-3). In WY2004 TDS concentrations in SVWD Well #9 ranged from 540 to 1,100 mg/L.

Sulfate concentrations in SVWD Well #9 show a similar increasing trend as seen in TDS (Figure 6-3). Prior to WY1994, sulfate levels were generally stable between 50 and 100 mg/L, well below the 250 mg/L secondary MCL. Since WY1994 an increasing trend is seen with sulfate concentrations showing more fluctuations, with concentration spikes up to nearly 500 mg/L (Figure 6-3). In WY2004, sulfate concentrations ranged between 180 and 480 mg/L in SVWD Well #9.

The increase in TDS and sulfate concentrations is attributed to the difference in geochemistry between groundwater from the Santa Margarita Sandstone and the Monterey Formation. Based on groundwater elevation trend data (Figure 5-8), SVWD Well #9 produced water primarily from the Santa Margarita Sandstone prior to WY1994. Due to declines in groundwater levels, a significant amount of the production has shifted to the Monterey Formation since WY1994.

The Monterey Formation is primarily a shale unit that is noted for high levels of organic materials, suggesting a reducing geochemical condition where sulfates would be more prevalent. The Santa Margarita Sandstone is a relatively clean sandstone unit composed primarily of quartz. Based on the differences in the mineralogical composition of these two geologic units, it would be anticipated that the Monterey Formation would be more highly mineralized, thereby producing higher TDS concentrations, and sulfate would be a major constituent of that increase.

WATER TREATMENT

SVWD applies treatment technologies to raw water extracted from wells to compensate for groundwater with concentration levels above or approaching these primary and secondary MCLs. SVWD provides treatment of groundwater at four water treatment plants (WTPs) prior to its distribution to customers. These facilities and their operation are listed below in Table 6-1. Each treatment directly relates to the water quality objectives for the well(s) connected to the facility and is further explained later in this section.

Table 6-1
Water Treatment Applied to SVWD Raw Water

Treatment Plant	Production Well(s)	Treatment Type
El Pueblo WTP	#11A, #11B	pH adjusted, oxidized w/ NaOCl, rapid dual media filter, sequestering agent, NaOCl
SVWD Well #10 WTP	#10	Air stripper, sequestering agent, dual media filter, sodium hypochlorite (12.5%)
SVWD Well #9 WTP	#9	Granular Activated Carbon (GAC), sodium hypochlorite (12.5%)
Orchard Run WTP	#3B, #7A	Air stripper, sodium hypochlorite (12.5%), sequestering agent, dual media filter

The El Pueblo WTP treats water from SVWD Wells #11A and #11B with caustic soda (NAOH) pH adjustment, oxidation using sodium hypochlorite, filtration, and additional chlorination as needed. SVWD Well #11A water is blended with SVWD Well #11B water prior to treatment to assist in the reduction of dissolved solids from both wells. Raw water is treated with a polyphosphate sequestering agent to mitigate the iron and manganese concentrations that are above the secondary MCL. However, the effectiveness of this type of treatment may be compromised in the future if increasing trends in iron and manganese continue. The combination of treatment technologies employed at the El Pueblo WTP reduces arsenic concentrations to a level between 2.4 and 3.5 μg/L, which is below both the 10 μg/L primary MCL, and the 4 μg/L PHG. Any additional treatment would simply be to further "polish" the water.

The SVWD Well #10 WTP treats water from SVWD Well #10 with an air stripper, filtration, and chlorination. Water is also treated with a polyphosphate sequestering agent to mitigate the iron and manganese concentrations that are occasionally above the secondary MCL. The air stripper is used at this treatment facility to eliminate taste and odor associated with hydrogen sulfide.

The SVWD Well #9 WTP treats water from SVWD Well #9 with a GAC filter, and post-chlorination. Although water is treated using two GAC filters in series and chlorine disinfectant, sulfate was detected in treated water at a concentration of 350 mg/L at the SVWD Well #9 water treatment facility on July 21, 2004. This concentration is 100 mg/L over the recommended secondary MCL lower limit of 250 mg/L and therefore is of particular concern. Although it is above the recommended lower limit, there is no action required to mitigate this concentration. It also should be noted that the secondary MCL for sulfate includes a range between 250 and 500 mg/L based on aesthetic water quality; therefore, the elevated concentrations are not of any public health risk but should be monitored. GAC treatment is not the best available technology for treating elevated sulfate levels; GAC treatment is used to remove chlorinated solvents and gasoline derivatives. The feasibility of alternate or additional treatment should be considered at this treatment facility. Water from SVWD Well #9 is treated using GAC and chlorine which has, thus far, successfully addressed the elevated levels of TDS in the raw water produced from the well.

The Orchard Run WTP treats water from SVWD Wells #3B and #7A with an air stripper, dual media filtration, chlorination, and a corrosion inhibitor/sequestering agent. The air stripper is used at this treatment facility to eliminate taste and odor associated with hydrogen sulfide.

RECYCLED WATER MONITORING

The Water Recycling Program is a water supply project and, as such, is recognized as a proactive step in addressing the water conservation objectives established by AB3030. The Water Recycling Program is designed to replace groundwater pumping that is used for irrigation and landscaping with highly treated recycled water that is suitable for unrestricted irrigation reuse. As a part of this program, SVWD collects water samples from surface water and groundwater locations near where recycled water is applied for irrigation or landscaping to monitor for any potential environmental impacts. All baseline data and current monitoring data are listed in Appendix E (Table E-2). The data include water quality parameters that are typically present in tertiary treated water effluent. The locations of each of these sampling points are shown in Figure 4-2.

To date, no significant changes have occurred in concentrations relative to baseline conditions. Figure 6-4 presents time-history graphs of this monitoring data for nitrate and TDS in Carbonera Creek, Bean Creek, and the three shallow monitoring wells compared to the average tertiary effluent concentrations and the secondary MCL. TDS has increased slightly in both Carbonera and Bean Creeks. These concentrations fluctuate seasonally with flow rate in these two creeks, presumably because TDS has the tendency to increase during periods of lower flow and decrease during periods of higher flow. Although there has been a slight increase in TDS concentrations since the inauguration of the recycled water program, samples from both creeks remain below the secondary MCL of 500 mg/L and between 300 and 450 mg/L for WY2004. It should also be noted that these increased TDS concentrations may be related to WY2004 precipitation patterns rather than to the use of recycled water.

