AB 3030
Ground-Water Management Plan
Soquel - Aptos Area

Soquel Creek Water District
and
Central Water District

Santa Cruz County, California

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Introduction

The Soquel Creek Water District (originally Soquel Creek County Water District) was originally formed in 1961, primarily to provide a local agency to interact with federal agencies to address flooding problems, most notably as a result of severe flooding in Capitola and Soquel in 1955. The original District boundaries extended from the present western boundary at 41st Avenue in Santa Cruz to the current location of Cabrillo College. By 1964, with the acquisition of the Monterey Bay Water Company, the District's boundaries and service area extended east-southeast to La Selva Beach, nearly to its current eastern boundaries. The Central Water District was originally formed in 1950 to provide potable water to the rural residences in the eastern foothills of Aptos. The District's boundaries have remained relatively constant since its inception, as have its ground-water resources, which have been monitored for the past thirty years.

In the mid-1960's, in response to a need for initial definition and understanding of its sole source of water supply, the Soquel Creek Water District, in cooperation with the City of Santa Cruz and the County of Santa Cruz, contracted with the U.S. Geological Survey to study and report on the ground-water hydrology of the Soquel-Aptos area, including the service area of the Central Water District. That work, which was conducted in 1966-67 culminated in a report entitled **Hydrogeologic Study of the Soquel-Aptos Area** (Hickey, 1968). In many respects, that cooperative effort with the USGS marked the beginning of ground-water management of the coastal aquifer system, which is now the subject of this ground-water management plan.

Assembly Bill 3030

In 1992, the California State Legislature adopted Assembly Bill 3030 (AB 3030); that legislation

was subsequently incorporated into the Water Code to encourage local public agencies/water purveyors to adopt a formal plan to manage ground-water resources within their jurisdictions. Within the scope of AB 3030, a local ground-water management plan can include up to twelve specific components. Although the plan need not be restricted to those specific components, the listed components are quite broad and cover essentially all of the ground-water management activities which have been implemented in the Soquel-Aptos area primarily by the Soquel Creek Water District over the last 15 to 30 years, beginning with the USGS/Hickey investigation in the mid-1960's, and continuing through the installation of dedicated monitoring wells at coastal sites and at new production well sites, and other management activities since 1981 as discussed in more detail herein. The potential components of a ground-water management plan listed in AB 3030 include:

- the control of saline water intrusion.
- identification and management of wellhead protection areas and recharge areas.
- regulation of the migration of contaminated ground water.
- the administration of a well abandonment and well destruction program.
- mitigation of conditions of overdraft.
- replacement of ground water extracted by water producers.
- monitoring of ground-water levels and storage.
- facilitating conjunctive use operations.
- identification of well construction policies.
- the construction and operation by the local agency of ground-water contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- the development of relationships with state and federal regulatory agencies.
- the review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of ground-water contamination.

The majority of the above items has been investigated by the Soquel Creek Water District and incorporated into its existing in-District ground-water management activities. The historic focus of ground-water management in the Soquel-Aptos area has been on water supply, quantity and quality, with appropriate provisions for coastal aquifer considerations, including but not limited to dedicated water level and water quality monitoring at the coast and inland, location and operation of wells to minimize water level impacts at the coast and on each other, as well as to control landward migration of seawater intrusion. The AB 3030 provisions not actively implemented to date are those more focused on hazardous material management, which could be components of a formalized management plan but have heretofore been less critical than quantity and non-hazardous quality issues. Also, the lack of any identified problem such as a "spill" or detection of organic or other hazardous chemicals in ground water beneath the area has decreased the need to include such considerations in management activities to date.

In summary, in nearly all respects, the Soquel Creek Water District has taken the lead role in developing and implementing a local ground-water management program, focused primarily on the coastal part of the aquifer system where the majority of water supply has historically been developed. To address concerns about overdraft and seawater intrusion, the Soquel Creek Water District has already effectively implemented a ground-water management program which is consistent with the opportunities provided by AB 3030; the ground-water management plan described herein can be envisioned as a formalization of that District's ongoing management in the Soquel-Aptos area.

Soquel-Aptos Area

Strictly speaking, there is no Soquel-Aptos Ground-Water Basin; rather, the Soquel-Aptos area refers to a central coastal portion of Santa Cruz County underlain by two different aquifers which are significant sources of ground water for municipal, industrial, and agricultural water supply, as well as numerous individual and small community domestic water supplies. Historically, there has been no consistent definition of the Soquel-Aptos area. In the first hydrogeologic study of the area, the USGS (Hickey, 1968) defined the area to extend from the San Lorenzo River and

the drainage divide between Granite Creek and Carbonero Creek on the west, to the drainage divide between Valencia Creek and Corralitos Creek on the east, and from the San Andreas fault on the north to Monterey Bay on the south. Twelve years later, the USGS (Muir, 1980) defined the area to cover about 50 square miles, extending south from the Zayante fault to Monterey Bay, west to Scotts Valley, and east to Watsonville.

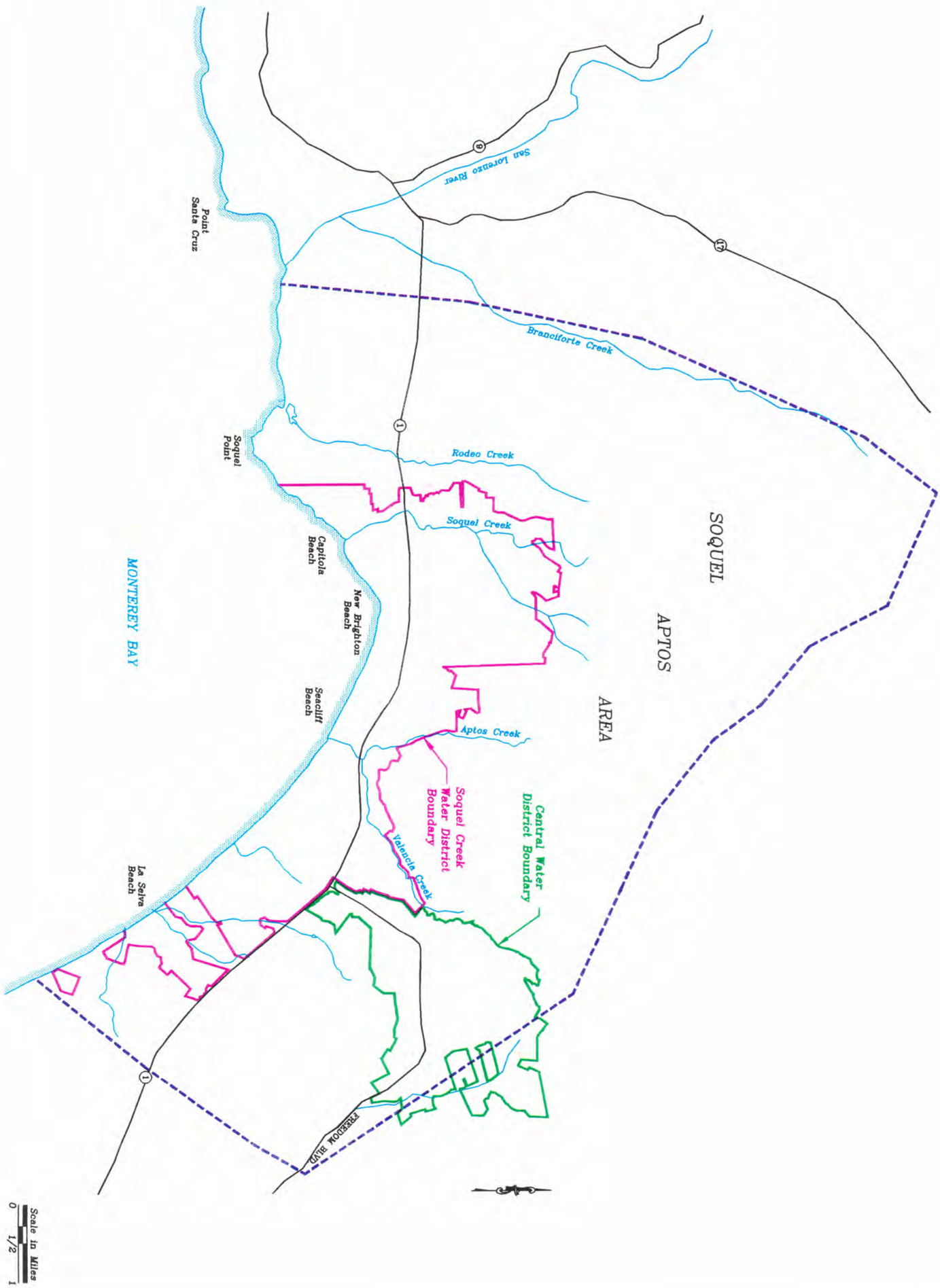
Essentially all the focused ground-water management activities in the area, which largely resulted from reaction to the 1980 USGS report, have been developed and implemented by the Soquel Creek Water District. The District's work has actively been from its western boundary at 41st Avenue in Santa Cruz to the southeastern end of its service area at Canon del Sol, between La Selva Beach and Sunset Beach; the District's exploration and monitoring have also extended north to the Zayante Fault and easterly to the service area of the Central Water District. Analytical work has historically extended westerly to the outcrop limits of the Purisima Formation (in the general vicinity of Branciforte Creek).

In Bulletin 118 **California's Ground Water** (1975), the State Department of Water Resources defined a basin called the Santa Cruz Purisima Formation Highlands to include the area overlying the aquifers from north and east of Santa Cruz to a boundary with the Pajaro Valley; a separate Soquel Valley basin was also included in Bulletin 118. Subsequently, in Bulletin 118-80 to define ground-water basins in California and to identify basins subject to critical conditions of overdraft, DWR (1980) included the same Santa Cruz Purisima Formation Highlands and Soquel Valley basins in an overall Santa Cruz - Pajaro basin, which was classified as subject to critical conditions of overdraft. According to Bulletin 118-80, the latter finding was "at the request of the City of Santa Cruz and a Supervisor of Santa Cruz County".