TDS in the shallow monitoring wells has remained relatively constant with the exception of the Mountain Brook Well (Figure 6-4). The TDS concentrations in this well fluctuate seasonally with a slight increasing trend. Two of the last three samples taken from the Mountain Brook Well are at concentration levels above the 500 mg/L secondary MCL. For WY2004 the concentrations ranged between 450 mg/L and 570 mg/L. The cause of increases in TDS at the Mountain Brook Well may similarly be unrelated to the use of recycled water in the area, especially given the timing of recycled water use in this area. Concentrations in SVWD Well #9 have also shown an increasing trend as seen in Figure 6-3, yet this trend began prior to the Water Recycling Project and is in all likelihood the result of the primary water resource of this well coming from the Monterey Formation as discussed above.

No significant increasing trends in nitrate concentrations have been observed (Figure 6-4), although since the Water Recycling Program began there have been two large spikes in nitrate concentrations in the shallow monitoring wells: one in the Mountain Brook Well of 2.1 mg/L in January 2003 and another of 1.6 mg/L in the Haas Well in January 2004. These spikes are well below the established MCL of 10 mg/L for nitrate, but should be noted due to the revealing nature of increased nitrate concentrations when evaluating the environmental impacts of recycled water. Nitrate detections can also be the result of fertilizer applications or the leaching of septic systems, although these conditions most likely have been present prior to the recycled water program.

In WY2004 the SVWD added two new chemicals to the list of water quality parameters evaluated as part of the recycled water monitoring program: nitrosodiethylamine (NDEA) and nitrosodimethylamine (NDMA). NDEA and NDMA are a byproduct of water treatment using chlorine. Although there are no established MCLs for these two constituents, SVWD proactively incorporated them into the monitoring program based on the recent development of notification levels for these parameters created by the DHS. Water samples from Bean and Carbonera Creeks, and the three shallow monitoring wells were analyzed NDEA and NDMA. The analyses indicated that all sample results were below the detection limit. These parameters have also been evaluated at the tertiary plant, itself. The City of Scotts Valley has informed SVWD that there have been no detections of either compound to date.

ENVIRONMENTAL COMPLIANCE SUMMARY

Background

The groundwater in the Scotts Valley region has been impacted by environmental contamination by releases from underground storage tanks, manufacturing sites, and unknown sources. SVWD does not regulate these environmental sites but does sample production wells and miscellaneous monitoring wells on a regular basis to ensure water quality and recognize threats to public health. Regulatory agencies that operate in the Scotts Valley region include the California Regional Water Quality Control Board (RWQCB), the Santa Cruz Department of Environmental Health (SCDEH), the California Department of Toxic Substances Control (DTSC), and the USEPA. The extent of groundwater monitoring associated with these sites relative to SVWD production wells is shown on Figure 6-5. A more detailed discussion of each site is provided below.

Scotts Valley Dry Cleaners

Site Characteristics

In 1993 the RWQCB began overseeing investigations in the vicinity of the Scotts Valley Dry Cleaners site on Mt. Hermon Road (Figure 6-6). These investigations included the detection of tetrachloroethene (PCE), and its daughter products trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE). These VOCs are known or suspected carcinogens that pose a potential human health risk in drinking water and therefore have very low primary MCLs. This site is of concern because SVWD Well #10 is located about 550 feet south of the suspected source area (Figure 6-6).

The Scotts Valley Dry Cleaners plume is shown on Figure 6-6. In WY2004, PCE was detected in 10 of 14 monitoring wells at concentrations ranging from 85 to 2,400 µg/L, TCE was detected in 3 of 14 monitoring wells at concentrations ranging from 5.3 to 12 µg/L, and cis-1,2-DCE was detected in 4 of 14 monitoring wells at concentrations ranging from 11 to 180 µg/L. The MCLs established by DHS for PCE, TCE, and cis-1,2-DCE are 5, 5, and 6 µg/L, respectively (DHS 2005).

The plume has wide lateral extent across the site with a narrow, high-concentration plume dictated by the elevated concentration levels detected in MW-9 (Figure 6-6). The southern extent of the plume, between the site and SVWD Well #10, has yet to be defined by monitoring well data. Three new monitoring wells have been constructed on the southern end of the site, although water sample results were not available at the time of production for this report. PCE concentrations in MW-9 have increased sharply since 2003. PCE concentrations have increased from 4 µg/L in 2000 to 2,100 µg/L in 2004. From October 2003 to November 2004, PCE concentrations increased from 840 to 2,100 µg/L (Figure 6-7). This rapid increase indicates that the contaminant plume is moving southerly in the direction of SVWD Well #10.

PCE concentrations for MW-15 and MW-16 show a general decreasing trend in recent years although concentrations still remain high (Figure 6-7). These two wells are both within close proximity to the suspected source area and have historically had much higher concentrations relative to other monitoring wells onsite. MW-7 PCE concentrations have significantly decreased in the last two years, yet still remain high relative to drinking water standards. The other 10 monitoring wells have shown a decreasing trend in recent years. Concentrations for these wells in their last sampling event were all significantly above the 5 µg/L MCL and ranged from 77 to 550 µg/L. All data related to the presence of chlorinated solvents at this site are presented in Appendix E, Table E-4.

TCE and cis-1,2-DCE have also been detected at the site at concentrations above MCLs. The most significant detection of these chemicals has been in MW-9 and MW-7 (Figure 6-7). Similar to PCE concentrations, TCE and cis-1,2-DCE are showing significant increasing trends in MW-9.

<u>Regulatory Compliance Summary</u>

The consultant to the property owner, SECOR International Inc. (SECOR), produces monthly status reports to the RWQCB to assess the progress of site investigation and remediation. Initially, a soil vapor extraction system was operated, but it was discontinued after recovery rates declined. The RWQCB requested that the site implement groundwater extraction as an interim measure to contain plume migration. SECOR determined the results of a February 2002 pilot test demonstrated that the cost of constructing and operating such a system was disproportionate to the risk posed by plume migration at the time. In September 2002, SECOR also performed an in-situ bioremediation pilot test that involved the injection of a carbohydrate solution to accelerate the anaerobic degradation of VOCs; however, the results of this pilot test were determined inconclusive (SECOR 2003).

In January 2004 SECOR conducted a high-vacuum dual-phase extraction (HVDPE) pilot test using regular bi-weekly extraction events in March and April 2004. The results of these extractions indicated that HVDPE was ineffective, although in a directive letter from the RWQCB dated June 4, 2004, SECOR was instructed to continue HVDPE until a more effective remedial technology could be analyzed and implemented. From the time of this letter, HVDPE progressed throughout WY2004 with no extraction events occurring in the month of July because of delays on cost estimates and HVDPE truck malfunction (SECOR 2004).

As required by the RWQCB, SECOR prepared a Revised Interim Remedial Action Plan (RIRAP) dated July 29, 2004. The RIRAP proposed the installation of three monitoring wells between the source area and SVWD Well #10. The RIRAP also proposed the construction of a pump and treat groundwater extraction (GWE) system to hydraulically control plume migration from wells MW-9, MW-15, and MW-16. HVDPE is to continue on the site until the GWE system is constructed. The RIRAP was accepted by the RWQCB in an August 4, 2004 letter indicating that the GWE system will operate until plume migration is controlled and PCE levels begin to decline in wells MW-9, MW-15, and MW-16, and at that point other remedial options can be considered for the site.

In WY2004 SECOR has continued to submit monthly status reports. Other correspondence between SECOR, the RWQCB, SVWD, and the Scotts Valley Planning Division are listed below:

- October 29, 2004, SVWD, addressed to the RWQCB, *Comments on Well Installation Report, Scotts Valley Dry Cleaner.* The letter addressed concerns of well depth relative to plume migration and chemical properties of contaminants, depth of soil samples taken relative to plume migration and chemical properties of contaminants, and the absence of SVWD well permits in the construction of wells.

- January 5, 2005, RWQCB, addressed to Mr. Russell Pratt/SECOR, *Scotts Valley Dry Cleaners, Review of Monthly Status Report and Directive.* The letter directs the Pratt Company/SECOR to increase groundwater pumping events to twice weekly until the full-scale pump and treat system is operational.
- January 18, 2005, SECOR, addressed to Scotts Valley Planning and Building Department, *Construction Plans for a groundwater pump and treat system.* Submittal of design plans to build the full-scale pump and treat facility.
- February 3, 2005, RWQCB, addressed to Mr. Russell Pratt/SECOR, *Scotts Valley Dry Cleaners, Review of Monthly Status Report.* The letter addresses concerns due to the lack of sampling events and HVDPE event during the month of December 2004. It also provides a directive to implement HCDPE events no less than twice per week.
- February 15, 2005, SVWD, addressed to the Scotts Valley Planning Division, *Comments on Use Permit Application #U05-002 and Design Review Application #DR05-003, Scotts Valley Dry Cleaners.* The letter addresses concerns of the design of a groundwater extraction system that lacks a vapor extraction component. The letter also reiterates the concerns of the October 29, 2004 letter to the RWQCB.

Compliance Assessment

The conditions at this site are of substantial concern to SVWD due to the proximity of SVWD Well #10. Because of the increasing PCE and TCE concentrations in MW-9, SVWD has commented to the RWQCB about these concerns.

In evaluating the groundwater elevation data for this site for the groundwater supply assessment, it appears that the monitoring wells are completed within the perched zone (Figure 6-9). The Wescosa Well to the north has water levels consistent with the lower Santa Margarita Sandstone or regional aquifer (R.L. Stollar 1988) whereas most of the Dry Cleaners site monitor wells have water levels consistent with the perched zone. A similar perched zone was described for the nearby Watkins-Johnson site (R.L. Stollar 1988). Figure 6-9 presents a cross section from the Watkins-Johnson site through the Scotts Valley Dry Cleaners site. This indicates that the Watkins-Johnson perched zone is lower in the Santa Margarita Sandstone than the one observed at the Scotts Valley Dry Cleaners site.

The site has only one deeper well to evaluate the potential impact of the Dry Cleaners site on the lower Santa Margarita Sandstone or regional aquifer. Furthermore, the groundwater elevation and contaminant distributions suggest the presence of more complex preferred flow paths within the perched zone.

SVWD Well #10 is screened in the Lompico Sandstone but is located in the approximate area where the Monterey Formation pinch-out occurs and the Santa Margarita Sandstone is in direct contact with the Lompico Sandstone (Figure 3-5). The hydrograph data indicate that the Santa Margarita Sandstone has a higher groundwater elevation than the underlying Lompico Sandstone in this area (Figures 5-19 and 5-20). Therefore, the potential exists for contaminants in the Santa Margarita to impact the Lompico Sandstone.

Scotts Valley Drive Chlorobenzene Plume

The chlorobenzene plume is located along El Pueblo Road and Scotts Valley Drive (Figure 6-10). Relatively low levels of VOCs have been detected in SVWD Wells #11A, #11B, and #11. The most predominant of these VOCs have been dichlorobenzenes (DCBs) and chlorobenzene. The DTSC previously investigated the site in October 1996. During the time of that investigation, the Florea and Carbonero Trailer Park Well #1 showed the most elevated concentrations of chlorobenzene and DCBs. The results defined the source of contamination to be in proximity to these wells, although no source was identified by the DTSC, and no additional investigations have been performed since.

Based on the available data, the chlorobenzene plume has expanded significantly since 1984. Initially, the plume impacted several private water supply wells at concentrations above MCLs. Elevated concentrations of DCBs and chlorobenzene have persisted at locations near the southern portion of the site, near Carbonero Trailer #1 and Florea wells in the Santa Margarita Sandstone (Figure 6-10). Importantly, the plume has migrated over 3,000 feet over the past 19 years and has been detected in SVWD Wells #11, #11A, and #11B at concentrations below MCLs. These data indicate that despite natural degradation of DCBs, the more mobile daughter product, chlorobenzene, is a persistent threat to Wells #11A and #11B, which are screened within the Lompico Sandstone.