Ultimately, when Bulletin 118-80 was revised by DWR in 1992, the boundary between the Pajaro Valley and the Soquel-Aptos area was better defined along the eastern boundary of the Soquel Creek Water District but along the western boundary of the Central Water Districts. That redefinition, and the coincident finding that the Soquel-Aptos area was not subject to critical conditions of overdraft, were based primarily on the initial implementation of Soquel Creek

Water District's current ground-water management program.

For purposes of local ground-water management under AB 3030, the Soquel-Aptos area is not an isolated ground-water basin but can be practically defined to coincide with the area of ground-water monitoring and management by the Soquel Creek Water District and the Central Water District: from the westerly outcrop of the Purisima Formation in the vicinity of Branciforte Creek to the eastern limits of the Soquel Creek and Central Water Districts' service area, and from the Zayante Fault to Monterey Bay (Figure 1).



SOQUEL – APTOS AREA
SOQUEL CREEK WATER DISTRICT AND CENTRAL WATER DISTRICT

FIGURE
1

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Soquel – Aptos Ground-Water Management Plan

Management Objectives (Goals) for the Area

The Soquel Creek and Central Water Districts currently develop all their water supplies from the two principal aquifer systems in the Soquel-Aptos area: the Purisima Formation and the Aromas Red Sands. Driven in large part by the sole dependence on local ground water, compounded by a 1980 USGS report that the Purisima Formation was both overdrafted and intruded, and that the Aromas Red Sands were developed to near their perennial yield, the Soquel Creek Water District initiated an extensive monitoring and management program in 1981 to protect the ground-water basin for itself and other pumpers, including the Central Water District, City of Santa Cruz, smaller community systems, agriculture, and individual domestic well owners. At that time, the general objectives of the monitoring and management activities were to better define the underlying ground-water resources and to determine whether they could support continued, or increased, pumping for water supply. Expressed in more specific terms, the objectives of the initial ground-water management activities were four-fold:

- development of a water supply to meet existing and projected demands for municipal water supply; since pumpage for other uses is from the same aquifer system, this objective indirectly includes agricultural, small community, and individual domestic water uses.
- avoidance of ground-water overdraft and any undesirable effects associated with it.
- identification of seawater intrusion, and prevention and/or control of it.
- preservation of ground-water quality for beneficial use.

The implementation of ground-water monitoring and management by the Soquel Creek Water District (SCWD) has allowed ongoing development of ground-water supplies to meet growth,

incorporated with a growing understanding of aquifer conditions relative to basin yield, overdraft, and intrusion over the last 15 years. However, in light of the nature of ground-water occurrence in a coastal environment and the significant increase in water demands since the formation of the District (from 2,000 to more than 5,000 acre-feet per year), plus notable other pumpage (e.g. 1,000 afy by Santa Cruz, 450 afy by Central Water District (CWD), 200 afy by Cabrillo College, and an estimated pumpage of about 3,500 afy from individual domestic and other private wells), the primary objectives or goals for ground-water management in the area, including management under AB 3030, remain unchanged from those originally established:

- continued development of water supply for overlying beneficial use
- avoidance of ground-water overdraft
- prevention or control of seawater intrusion
- preservation of ground-water quality.

Ground-Water Basin Conditions

All water supply in the Soquel-Aptos area is ground water developed from the two principal aquifer systems underlying the area: the Purisima Formation and the Aromas Red Sands.

The Purisima Formation, of Pliocene geologic age, is a sequence of grey, sometimes described as blue, moderately consolidated, silty to clean, fine to medium sandstone containing siltstone and claystone interbeds (Greene, 1977). It underlies the entire District. It has not been explored to basement north of the District's boundaries but is thought to terminate at or near the Zayante Fault. Between the western SCWD boundary and the CWD area, the Purisima extends from the ground surface to granite basement. The granite basement, which is uniformly dipping to the southeast, is approximately 450 feet beneath sea level at the western SCWD boundary and approximately 1,300 feet beneath sea level in the CWD area. Farther to the southeast, the Purisima continues to dip at the same rate, but is overlain by the predominately unconfined Aromas Red Sands.

Based on the lithologic and geophysical logs developed during the installation of SCWD's network of production wells and monitoring wells, combined with other water well logs and a few geophysical logs of oil and gas borings in the vicinity, seven distinct subunits of the Purisima Formation have been identified and designated AA, A, B, C, D, E, and F, from deepest to shallowest. Ground water occurs in all the subunits of the Purisima beneath the Soquel-Aptos area. Except in the vicinity of its outcrop at the surface, the Purisima subunits are confined by claystone or siltstone interbeds between them. In general, fresh water is introduced into the various Purisima subunits through the recharge areas, or outcrop locations, of the subunits and then flows through the respective subunits generally toward Monterey Bay. Since the various

subunits are confined away from the recharge areas, ground water occurs in them under pressure, and water levels completed into one or more of the various subunits will rise above the overlying confinement, and usually to some elevation above sea level. Ground-water elevations generally increase with distance away from the coast.

The Aromas Red Sands, of Pleistocene geologic age, are a brown to red, poorly consolidated, fine to coarse-grained sandstone containing lenses of silt and clay. Based on limited lithologic and geophysical logs and other geologic data, the Aromas is underlain by the Purisima Formation throughout the eastern third of the Soquel-Aptos area, although the exact depth of the contact has not been identified. Essentially unconfined throughout the Soquel-Aptos area, the Aromas Red Sands contain fresh water above a wedge-shaped intrusion of sea water which is about 200 feet below sea level at the coast line and slopes away from the coast to nearly 500 feet below sea level in the vicinity of SCWD's Seascape and Altivo water supply wells.

Historical Concerns: Ground-Water Overdraft and Seawater Intrusion

In its 1980 report, the USGS concluded that the two main factors which would limit ground-water development in the Soquel-Aptos area were seawater intrusion and the potential yield of the aquifer system, i.e. avoidance of overdraft. The USGS also concluded that: 1) pumpage was then exceeding the potential yield of the Purisima Formation; 2) seawater intrusion had resulted from depressed ground-water levels near the coast, and had progressed to the vicinity of Capitola; and 3) pumpage from the Aromas Red Sands was near the potential yield of that aquifer beneath the Soquel-Aptos area.

Although the 1980 USGS conclusions have been reversed by SCWD's monitoring and analyses since 1981, the concerns remain unchanged. In order to maintain a dependable ground-water supply from the coastal Purisima and Aromas aquifers, there is a need to avoid overdraft, i.e. pumping in excess of perennial ground-water basin yield, and to prevent or control the most likely result of overdraft in that ground-water environment, seawater intrusion.

Ground-Water Monitoring

Since the Soquel Creek Water District is both the largest water supply agency in the Soquel-Aptos area, and since the District is predominantly located along the coast where overdraft and intrusion are of the most immediate concern, the District has undertaken the lead role in developing and implementing water resource management in the area. As such, SCWD has been actively involved in the management of both ground-water and surface water resources in the Soquel-Aptos area for the last 15 to 30 years. The District's ground-water management activities to date are multi-fold and consist of:

- regular collection of streamflow and precipitation data and ground-water elevation and quality data.
- well testing to determine aquifer characteristics and individual well and pumping plant performance.
- analysis of ground-water levels and quality, and aquifer storage and yield.
- management of ground-water pumping based on all the above factors to avoid detrimental effects on the aquifer system.
- location and operation of wells to minimize mutual pumping interference among wells and to minimize the impacts of pumping water levels near the coastline.
- ongoing collection and analysis of data, as well as other planning, for ultimate development of supplemental surface and ground-water supplies to partially meet projected water demand; such supplemental supplies would then be conjunctively managed with the District's current ground-water resources.

As part of the above management activities, SCWD initiated a ground-water monitoring and management program in the Purisima Formation in 1981; that network and program were expanded into the Aromas Red Sands in 1986. Complementing the SCWD monitoring network and program is the ground-water monitoring of the Central Water District; its monitoring of ground-water levels and quality in its production wells extends from 1966, which is also when SCWD began its monitoring of water levels and quality in production wells. The overall

monitoring program is built around the collection of ground-water data from a network of production and monitoring wells, predominantly located near the coast (Figure 2). There is no existing or planned offshore monitoring of fresh water aquifers beneath the floor of Monterey Bay. Details regarding the various monitored wells and the types of data being collected are included in the Appendix. In general, some of the monitored production wells are completed in the Purisima Formation, others are completed in the Aromas Red Sands. All the dedicated monitoring wells are multiple completion wells, completed into the various subunits of the Purisima Formation or to various depths in the Aromas Red Sands above and at the fresh-salt water interface in that aquifer near the coast.

Ground-Water Elevations

In general, there has been relative stability of ground-water levels throughout the Soquel-Aptos area, both preceding and since inception of the SCWD ground-water monitoring program. Although there were far fewer wells measured before the SCWD program began, and although those wells were measured less frequently (typically semi-annually rather than SCWD's monthly or quarterly measurements) and were limited to production wells (before the installation of any dedicated monitoring wells), hydrographs of historical water levels did not show any short- or long-term trends that would suggest "overdraft" conditions. Of course, there remains a concern, in a coastal aquifer system, that ground-water levels may never seriously decline because seawater could intrude under adverse (overdraft) conditions, giving an impression of stability in the aquifer system when it might actually be overdrafted. The latter consideration has been addressed in the SCWD coastal monitoring program by measuring water levels and also sampling and analyzing ground-water quality.

Purisima Formation - Local declines in Purisima Formation ground-water levels have generally been coincident with the start-up of new wells, increased production in existing wells, and low precipitation years. Conversely, there have been some historic increases in ground-water levels which have followed the shut-down or reduction of pumping from certain wells. For example, there was a local rise in water level during the mid-1980's following the removal of SCWD's

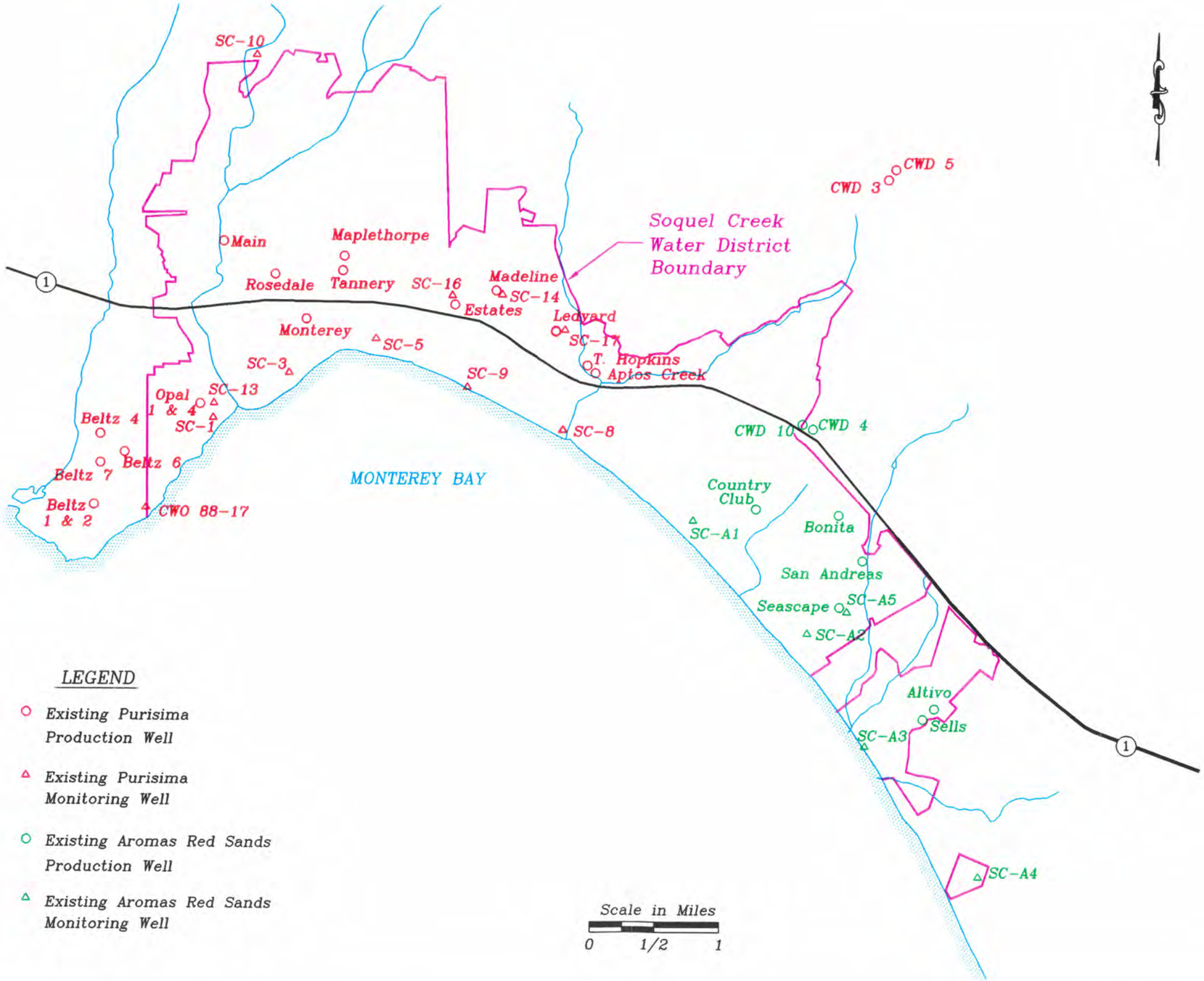

FIGURE 2

LOCATIONS OF PURISIMA AND AROMAS RED SANDS WELLS
SOQUEL CREEK WATER DISTRICT AND CENTRAL WATER DISTRICT

Soquel - Aptos Ground-Water Management Plan

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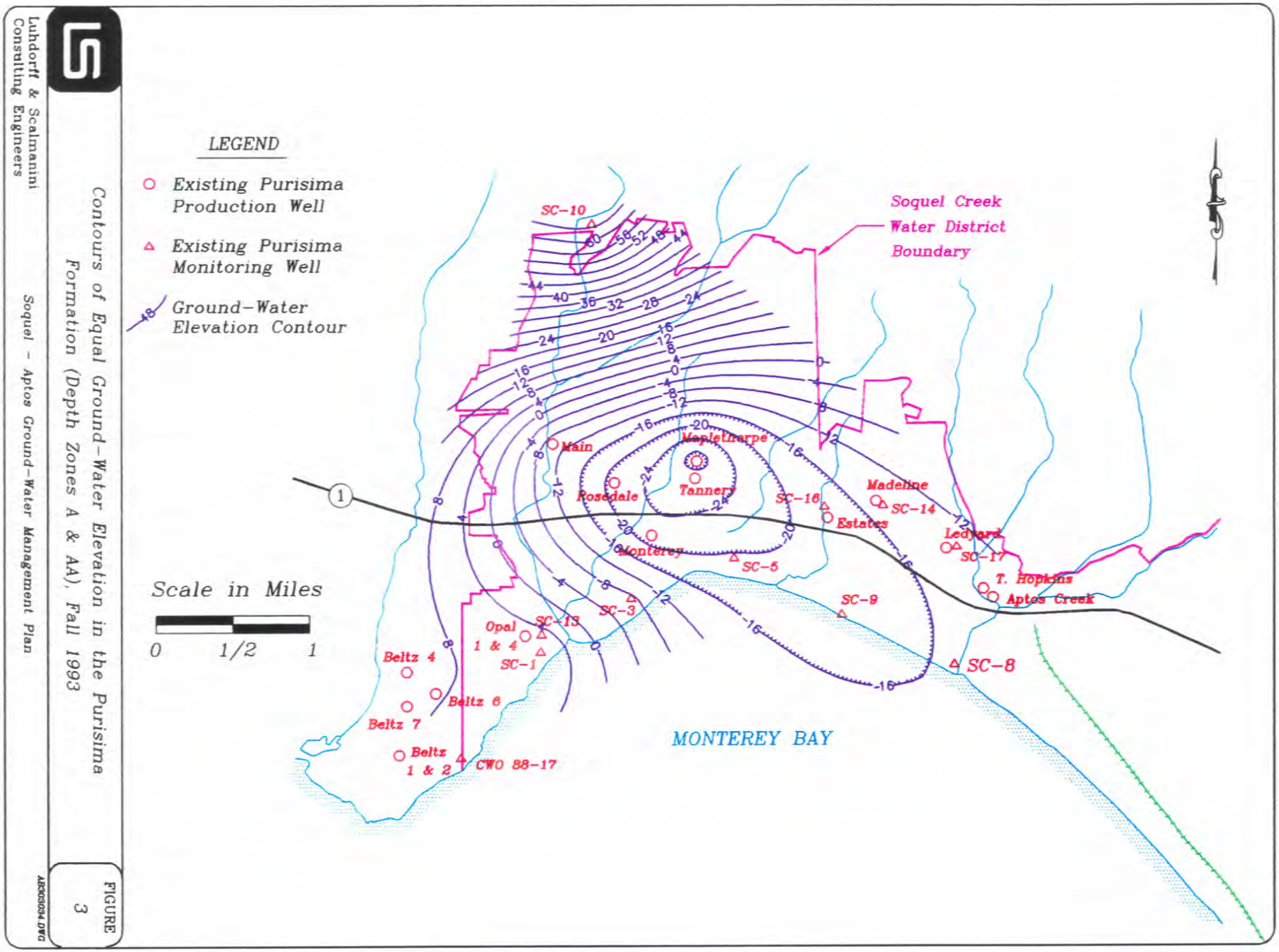
Opal 4 well from service. Likewise, there was a sharp increase in the water level in 1989 and a sharp decrease in 1994 following the respective decrease and increase in production from the Opal 1 well. A less pronounced effect was also experienced in the shallower Purisima subunit above the Opal 1 and Opal 4 well completions. This difference in the magnitude of response reflects the relative confinement between Purisima subunits. Other examples include local decreases and/or fluctuations in ground-water levels that correspond to the startup of new wells since the early 1980's (SCWD's Rosedale and Estate wells) and also reflect SCWD's management actions to distribute pumpage throughout its wellfield to maintain coastal water levels as high as possible.

Of some concern from a ground-water management perspective are depressed coastal water levels in the central portion of the District between about New Brighton Beach and Aptos Creek, notably in the Purisima A subunit where water levels have been near historic low and continuously below sea level. Contour maps of equal ground-water elevation in Purisima Subunit A for fall 1993 and spring 1994 (Figures 3 and 4, respectively) illustrate recent areal ground-water conditions in the Purisima Formation. Ground water flows generally southward toward the coast, until reaching the area near the central portion of the SCWD wellfield (the Rosedale, Monterey, Maplethorpe, and Tannery wells) where pumping depressions have formed, reversing the seaward gradient of ground-water flow between those wells and the coast. Thus, recharge from the north is being intercepted by pumping before reaching the coast, which has had the effect of lowering water levels in some of the coastal Purisima monitoring wells.