DCBs are halogenated semi-volatile compounds which occur in the form of 1,2-DCB, 1,3-DCB, and 1,4-DCB. DCBs naturally degrade under anaerobic conditions in the subsurface, forming a more soluble and mobile chlorobenzene. DCBs have been historically linked to generation of mothballs, insecticides/pesticides, aerosols, and use as cleaning products for various machineries. Chlorobenzene has been linked to transformer oils, leather tanning processes, production of pesticides/herbicides, degreasing operations, paints, and dry-cleaning operations (ETIC 2004). Table 6-2 below compares the maximum detected concentrations of DCBs (totaled) and chlorobenzene to their respective MCLs.

Table 6-2
MCLs for Dichlorobenzenes and Chlorobenzene

Chemical	Maximum Detected Groundwater Concentration (ug/L)	MCL (ug/L)
DCBs (total)	1,500	5 to 600
Chlorobenzene	76	70

From the available data, it appears that the plume originated in the Santa Margarita Sandstone in the vicinity of Carbonero Trailer #1 and Florea wells. Initial transport is toward the northwest along with the regional flow pattern for the Santa Margarita Sandstone (Figure 5-12). The specific gravities of chlorobenzene, 1,2-DCB, 1,3-DCB, and 1,4-DCB are all greater than one (Verschueren 1983), and therefore these chemicals would have tendencies to be heavier than water in the separate phase and progress vertically through the aquifer toward the Lompico Sandstone. At some point north of Scotts Valley Drive, the plume migrated vertically downward into the Lompico Sandstone. This area is located where the Santa Margarita and Lompico

Sandstones are in direct contact (Figure 3-5). In the Lompico, migration has been towards the active pumping wells at SVWD Wells #11A, #11B, and #11 in response to the regional flow in the Lompico Sandstone (Figures 5-21 through 5-24).

Recently, SVWD has submitted a proposal pre-application to the DHS, Division of Drinking Water and Environmental Management, for a California Proposition 50 Grant to fund further investigation of the chlorobenzene plume under chapter 4a.4, Drinking Water Source Protection. The application for the grant was submitted on November 30, 2004. A continued effort by SVWD in pursuing the source and remediation of this plume is the type of proactive measure the district can make in accordance with the AB3030 groundwater management plan.

Camp Evers Plume

Site Characteristics

Petroleum hydrocarbons including benzene and gasoline additives such as methyl-tert-butyl ether (MtBE), tert-butyl alcohol (TBA), and 1,2-dichloroethane (1,2-DCA) have been detected in groundwater in the vicinity of and downgradient from gasoline stations located at the intersection of Scotts Valley Drive and Mount Hermon Road (Figure 6-11). The RWQCB has concluded that these gasoline stations are the most likely source of benzene, MtBE, TBA, and 1,2-DCA detected in the nearby Mañana Woods #2 water supply well.

In 2002, significant characterization work was conducted to further define the lateral and vertical extent of contamination from the gasoline stations. Seven multi-level monitoring well clusters were installed between April and October 2002 in areas downgradient from the stations. In addition, a dedicated downgradient groundwater remedial extraction well, CEEW-1, was installed at the Kings Village Shopping Center. CEEW-1 is screened from depths of 93 to 153 feet below the ground surface, and it is within the Santa Margarita Sandstone.

Based on the recent site data (Delta 2005), two separate MtBE plumes occur at different depth intervals within the Santa Margarita Sandstone (Figure 6-11). The upper plume is considered to be within upper Santa Margarita Sandstone which is considered equivalent to the perched zone noted at the Watkins-Johnson site (R.L. Stoller 1988). The lower plume is within lower Santa Margarita Sandstone which is considered equivalent to the Regional Santa Margarita Aquifer (R.L. Stoller 1988), which is associated with the water resource of the Mañana Woods #2 and SVWD Well #9. SVWD Well #9, which has historically had detections of benzene and 1,2-DCA, but not MtBE, is located about 1,000 feet northwest of Mañana Woods #2 (Figure 6-11). However, MtBE was detected in spent GAC removed from the site in WY2004.

MtBE and TBA concentrations have declined in wells CEMW-6, CEMW-16, CEMW-19B and Mañana Woods #2; however, TBA concentrations have increased in CEMW-6 and CEMW-16 in the same time period (Figure 6-12). TBA has often been characterized as a degradation product of MtBE and should be monitored closely in relation to the California DHS drinking water notification level of 12 µg/L.

Benzene concentrations across the site have been declining in recent years, with only one detection in the deeper portion of the Santa Margarita Sandstone of 8.3 µg/L in well CEMW-15 (Figure 6-12). The benzene concentrations detected in the Mañana Woods wells have also been steadily declining since in November 2003. For WY2004 these concentrations ranged from 3.2 to 6.5 µg/L, above the 0.5 µg/L MCL.

Regulatory Compliance Summary

MtBE and benzene are the primary constituents of concern in this area (Delta 2005). The DHS has set the primary MCLs for benzene and MtBE at 0.5 µg/L and 13 µg/L, respectively; a secondary MCL for MtBE was established based on taste and odor at 5 µg/L (DHS 2005). MtBE and benzene continue to be detected above their respective primary MCLs in wells offsite from the gasoline stations. TBA continues to be detected in these offsite wells. TBA is regulated by the DHS with a drinking water notification level of 12 µg/L (DHS 2005).

The groundwater extraction treatment system provides hydraulic control downgradient from the gasoline service stations to prevent further impact to Mañana Woods #2 or other downgradient wells (Delta 2005). Regulatory oversight of the Combined Camp Evers Site is provided by the RWQCB. Regular quarterly monitoring reports and remedial system performance summary reports are provided to the RWQCB and SVWD to monitor system performance.