Aromas Red Sands - Hydrographs of SCWD's coastal monitoring wells show similar trends since monitoring began in 1986. Water levels increased until 1990, before declining one to three feet gradually to the present. Despite these small declines, coastal water levels have remained above sea level from Rio del Mar to La Selva Beach. Farther southeast at Canon del Sol, the closest SCWD monitoring to a nearby regional pumping depression in the Pajaro Valley, ground-water levels have decreased fairly steadily since 1986 to the lowest observed levels in the recent historic period, now in the range of less than one foot above sea level to below sea level.



Contours of Equal Ground-Water Elevation in the Purisima Formation (Depth Zones A & AA), Fall 1993

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FIGURE 3

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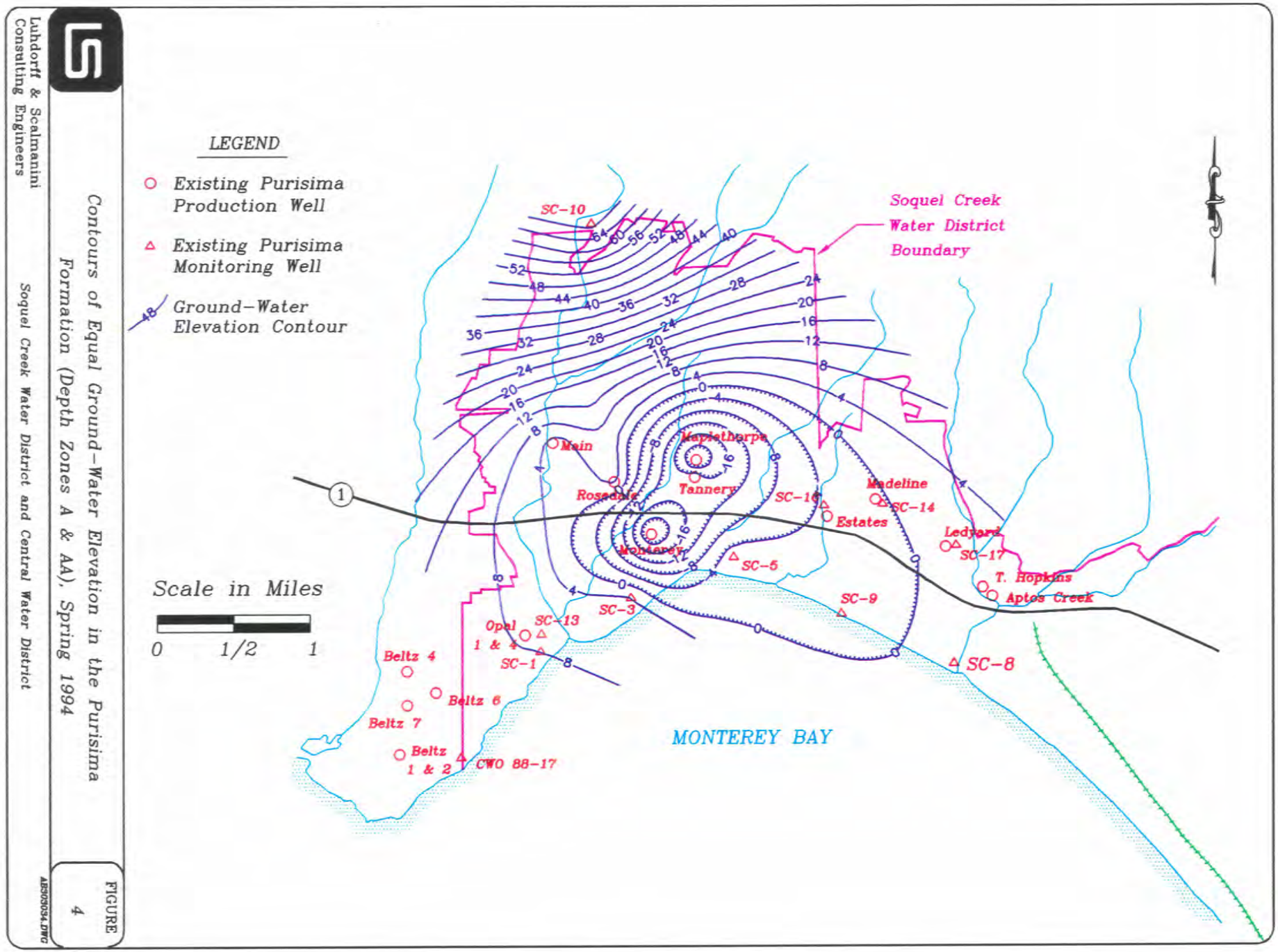

Contours of Equal Ground-Water Elevation in the Purisima Formation (Depth Zones A & AA), Spring 1994

Soquel Creek Water District and Central Water District

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FIGURE 4

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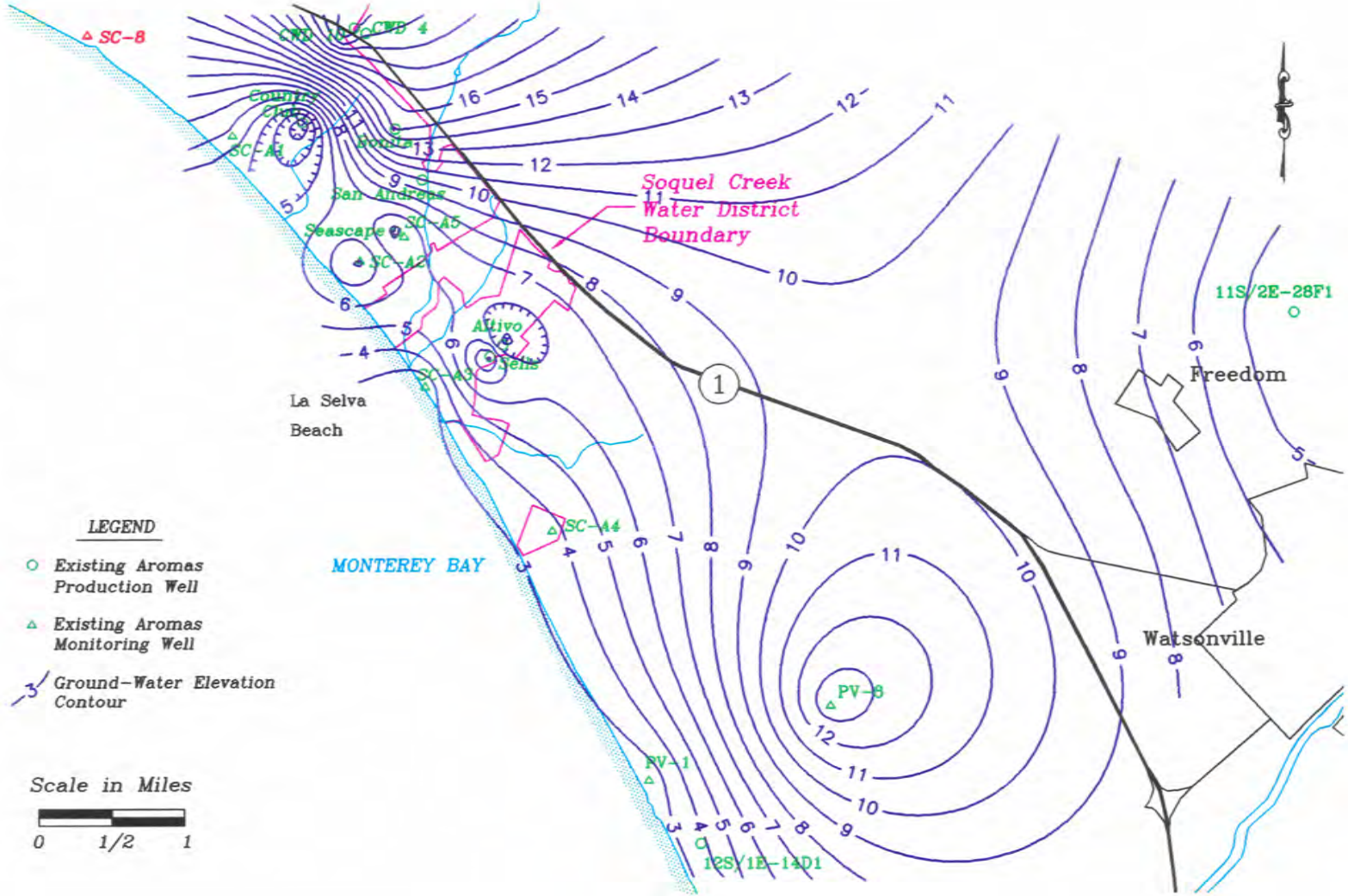
Contour maps of equal ground-water levels for spring 1989 and fall 1991 (Figures 5 and 6) illustrate the recent change in areal ground-water conditions in the Aromas area. As recently as 1989, ground water flowed generally westward toward the coast; however, by 1991 and continuing to the present, ground-water levels in the greater Pajaro Valley area had lowered significantly, causing a shift in ground-water flow direction to parallel the coast. Thus, somewhat similar to the Purisima area, recharge from the inland area is being influenced by pumpage that has caused a change in ground-water flow, with the effect of slightly lowering water levels in the coastal Aromas monitoring wells.

Ground-Water Quality

Ground water in the Purisima Formation can generally be classified into two water quality types. In the Purisima A subunit, ground water is a calcium bicarbonate water; in the upper Purisima subunits, ground water is generally a calcium-magnesium bicarbonate water. Ground water in the Aromas Red Sands is consistently a calcium-magnesium bicarbonate type. Ground-water quality from the Districts' production wells surpasses all state and federal standards for municipal water supply, with the exception of the naturally present concentrations of dissolved iron and manganese in the Purisima Formation, which are near the secondary (aesthetic) drinking water standards of 0.3 mg/l for iron and 0.05 mg/l for manganese. Dissolved iron and manganese concentrations in the Aromas Red Sands are well below drinking water standards. Analyses for synthetic organic chemicals are conducted in accordance with the requirements of the California Code of Regulations, Title 22. No organic chemicals have been detected in municipal water supplies. As a result of the non-presence of organic constituents in municipal supplies, the Department of Health Services has granted the District a waiver for further testing of these constituents until 1998.

Nitrate concentrations in shallow parts of the Aromas Red Sands near agricultural and unsewered areas are locally elevated but are still well below the State standard of 45 mg/l. Nitrate concentrations have not impacted domestic water supplies.



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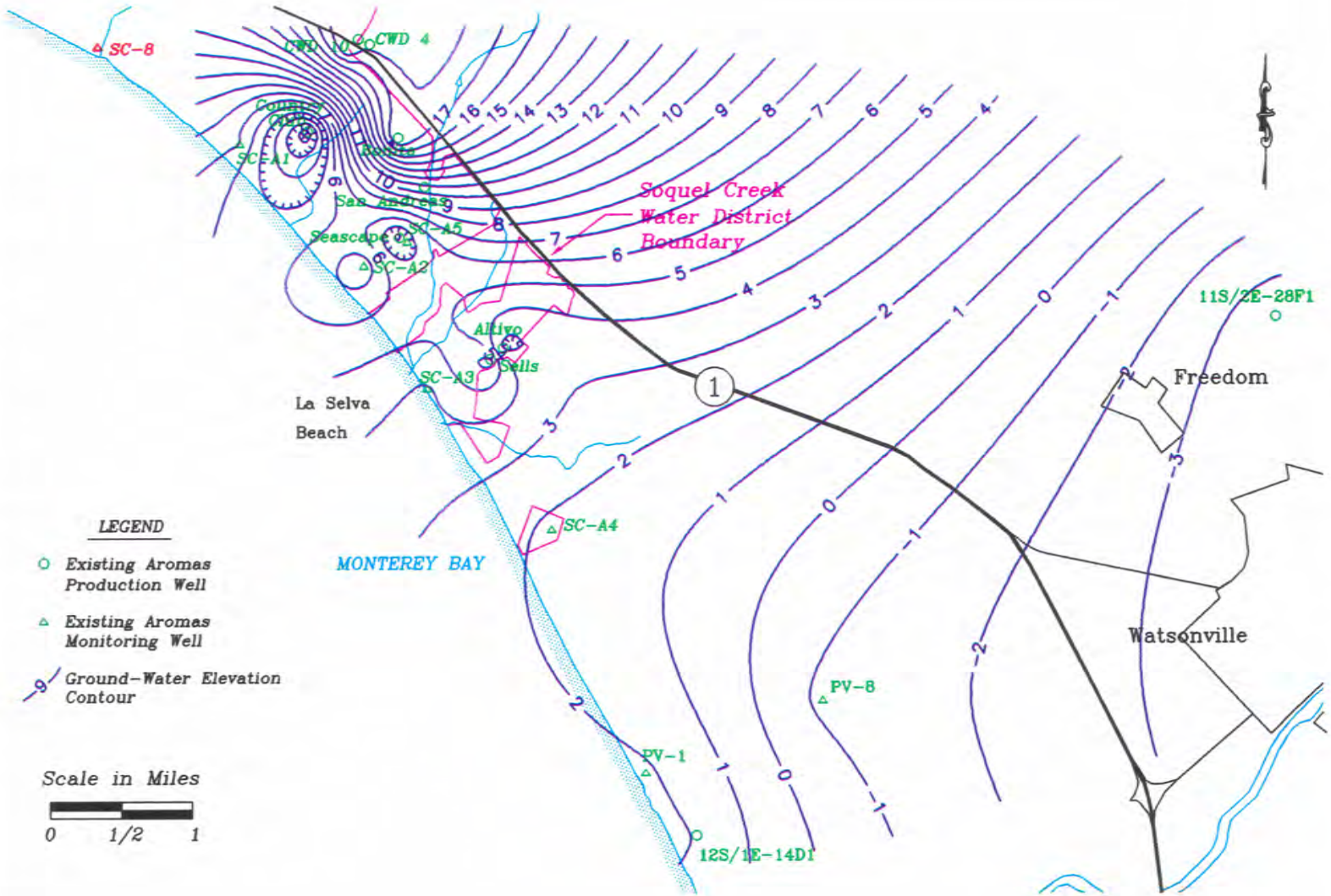
Contours of Equal Ground-Water Elevation in the Aromas Red Sands (Depth Zone B), Spring 1989

Soquel - Aptos Ground-Water Management Plan

FIGURE 5



Contours of Equal Ground-Water Elevation in the Aromas Red Sands (Depth Zone B), Fall 1991

Soquel - Aptos Ground-Water Management Plan

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FIGURE 6

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Purisima Formation - Concentrations of total dissolved solids (TDS) in the Purisima Formation range from approximately 200 to 600 mg/l. Long term water quality data from production wells indicate no significant trends. Ground-water quality in the coastal Purisima area is generally unchanged since monitoring began in 1983. Gradual increases in chloride (and TDS) concentrations have been observed in wells SC-1A and SC-5B since 1987; however, the current values of about 40 and 130 mg/l, respectively, are still relatively low. Chloride (and TDS) concentrations in one well (SC-5D) increased sharply from 800 mg/l chloride in 1990 to approximately 1,750 mg/l in 1992, but this change does not appear significant to local ground-water supply since water supply wells are not completed in this Purisima subunit near this local degradation. Ground-water levels in this well have been significantly above sea level since monitoring began, and any water quality change would thus appear to be unrelated to any landward movement of sea water.

Aromas Red Sands - Ground-water quality in the coastal Aromas area has shown a notable recent increase in chloride (and TDS) concentrations in the "B" depth zone monitoring wells (above the original fresh-salt water interface) at sites SC-A2 and SC-A3. The chloride concentration increase in Well SC-A2B has been small and gradual, from about 30 mg/l chloride in 1989 to 72 mg/l in 1994. The increase in Well SC-A3B has been very pronounced, from 10 to 165 mg/l chloride during 1993, and to 260 mg/l by mid-1994. At the same time, the concentrations of nitrate in the shallow monitoring wells at SC-A2 and SC-A3 have notably declined (from nearly 80 mg/l to less than 35 mg/l at SC-A2C, and from nearly 35 mg/l to less than 20 mg/l at SC-A3C), reducing concern regarding possible impacts of on-site waste disposal in that area (Seascape and La Selva Beach). Ground-water quality in the remaining Aromas monitoring wells and in the Aromas production wells has remained relatively unchanged.

The increases in TDS and chloride concentrations at monitoring wells SC-A2B and SC-A3B are of concern in that they suggest the possible landward movement of the fresh-salt water interface which had apparently remained unmoved prior to 1993 (since the initial detection of the interface in the early 1970's, and since the installation of dedicated monitoring in 1986). While an exact cause is not clear, it would initially appear that the recent small decline in coastal water levels is

allowing the interface to move slightly landward. Since the coastal water levels are still positive (above sea level), the small change and associated movement may not be of great significance to water supply, assuming the trend does not continue. However, some conclusions should be drawn based on the initial changes:

- the monitoring was intended as an early detection system, and a change has been detected.
- the increased TDS and chloride are at depth, i.e. at the fresh-salt water interface; the inland production wells are completed to shallower depths, less likely to be impacted, except possibly by upconing due to pumping; the latter was considered in the design of the closest SCWD well (Sells), but those design considerations could be changed by landward movement of the interface.
- continued monitoring, at an increased frequency (in production and monitoring wells), and interpretation are warranted as part of this management plan.
- anticipated proactive reaction to protect pumping capacity for water supply would also be appropriate, both as part of this management plan and as part of SCWD's maintenance of water supply capability.

Ground-Water Pumpage

The most complete analysis and summary of ground-water pumpage in the Soquel-Aptos area was prepared by the Soquel Creek Water District for the year 1990 (Faler, 1992). That analysis and summary divided pumpage into three general categories: 1) the largest components of pumpage by SCWD and the City of Santa Cruz, 2) the wide range of pumpage by smaller districts and water companies, and 3) individual and other private pumpers. For 1990, SCWD concluded that area-wide pumpage from the Purisima and Aromas aquifers totaled nearly 11,400 acre-feet. Notable in that total were Soquel Creek Water District (5,000 acre-feet, divided approximately 65 percent from the Purisima and 35 percent from the Aromas), the City of Santa Cruz (1,100 acre-feet, all from the Purisima), Central Water District (455 acre-feet, all from the Aromas), and Cabrillo College (200 acre-feet, all from the Purisima). A couple of other small systems (Mar Vista Water Company and San Andreas Mutual Water) pumped slightly more than 100 acre-feet

each. All other small water companies and water systems each pumped less than 100 acre-feet; many pumped less than 5 to 10 acre-feet. Individual domestic wells and other private wells were responsible for nearly 3,500 acre-feet of pumpage throughout the area in 1990.