With the full-time operation of groundwater extraction, periodic pumping from other monitoring wells was discontinued in December 2002 (SECOR 2003). However, remedial facilities are still operated at two of the four gasoline stations. At the Tosco site, soil vapor extraction and air sparging is ongoing. At the Shell site, soil vapor extraction is ongoing. Groundwater extraction from beneath the Shell site was terminated in the middle of 2002, when the City of Scotts Valley (City) and Shell failed to negotiate terms for discharge of extracted water to the sanitary sewer system (RWQCB 2003). The City had requested a release from the dischargers for any potential penalties (fines for violations) that might be incurred as a result of accepting discharge of the treated groundwater to the sewer system. The discharger declined to provide any release or waiver and as a result the City denied use of the sewer for discharges of treated wastewater from the site.

Compliance Assessment

Groundwater from the Mañana Woods #2 well is treated using GAC and other wellhead treatment to remove VOCs and other constituents prior to distribution to its customers. The Mañana Woods treatment facility was upgraded on October 30, 2003 and has operated continuously since that time (Delta 2005).

Operation of the downgradient extraction well may be contributing to the declining trend in MtBE, but may not have the same effect on CEMW-19B, which is screened in the deeper portion of the Santa Margarita Sandstone. In this well MtBE and TBA concentrations, although relatively low compared with CEMW-6 and CEMW-16, have shown a slightly increasing trend since May 2003. This is of particular concern to SVWD because of the continuity between this portion of the Santa Margarita and the water resource used by SVWD Well #9 as discussed previously. Well #9 is currently monitored for MtBE and raw water pumped from the well is treated using GAC, which is considered best management practice (BMP). Historical MtBE and TBA concentrations for each of these wells are presented in Appendix E, Table E-5, and historical concentration data for all wells on the site are available from *Fourth Quarter 2004 Quarterly Monitoring Report* (Delta 2005).

Watkins-Johnson Site

Site Characteristics

In 1984 contamination of soil and groundwater at the Watkins Johnson site was detected with multiple VOCs including PCE and TCE. The Watkins-Johnson site was responsible for metal machining, and the manufacture of industrial furnaces and electronic parts, and the site served as a research and development facility. The contamination has been attributed to the disposal of contaminants in a septic leach field drainage system. The site is classified as a federal Superfund Site. The USEPA is the lead regulatory agency overseeing remedial activities at the Watkins-Johnson site. Issues related to the National Pollutant Discharge Elimination System (NPDES), which permits discharge of treated groundwater to Bean Creek, are regulated by the RWQCB.

Characterization of site conditions including geology and groundwater were completed in 1988 (R.L Stollar 1988), and a Remedial Investigation was completed in 1991 (Watkins-Johnson 1991). The TCE plume, which originally extended over 2,000 feet toward Bean Creek, is now restricted to a few isolated locations. Due to the decline in concentrations below MCLs, the groundwater monitoring program was reduced to two regional zone wells (WJ-41 and WJ-43) in the first quarter of 2003 (Arcadis 2003). No concentration contours or plume map are provided in this section due to the absence of detections in adjacent wells and the overall successful cleanup efforts of the site.

The site history shows that TCE and PCE concentrations have declined over time. The maximum TCE concentration onsite was 13,000 µg/L in 1986. Samples taken in WY2004 from WJ-41 contained concentrations of TCE ranging from 1.9 to 22 µg/L, and PCE concentrations ranging from 0.52 to 3.9 µg/L. No TCE was detected in WJ-43, although PCE concentrations ranged from 4.6 to 13 µg/L. An MCL of 5 µg/L is established for both TCE and PCE.

Groundwater extraction from the regional Santa Margarita aquifer is currently still active from wells RA-1 and RA-2 (Figure 6-13); however, RA-1 has not operated since the second quarter of 2004.

Regulatory Compliance Summary

Groundwater extraction from the perched zone of the Santa Margarita aquifer and the deeper, regional portion of the Santa Margarita aquifer began in 1985 and is currently still active to contain the remaining contamination plume. Total groundwater pumping at the Watkins-Johnson site has slowly declined from a maximum of 464 acre-feet in WY1986 to 143 acre-feet in WY2004.

A soil vapor extraction (SVE) system was operated from 1994 to 2001 to remediate contaminants in the vadose zone beneath the site. Following the shutdown of the SVE system, confirmation soil testing was performed in 2002 to assess the effectiveness of the cleanup. VOCs were detected in the confirmation soil samples; therefore a vadose zone leaching model (VLEACH) was constructed to assess potential impacts to groundwater if the SVE system were shut down permanently. The VLEACH model suggested that there would be negligible future impacts to groundwater from the residual TCE remaining in the soil (Arcadis 2003).

Hidden Oaks Well and SVWD Well #9

The Hidden Oaks Well was formerly used by SVWD for water supply (Figure 6-11). However, that use was stopped in 1991 due to detection of elevated levels of benzene, 1,2-DCA, and other gasoline-related constituents (Appendix E, Table E-6). The source of those detections was never determined. The gasoline stations at Mount Hermon Road and Scotts Valley Drive began monitoring this well in 1999 in order to help define the extent of contamination originating from their sites. Benzene has been detected in the well in the recent sampling. However, levels have declined significantly since 1993 with recent benzene detections below 1 μg/L but above the 0.5 μg/L MCL. Because the Hidden Oaks Well is inactive as a production well, its destruction has been considered in previous annual reports. However, this well is currently part of the monitoring program for the Camp Evers MtBE plume and provides useful data regarding water levels and quality.

Benzene and 1,2-DCA have been historically detected in SVWD Well #9. In addition, TCE and 1,2-DCE have also been detected sporadically at low concentrations in SVWD Well #9 since 1998. As a result, groundwater from SVWD Well #9 is treated with a GAC treatment system to remove any VOCs prior to delivery to customers. The source of TCE and 1,2-DCE has not been determined. However, within the capture zone of SVWD Well #9 are the Watkins-Johnson site, Scotts Valley Transit Center, Thermal Systems Manufacturing, office buildings and complexes, former Sky Park Airport, fire station, and medical offices (Todd Engineers 2001, 2003).

The source of the benzene and 1,2-DCA contamination has also not been identified, although it appears that the source has been depleted because 1,2-DCA has not been detected since 1996 and benzene has not been detected since 1999. The source of the benzene and 1,2-DCA in SVWD Well #9 and the Hidden Oaks Well could possibly originate from the same location.