Areas of Concern / Identified Problems

In any coastal aquifer system there is obvious concern that fresh water pumping could directly (by locally lowering ground-water levels in and immediately around a pumped well) or indirectly (by regionally lowering ground-water levels) induce saline water to intrude into a well or into the aquifer system in general. Investigation and management activities in the Soquel-Aptos area to date have focused on identifying whether any saline intrusion is present and whether pumping practices have caused, or could potentially cause, saline intrusion. Based on field investigation and analyses over the last 10 to 15 years, a number of positive factors have been identified about ground-water conditions (the confined and unconfined nature of the Purisima and Aromas aquifers, generally positive inland ground-water levels, generally stable ground-water quality, and aquifer characteristics and well yields). Those same efforts have also allowed identification of three areas of concern, which ultimately became the focus of the ground-water management plan described herein; those areas of concern are:

- depressed coastal ground-water levels in the Purisima Formation
- the presence and some apparent landward movement of a fresh/saline interface in the Aromas Red Sands
- the ability to meet projected increases in future demand without exacerbating, and while potentially improving, the two preceding concerns.

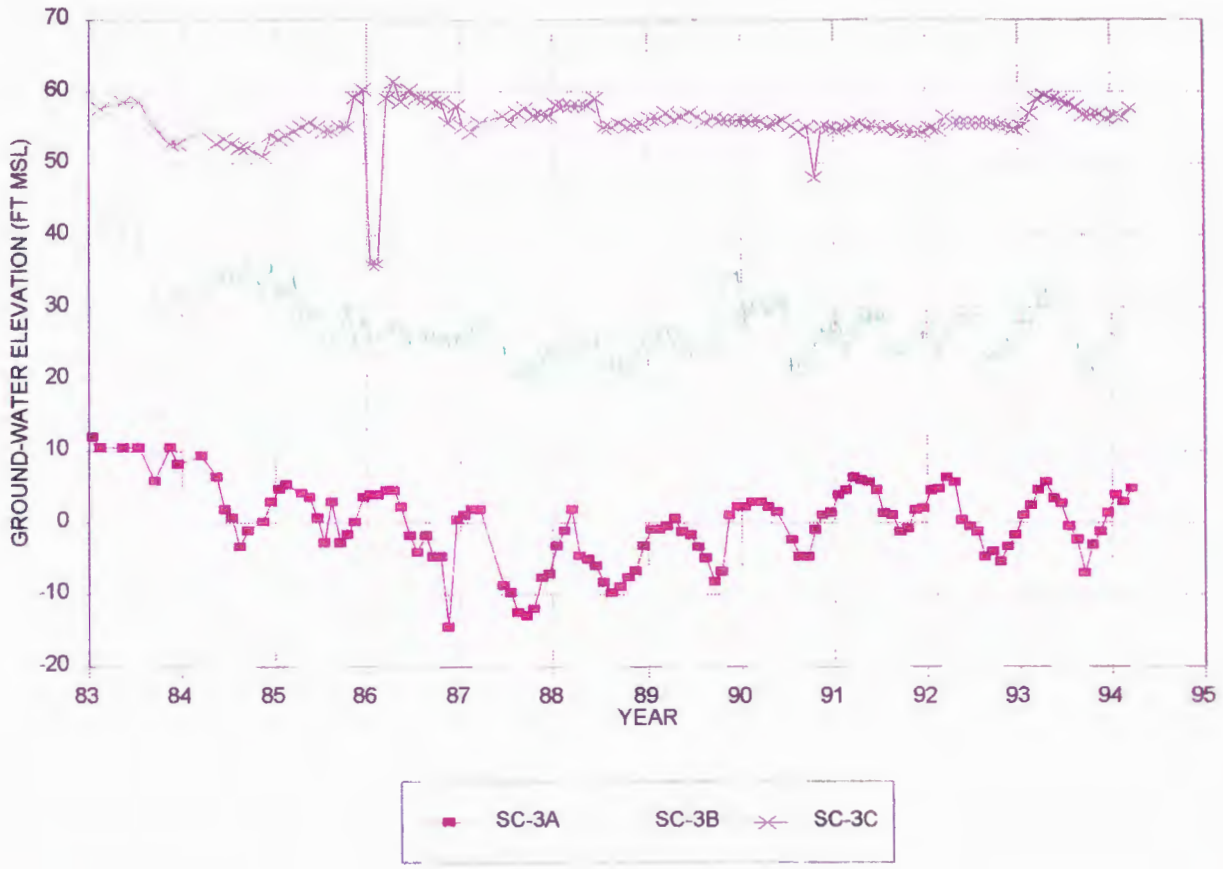
Depressed Purisima Water Levels - Ground-water levels in the Purisima Formation have typically responded to pumping patterns in the SCWD wellfield. Toward the west, where pumping has been reduced in recent years, coastal ground-water levels have been consistently about 10 feet above sea level in the 1990's after a steady recovery from lower levels (0 to 5 feet

MSL) in the early 1980's (Figure 7). Conversely, as SCWD's total pumpage increased in the 1980's, coastal ground-water levels declined in the deeper Purisima subunits and have ranged from fluctuating near sea level beneath Capitola (Figure 8) to fluctuating below sea level from New Brighton Beach to Aptos Creek (Figures 9 and 10). The latter conditions raise concerns for the potential landward intrusion of sea water from Monterey Bay, although none has been detected in the Purisima. Ultimately, the presence of such conditions precipitates the need for management action to redistribute pumping in the wellfield and to supplement the local water supply with a supplemental supply, as discussed in this plan, to achieve the basin goals of avoiding overdraft and preventing seawater intrusion.

Saline Interface in the Aromas Red Sands - When the Aromas Red Sands were first explored by the Soquel Creek Water District 25 years ago, a fresh water/saline water interface was encountered (at a depth of nearly 500 feet below sea level at the SCWD Seascape well site), although it was not originally recognized as such. Subsequent investigation about ten years ago identified a largely uniform, wedge-shaped body of saline ground water beneath the fresh ground water along most of the Soquel-Aptos portion of the Aromas Red Sands. The position of the interface was essentially unchanged from where it was initially detected 15 years earlier and, for the first six or seven years of detailed monitoring, it appeared to remain fixed. However, although water levels have not significantly changed (up to about two feet of decline) and remain continuously well above sea level, water quality at two dedicated coastal monitoring sites has shown a degradation (increased concentrations of total dissolved solids and chloride) over the last two years.

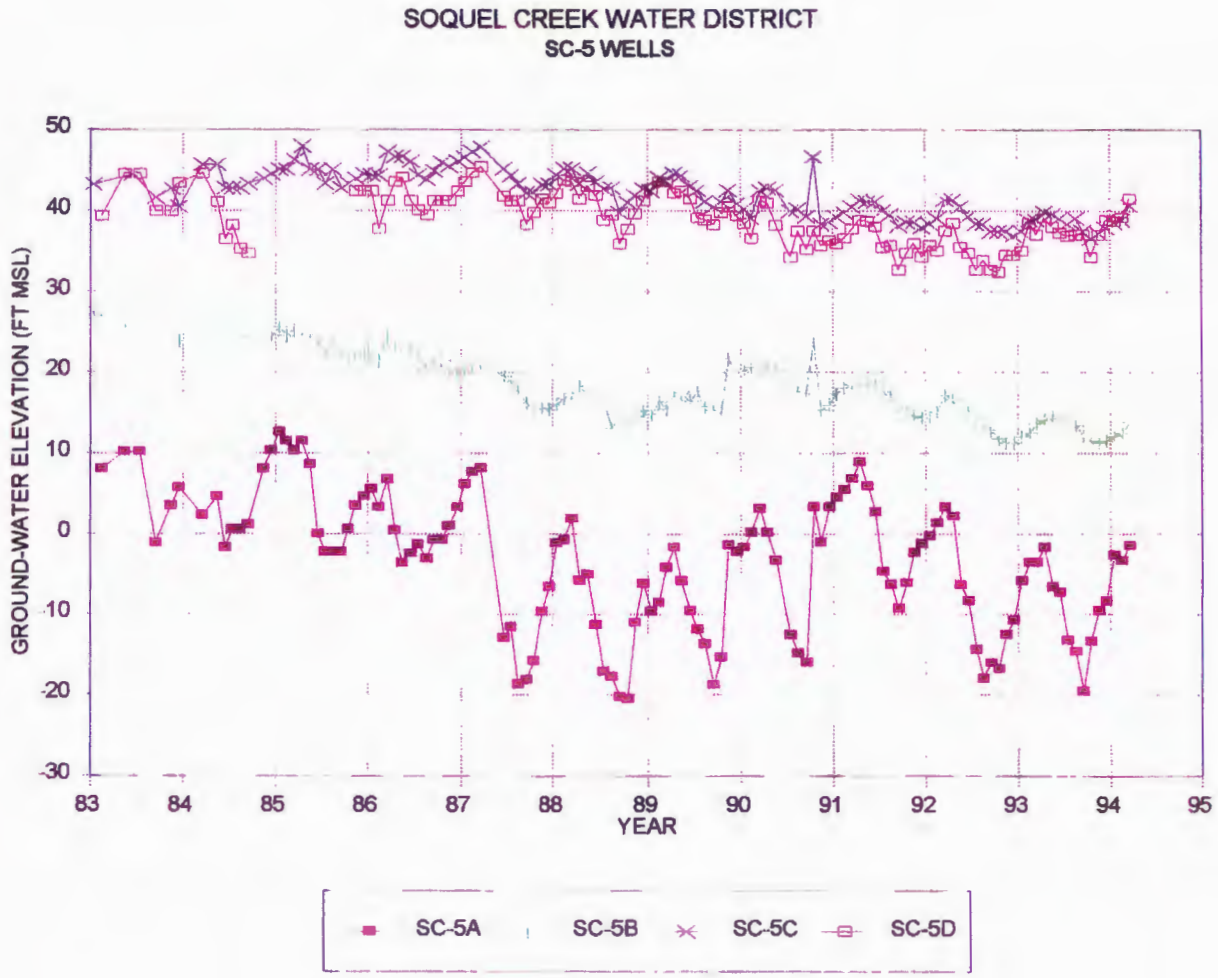
The presence of saline water beneath fresh ground water near the coast appears to have initially been naturally present, attributable to the specific gravity difference between fresh and saline waters. However, its presence, exacerbated by its possible movement in the last couple of years, raises concern about pumping practices and aquifer/basin yield of the Aromas in the Soquel-Aptos area. Those factors precipitate the need for management action to further investigate the change in quality at the monitoring wells, potential impacts on water supply wells, and the need to modify pumping practices and/or augment basin yield through conjunctive use or other action to

SOQUEL CREEK WATER DISTRICT
SC-3 WELLS



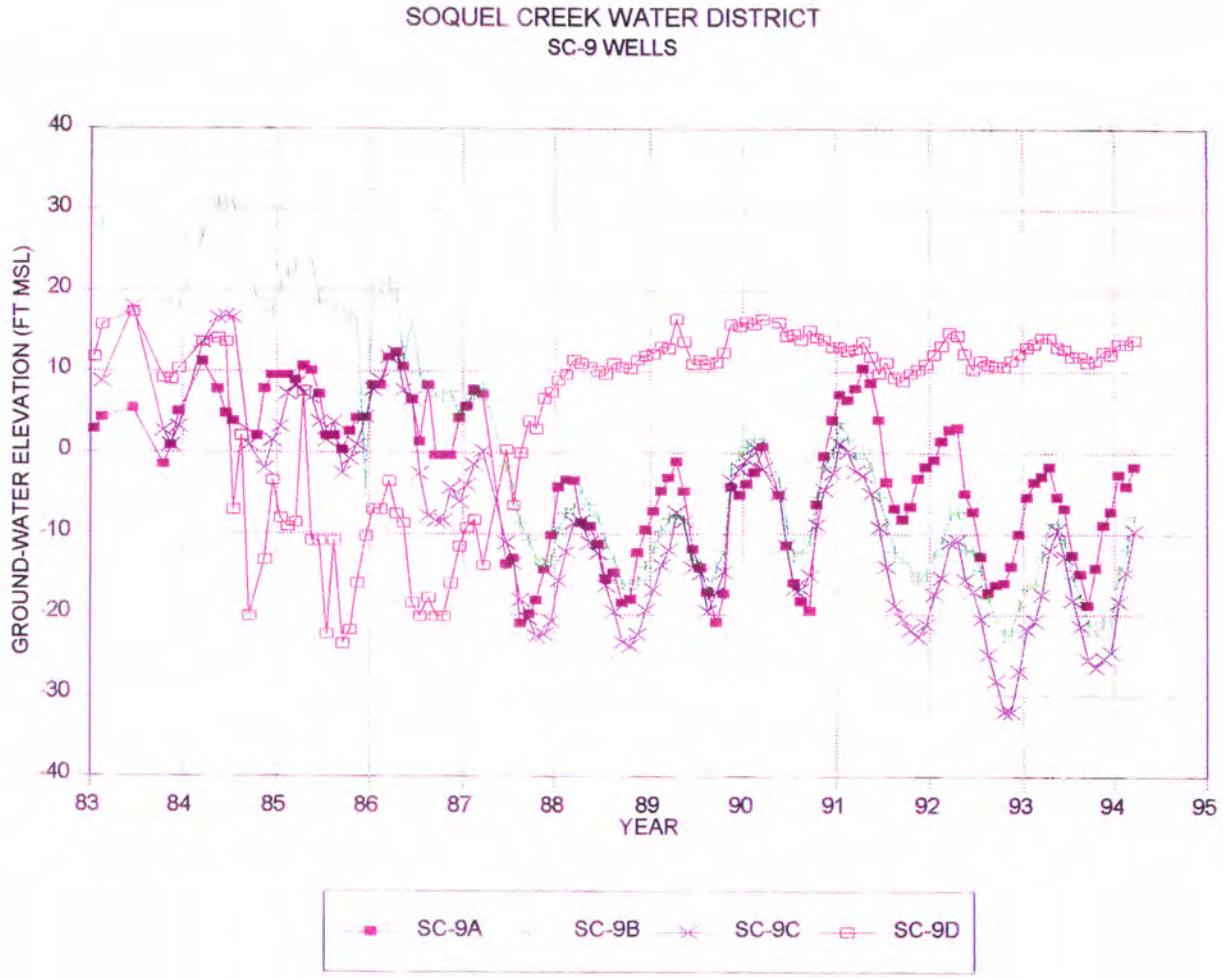
Ground- Water Elevation Hydrograph, SC-3 Purisima Wells

FIGURE
8



Ground–Water Elevation Hydrograph, SC–5 Purisima Wells

FIGURE 9

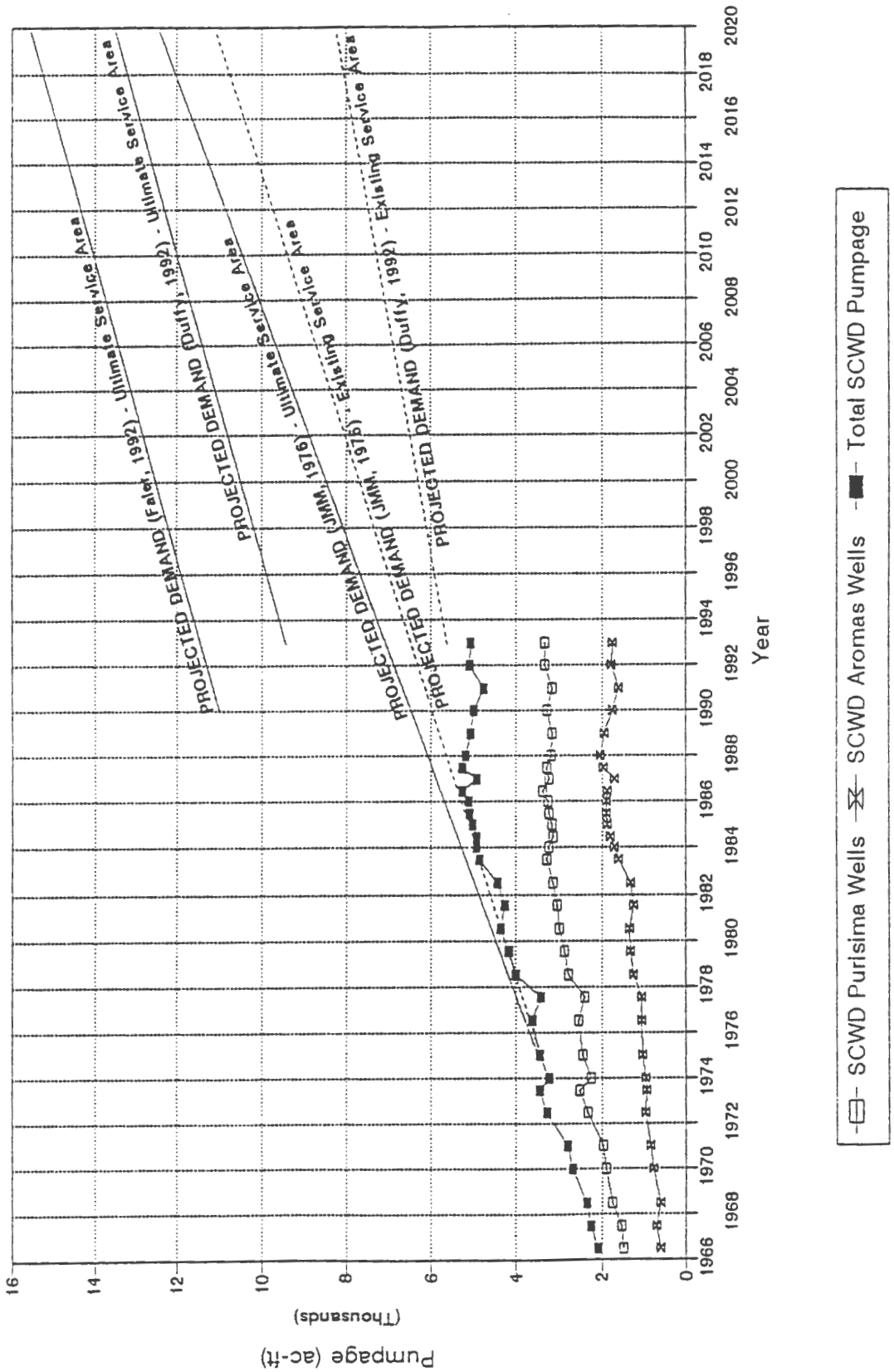


Ground-Water Elevation Hydrograph, SC-9 Purisima Wells

FIGURE 10

achieve the basin goal of controlling seawater intrusion.

Meeting Projected Water Demand - As delineated in this plan, ground-water pumpage to meet total water demand in the Soquel-Aptos area was estimated to be about 11,400 acre-feet in 1990 and is estimated to be about the same or slightly higher today. Projections are that municipal and small system water demand will increase total water demand to around 15,000 acre-feet per year by the year 2020 (Figure 11). In light of the two conditions of concern currently identified in the area, depressed coastal water levels in the Purisima Formation and possible landward migration of seawater intrusion in the Aromas Red Sands, both under current pumping demands, there is a definite need to implement a ground-water management plan as described herein. That plan would serve as a basis for maintaining use of ground water, complemented by supplemental water supplies as necessary, to accomplish the basin objectives of water supply for overlying beneficial use while also accomplishing the other objectives of avoiding overdraft and preventing or controlling seawater intrusion.