Hacienda Drive Shell

The Shell gasoline service station at 1 Hacienda Drive is currently regulated by the RWQCB for contamination resulting from an underground storage tank (UST) fuel release. Shell operated a groundwater extraction system from June 2000 until the third quarter of 2003 (Delta 2003). The GWE system resulted in a positive reduction in concentration levels across the site. Concentrations of MtBE, benzene, TBA, and other gasoline-related compounds have decreased in recent sampling events.

The Hacienda Shell site is underlain by approximately 150 feet of Santa Cruz Mudstone that separates the site from the deeper Santa Margarita Sandstone. The site also has a thin cover of more recent alluvial deposits. Groundwater flow is primarily along the contact of the alluvium and the Santa Cruz Mudstone directed towards Glenwood and Carbonera Creeks.

Quarterly monitoring continues to take place at the site and includes sampling from five wells and two surface water locations in Glenwood Creek. Results from monitoring events are reported to the RWQCB.

CONTAMINATION PREVENTION

The AB3030 Management Plan emphasizes prevention of contamination. Programs and studies have been implemented to support prevention activities, including this document. This work has included a Drinking Water Source Assessment and Protection (DWSAP) program, adoption of a more stringent local well ordinance in WY2004, and a septic system survey.

The 1996 reauthorization of the federal Safe Drinking Water Act included amendments that established several new initiatives requiring state implementation. One of those initiatives is the development of a program within each state to assess sources of drinking water and the encouragement of states to establish protection programs. In California, the DHS, Division of Drinking Water and Environmental Management, is the agency responsible for development and implementation of the DWSAP program, which is intended to:

- Identify the locations of all surface water and groundwater drinking water sources,
- Delineate source protection areas for both surface water and groundwater,
- Identify all potential sources of significant contamination within each source protection area,
- Determine the susceptibility of drinking water sources to contamination within protection areas,
- Assess new sources of drinking water,
- Encourage local entities to develop source water protection programs, and
- Encourage local entities to develop contingency plans for alternate drinking water supplies.

Todd Engineers prepared a DWSAP program for seven water supply wells for SVWD in accordance with DHS guidelines in September 2001, with revisions in February 2003. The assessment included the delineation of the area surrounding each well through which contaminants might migrate and impact the well, and an inventory of activities that might lead to the release of microbiological or chemical contaminants within the delineated area. This evaluation enabled a determination to be made as to the susceptibility of each well to contamination. The DWSAP program is intended to be a tool for the development of wellhead protection programs. The DWSAP program was submitted to and approved by the DHS.

The assessment included the delineation of the 2-, 5-, and 10-year protection zones for each well. The protection zones or capture zones were intended to define the areas contributing water to a pumping well over time. The size of the protection zones varied based on the aquifer parameters, the pumping rate of the well, and the method of analysis used. Protection zones were estimated by various methods, from simple fixed radius calculations to more rigorous capture zone modeling, depending on the level of information available for each well. The AB303 numerical model update will be capable of updating these protection zones. The model is to incorporate a more in depth analysis of the hydrogeology of the region and will be capable of providing a more quantitative assessment of these zones. At that point, SVWD will have the opportunity to revise the DWSAP program and use model scenarios to justify further well protection action.

The DWSAP program also established the physical barrier effectiveness (PBE) of each well. The PBE is an estimate of the ability of the natural geologic materials, hydraulic conditions, and construction features of a well to limit the movement of contaminants to the well. An inventory of possible contaminating activities (PCAs) in the vicinity of the wells was prepared. The PCA inventory was input to a geographical information system (GIS) to allow assessment of the geographical relationships between the protection zones and PCAs. PCAs include any activities that could potentially result in the release of contaminants. A vulnerability ranking was performed to determine which PCAs pose the greatest threat of contamination to the wells. Although the model currently being developed by ETIC will not change the results of the DWSAP program it will have the ability to more accurately define PBEs and possibly alter the PCA ranking system accordingly.

A major and widely practiced component of contamination prevention is well regulation. Well regulation has historically been performed by the DWR and Santa Cruz County in the Scotts Valley area. Well regulation involves the regulation of well construction, abandonment, and destruction to mitigate improperly constructed or abandoned wells which can provide a medium for the migration of contaminants from surface sources into the aquifer. The Water Code empowered SVWD to adopt rules and regulations for such a program and SVWD enacted Ordinance No. 119-96, Section 3.30, to address such issues. SVWD revised Section 3.30 to enhance groundwater protection on February 12, 2004 by the adoption of ordinance 137-04.

California Water Well Standards (DWR, December 1981 and June 1991) establish requirements for proper well construction and also require that inactive wells be properly maintained or destroyed if the owner does not intend to use the well in the future. The objective of destruction is to restore as nearly as possible those subsurface conditions that existed before the well was constructed so that the well does not impair the quality of water in contact with the well or act as a conduit for further migration of contaminants.

In 1997, an investigation of septic systems in the Scotts Valley area identified a large number of active septic systems with potential groundwater contamination impacts. The water quality impacts associated with septic systems usually include microbiological contamination, TDS, nitrite, and nitrate. Septic system density of more than one system per acre is considered to pose a very high risk of contamination if the systems are located in close proximity to production wells. Septic systems at a density greater than one per acre were identified within Scotts Valley in the 1997 study. The City currently requires any lands that are developed or will be developed within the sanitary sewer assessment district or within 200 feet of an existing sewer main to connect to the City sewer system. The 1997 study discovered some densely packed septic systems within close proximity of the SVWD production wells and possibly within the capture zones. Again, these capture zones can be revised based on the AB303 numerical model update.

A significant portion of the contamination prevention process in the Scotts Valley area is the cooperative effort of environmental regulation by multiple public agencies. The RWQCB, DHS, USEPA, DTSC, and Santa Cruz County Environmental Health Services provide oversight to environmental compliance sites and direct responsible parties on cleanup efforts ranging from remediation to quarterly monitoring. SVWD has the ability to comment on these activities and their progress in direct relation to the groundwater resource supplies of the district. SVWD has played a proactive role in the process and has assisted in the effort to keep the water supply and general environmental health of the region in good standing. This cooperation should be continued to maximize the contamination prevention efforts of all private parties and public agencies involved.

CHAPTER 7 – CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Santa Margarita Sandstone

Groundwater flow in the Santa Margarita Sandstone is characterized as compartmentalized, where groundwater flows from a local recharge area towards a local discharge point. Groundwater recharge is primarily from precipitation falling on Santa Margarita Sandstone outcrops or infiltration along a portion of Carbonera Creek. Groundwater outflow is typically through discharge at a spring or stream. Bean Creek is a major discharge point for the Santa Margarita Sandstone. Groundwater outflow also occurs where the Santa Margarita and Lompico Sandstones are in direct contact.

Groundwater pumping from the Santa Margarita Sandstone was estimated at 311 acre-feet in WY2004, up from 284 acre-feet in WY2003. Only a minor portion of the WY2004 pumping was for water supply, as both the water supply wells, SVWD Well #9 and Mañana Woods #2, also get a significant portion of their production from deeper zones. Over 50% of this production was for environmental remediation of contaminant plumes. The remainder is for irrigation and landscaping purposes by private users. The Santa Margarita Sandstone/Monterey Formation accounts for only about 2% of the total production by SVWD.

Declining groundwater levels continue to be an issue for the Santa Margarita Sandstone primarily in South Scotts Valley area – Camp Evers subarea. These groundwater level declines are due to a combination of concentrated pumping and outflow to the Lompico Sandstone.

Water quality in SVWD Well #9 has declined in recent years, with a rise in TDS that is mainly due to a rise in sulfates. Much of this decline is the result of a higher percentage of the pumping being derived from the Monterey Formation, as groundwater levels have declined over 160 feet in the Santa Margarita Sandstone near SVWD Well #9 over the past 20 years.

The Santa Margarita Sandstone has been impacted by several contaminant plumes, including the Watkins-Johnson site, the Camp Evers MtBE plume, and the Scotts Valley Dry Cleaner. SVWD Well #9 is treated using GAC to remove any low levels of solvents and gasoline-derived chemicals. Benzene, 1,2-DCA, TCE, and 1,2-DCE have historically been detected in this well and MtBE has been detected in spent carbon from the GAC filters treating water from this well, although the source has yet to be determined.

Lompico Sandstone

Groundwater flow in the Lompico Sandstone is primarily controlled by the large pumping wells completed within this geologic unit. The groundwater elevation maps for the Lompico Sandstone show the development of a depression along the eastern margin of the basin at these pumping centers. In most areas, groundwater levels in the Lompico Sandstone have declined 150 to 200 feet over the past 20 years in the Scotts Valley area. Groundwater levels are stable to declining in Lompico Sandstone in the Scotts Valley area. These changes are primarily in response to shifts in the groundwater pumping by the various users.

Groundwater pumping from the Lompico Sandstone was estimated at 2,086 acre-feet in WY2004, down from 2,303 acre-feet in WY2003. Nearly all, over 97%, of the WY2004 Lompico Sandstone production pumping was for water supply. The Lompico Sandstone accounts for approximately 68% of the total production by SVWD. Only a minor amount was for irrigation and landscaping purposes by private users.

Groundwater outflow from the Lompico Sandstone is primarily through groundwater pumping wells. Few natural discharge points are noted for the Lompico Sandstone in the Scotts Valley area. Historically, groundwater from the Lompico Sandstone may have recharged the Santa Margarita Sandstone through the area of direct contact in the South Scotts Valley area - Camp Evers subarea.

Groundwater in the Lompico Sandstone is primarily being recharged from the Santa Margarita Sandstone. The amount of groundwater flow from the Santa Margarita to the Lompico Sandstone is considered to have increased as the result of decreasing groundwater levels in the Lompico Sandstone due to increased pumping. Other recharge areas are limited to surface exposures of the Lompico Sandstone along the northern and western margins of the Santa Margarita Sandstone either directly by precipitation or infiltration from streams.

Water quality in Lompico Sandstone has declined in recent years, with a rise primarily in TDS, iron, and manganese. This is likely due to the inflow of groundwater from the north where the groundwater is inferred to have had a higher residence time in the aquifer, allowing it to become more highly mineralized. Water samples from SVWD Wells #11A and #11B have historically contained arsenic. This is the only area where SVWD may have an issue with the new lower MCL for arsenic. A more in depth investigation of the possible sources of arsenic in the groundwater may be necessary to avoid any future compliance issues that may arise if concentrations remain at current levels.

The Lompico Sandstone has been less impacted by contaminant plumes. Low levels of chlorobenzene have impacted Wells #11A and #11B. The source was tentatively identified as near the Carbonera Trailer Park by DTSC, but was not delineated. The Scotts Valley Dry Cleaners may potentially impact SVWD Well #10, but PCE has not been detected in SVWD Well #10 to date. Site data indicate transport of PCE towards SVWD Well #10; however, insufficient characterization has been performed to date to adequately define the plume.

Butano Formation

The role of the Butano Formation has only recently been identified during the hydrogeologic characterization for the AB303 numerical model update. However, groundwater flow cannot be evaluated at this time because the only two wells completed within the Butano Formation that have groundwater elevation data are also significant groundwater production wells.

Groundwater pumping from the Butano Formation was estimated at 588 acre-feet in WY2004, up from 535 acre-feet in WY2003. The Butano Formation accounts for about 30% of the total production by SVWD. All of the metered WY2004 Butano Formation production pumping comes from the SVWD Wells #3B and #7A and was for water supply. Estimates of private Butano Formation pumping will be included in the AB303 numerical model update.

Groundwater recharge is inferred to come primarily from the infiltration of precipitation or stream flow occurring on Butano Formation outcrops or north of Scotts Valley. Groundwater outflow is not clearly understood at this point. The AB303 numerical model update should provide some insights into groundwater flow within the Butano Formation.

The decline of groundwater levels in the Butano Formation is also unclear due to the lack of data. However, groundwater elevations appear to have stabilized since WY1997 despite increasing pumping over this time. However, recent groundwater elevation data have only been collected while the pumps were operating. The Butano Formation may hold the best opportunity for expansion of groundwater resources in the future. To this end consideration should be given to developing a plan to investigate and obtain additional data to better understand the hydrogeology of the Butano Formation.

Water quality in the Butano Formation has varied in recent years. TDS concentrations have risen above secondary MCLs, whereas iron concentrations have declined below secondary MCLs. Manganese occasionally exceeds secondary MCLs. Otherwise, other water quality parameters are well within drinking water standards. Also, arsenic and nitrate have never been detected in the Butano Formation wells.

PROGRESS ON PREVIOUS RECOMMENDATIONS

Part of SVWD's accomplishments over the past year includes progress on the recommendations included in the 2002-2003 SVWD GWM Program Annual Report (Todd Engineers 2003). This report offered the following recommendations:

- Continue GWM Program,
- Evaluate Groundwater Storage,
- Evaluate Stream Flow/Groundwater Relationships,
- Update the Computer Model,
- Continue to Update Regulators on the Revised Hydrogeologic Conceptual Model, and
- Continue to Add Water Recycling Customers.

SVWD has continued the GWM Program through the publication of this document and its continued effort to monitor groundwater conditions throughout the Santa Margarita Groundwater Basin. The specific recommendation of continued sampling of TDS, chloride and nitrate as part of the Water Recycling Program monitoring has been completed. Discussions with Watkins-Johnson regarding future monitoring of wells installed for its environmental restoration program as that project winds down have not been completed.

In July 2004, SVWD was awarded a $225,000 Local Groundwater Assistance Program grant from DWR to update the existing groundwater model. The objective of the numerical model update includes a re-evaluation of the hydrogeological conceptual model. This updated hydrogeological conceptual model will be incorporated into an updated numerical model that can proactively and efficiently support groundwater management. Work on the grant project began in August 2004 and is anticipated to be completed during the summer of 2005. The work funded by this grant is anticipated to:

- Evaluate Groundwater Storage,
- Evaluate Stream Flow/Groundwater Relationships, and
- Update the Computer Model,

SVWD has discussed the implications of the revised hydrogeological conceptual model with regulators of environmental restoration projects in the basin. In particular, SVWD has discussed and presented these data to the RWQCB concerning the potential implications of PCE from the Scotts Valley Dry Cleaners impacting SVWD Well #10.

The Water Recycling Program nearly doubled the acre-feet delivered from WY2003 to WY 2004 and continues to expand operations throughout the Scotts Valley area. SVWD and the City of Scotts Valley are committed to providing access for new recycled water customers in the future.

RECOMMENDATIONS

Based on the groundwater supply and water quality assessment, the following recommendations have been developed:

Water Conservation

- Water conservation programs have been effective in boosting public awareness on methods to conserve water. An embodiment of this program is the "Landscape Irrigation Workshop" conducted by SVWD and SLVWD and the rebates offered to SVWD customers for using low-flow appliances. SVWD should continue its education efforts on water conservation and investigate other incentives to reduce consumption by its customers. SVWD should also consider updating its current water conservation efforts to reflect the conservation practices of other water purveyors in Santa Cruz County.

Water Supply

- Investigation of potential sites to augment groundwater recharge should continue. Favorable locations would be areas that overlie thick, unsaturated zones in the Santa Margarita Sandstone which have the capacity to accept significant recharge. Locations near the contact of the Santa Margarita – Lompico Sandstone would also potentially benefit recharge to the Lompico Sandstone as well. These areas would include Santa Margarita Sandstone outcrop areas, such as the Springs Lakes area and the southern end of the Hanson Aggregates Quarry. Another potential recharge area includes the losing reach of Carbonera Creek where it directly overlies the Santa Margarita Sandstone.
- The Water Recycling Program appears to be successful in providing an alternative water supply for landscape irrigation. Current efforts to expand the program should be continued.
- SVWD should present the updated hydrogeological conceptual model to the USEPA and Watkins-Johnson and discuss the anticipated duration of the ongoing environmental restoration program. In WY2004, 143 acre-feet of groundwater was pumped by the Watkins-Johnson remediation wells. This amount is greater than the current water supply

pumping from the Santa Margarita Sandstone, and is likely impacting the production from SVWD Well #9. It may be appropriate to significantly reduce groundwater pumping at the site where groundwater levels and VOC concentrations would continue to be monitored to verify whether VOC concentrations remain stable and that groundwater levels improve.

- The AB303 numerical model update should be applied to better quantify the water budget and changes in groundwater storage for the Scotts Valley area. These estimates can be used directly to evaluate the sustainable yield for the Scotts Valley area.

Water Quality

- Impacted water beneath the Scotts Valley Dry Cleaners site has not been adequately characterized, with particular emphasis on potential impact to SVWD Well #10. Increases in PCE concentrations in MW-9 between the release area and SVWD Well #10 suggest PCE transport towards SVWD Well #10. More multi-level well completions are necessary to characterize the complex hydrogeology and PCE distribution in this area. The PCE concentrations near the source are in the upper, or perched, Santa Margarita Sandstone. Only one monitoring well has been completed in the lower, or regional, Santa Margarita Sandstone to evaluate contaminant migration toward the lower zone.
- As the Water Recycling Program continues to expand, the monitoring program should continue to be updated as well. In particular, additional shallow monitor wells should be identified that could be used to expand the water quality monitoring network.

Monitoring Data

- Groundwater elevation data are key to monitoring the groundwater supply. The SVWD should review its current groundwater elevation monitoring plan to ensure that groundwater elevations are collected from the specified wells on, at a minimum, a semi-annual basis.
- Groundwater level monitoring equipment in the SVWD production wells should be checked and calibrated periodically. Equipment upgrades should be investigated that can measure and record groundwater levels automatically.
- Monitoring of precipitation and evaporation in the Scotts Valley area has been performed by SVWD, the City of Scotts Valley, and private consultants. Often data trends can be verified by comparison to the CIMIS station data at De Laveaga Golf Course. Installation of a CIMIS climate monitoring station in Scotts Valley would consolidate these data and provide an accurate and easily accessible record of precipitation, evaporation, and evapotranspiration, among others.

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