Soquel Creek Water District Pumpage and Projected Demand

FIGURE 11

Elements of the Soquel-Aptos Ground-Water Management Plan

In response to reported conditions of overdraft and seawater intrusion in 1980, the Soquel Creek Water District implemented a program of ground-water monitoring and management which has allowed it to better define and understand basin conditions, and to continue to meet increasing water demands over the past 15 years. Information derived from the SCWD management program has also allowed other public and private pumpers to continue to rely on the ground-water basin for some or all of their water supply without significant concern that the resource was either overdrafted or otherwise negatively impacted, i.e. degraded by seawater intrusion. In that light, the SCWD program has already started managing local ground-water resources consistently with the opportunity provided by AB 3030. However, the occurrence of depressed coastal water levels in the Purisima Formation and the possible landward movement of saline water in the Aromas Red Sands, in the context of projected increasing water demand over the next 25 years, lead to a need for a broader based ground-water management plan.

To address the identified concerns and problem areas in the aquifers beneath the area, this Soquel-Aptos Ground-Water Management Plan has been developed to provide a framework for present and future actions. As has been the case for the SCWD ground-water management activities over the past 15 years, it is expected that this plan will be updated as new data are developed, particularly in light of the key role that ground-water monitoring (water levels and quality) has played, and will continue to play, in defining ground-water conditions and aquifer response to management actions.

The management objectives, or goals, for the Soquel-Aptos area include the following:

Goal 1: Continued Development of Water Supply
Goal 2: Avoidance of Overdraft
Goal 3: Prevention or Control of Seawater Intrusion
Goal 4: Preservation of Ground-Water Quality

To accomplish those goals, with recognition of the opportunities provided by AB 3030 for local agency management of ground-water resources, this plan identifies a number of plan elements which are divided into primary, or essential, elements and secondary, or potential, elements. In both categories, the elements restate or expand certain of the existing SCWD plan elements to recognize the effectiveness of the implemented plan, the probable need for additional activity (e.g. development and conjunctive use of supplemental surface water with existing ground water), and the possible wider focus on local ground-water management (e.g. cooperation with the City of Santa Cruz and/or the Pajaro Valley Water Management Agency) to address the impacts of regional resource opportunities and/or challenges. In summary, the Ground-Water Management Plan will enable the District to continue use of local ground water for municipal and other water supply and to work with other agencies via implementation of the following management plan elements.

Primary (Essential) Plan Elements

Monitoring of Ground-Water Levels and Quality
Monitoring of Surface Water Flows and Quality
Control of Seawater Intrusion
Avoidance of Overdraft Conditions
Distribution of Wellfield Pumpage
- relocation of coastal pumpage in both the Purisima and Aromas aquifers
- uniform drawdown in the Purisima aquifer
- inter-aquifer transfer
- control of out-of-basin flow

Implementation of Conjunctive Use Operations
- in-lieu surface water use in Purisima area
- artificial recharge in Aromas area

Continuation of Public Education and Water Conservation Programs

Secondary (Potential) Elements

Identification and Management of Recharge Areas and Wellhead Protection Areas
Identification of Well Construction, Abandonment, and Destruction Policies
- water quality protection
- manage vertical distribution of pumpage

Development and Continuation of State and Federal Agency Relationships
Identification and Mitigation of Soil and Ground-Water Contamination
- involvement with other local agencies on investigation, cleanup, and closure

Provisions to Add Additional Elements as appropriate

Primary Element 1 - Ground-Water Monitoring

Originally implemented in 1981 and subsequently expanded to now include the entire Soquel-Aptos area, monitoring of ground-water levels and quality is a primary element in defining ground-water conditions and aquifer response to pumping, recharge, and basin management actions. Dedicated monitoring wells have been constructed for specific purposes, such as seawater intrusion and inter-aquifer flow, as well as to provide data on regional hydrogeologic conditions. The monitoring wells, constructed as deep as 1,100 feet and isolating up to six individual aquifer subunits, are used to monitor regional and local basin conditions, as well as water levels surrounding individual pumped wells. The dedicated monitoring wells are incorporated with a network of production wells that allow increasing understanding of basin hydrology, including lateral and vertical movement of ground water. As a result, they provide a basis for management of the area via response to natural and pumpage-induced conditions, i.e. distribution of pumpage in response to locally high and low ground-water levels. This Ground-Water Monitoring Element is essential to accomplishment of all four goals for the basin.

Primary Element 2 - Surface Water Monitoring

Since the initial interpretation of ground-water monitoring by SCWD, it has been recognized that there are limits to ground-water development for water supply, e.g. that the aquifer system could not be significantly drawn down, or "mined", without probable intrusion from Monterey Bay. In

the early 1980's, anticipating that water demands could ultimately exceed aquifer yield, and that a supplemental water supply could be required by the end of the century, SCWD began a program to monitor and analyze surface water resources, notably on Soquel Creek, in order to ultimately design a local supplemental surface water project. The results of that work are increasingly important in light of the concern/problem areas associated with depressed coastal Purisima water levels and possible landward migration of saline water in the Aromas. Surface water data also allow analysis and interpretation of recharge and water quality impacts on the aquifer system. Ultimately, the availability of a supplemental surface water supply, whether from Soquel Creek or other sources, will allow conjunctive use operations to be implemented; thus, the Surface Water Monitoring element is essential to accomplishment of all four Basin Goals.

Primary Element 3 - Control of Seawater Intrusion

There has been no historical detection of seawater intrusion in the Purisima Formation, despite occasionally depressed coastal ground-water levels. It appears that the confined nature of the Purisima subunits has helped protect the basin from rapid response (intrusion) to lowered water levels such as might occur in an unconfined aquifer contiguous to a saline water body. Conversely, the nature of ground-water occurrence in the Aromas Red Sands is such that, in the Soquel-Aptos area, saline water intruded beneath fresh ground water near the coast long ago. That wedge-shaped presence of saline water is apparently natural, due to the greater specific gravity of sea water. A primary objective of ground-water management in the area is to keep it from moving inland and thus degrading fresh ground water. Although both coastal and inland pumping have not resulted in any significant decrease in water levels, there has been some apparent movement of the fresh/saline interface in the last two or three years. Further investigation of the causes and extent of such movement, followed by management action such as modified pumping patterns, artificial recharge, etc., will be essential to the accomplishment of Basin Goals 3 and 4.

Primary Element 4 - Avoidance of Overdraft

On a long-term basis, there has not been a widespread, steady decline in ground-water levels throughout the Soquel-Aptos area. Notably in the Aromas Red Sands, water levels have been near constant and above sea level, although there has been a slight decline over the last couple of years. More significant in the Aromas has been the rotation of ground-water flow direction from discharge toward Monterey Bay to discharge (subsurface outflow) toward the Pajaro Valley in the last few years. In the Purisima Formation, there has been a depression of coastal ground-water levels in one or more Purisima subunits in the central portion of SCWD, but also a recovery of coastal ground-water levels to well above sea level in all the Purisima subunits in the western portion of the District.

In the mid-1980's, the USGS developed a multi-layered numerical model of a coastal aquifer system, and used the Purisima Formation in the Soquel-Aptos area for calibration and application of the model to analyze aquifer response to pumping and to identify the general location and potential impact of the offshore fresh/saline interface. Part of this element of overall ground-water management will be to utilize that model along with the multiple regression relationships developed by SCWD to further analyze the yield of the Purisima in order to decrease pumping depressions and maintain subsurface outflow toward Monterey Bay. A further part of this element will be to expand the model by adding the Aromas Red Sands above the layered Purisima in order to more precisely analyze the yield of those aquifer materials and thus avoid any overdraft conditions which would induce landward movement of saline water. Collectively, the yield of the Purisima and Aromas aquifers would be the basis for planning on long-term ground-water supplies to meet a component of total water demand; the magnitude of supplemental water requirements, potentially in conjunctive use with ground water, will thus be defined to accomplish Basin Goal 2.

Primary Element 5 - Distribution of Wellfield Pumpage

Historic SCWD pumping practices in the Purisima Formation have demonstrated the effectiveness

of both areal and vertical distribution of pumpage on ground-water levels. To a lesser extent, vertical distribution of Purisima pumpage has also demonstrated an ability to manage water quality to meet secondary drinking water standards for dissolved iron and manganese. However, those pumping practices have also identified the lower yield of the shallower Purisima subunits, both in terms of individual well yield and lower aquifer transmissivity, resulting in lower flow through the shallower aquifer subunits. Ultimately, though, identification of high ground-water levels provides targets for relocation of some pumpage in order to decrease stress on the aquifer where water levels are depressed and thus pursue a more uniform drawdown in contrast to significant local pumping depressions.

In the Aromas, if saline water has begun to migrate landward, particularly if due to wellfield pumping practices, it may be effective to relocate some coastal pumpage inland to achieve sufficiently higher coastal water levels to preclude the natural intrusion from migrating.

Finally, depending on the yield of the Aromas and the potential to increase inland pumpage, there is a potential management action which would effectively "transfer" pumpage from the Purisima to the Aromas, i.e. deliver water from the Aromas to overlying use above the Purisima, allowing an offsetting decrease in Purisima pumpage. As long as such pumpage does not cause or exacerbate any intrusion, it could have the double benefit of reducing pumping stress in the Purisima with some recovery of water levels, and delivering water for municipal supply that meets secondary drinking water standards for dissolved iron and manganese without treatment. Implementation of this element addresses all four Basin Goals.

Primary Element 6 - Implementation of Conjunctive Use Operations

Based on monitoring of ground-water conditions in both the Purisima and Aromas aquifers over the last 10 to 15 years, in combination with projected water requirements over the next 25 years, it appears that meeting those requirements will require supplemental water to complement ground water. While other management activities, such as areal and vertical distribution of pumpage and potential inter-aquifer transfer, will contribute to area goals, ground-water level projections in the

Purisima indicate a need for more widespread distribution of pumping (beyond the SCWD boundaries) complemented by supplemental water in order to cause coastal water level recovery.

Based on the results of ongoing surface water monitoring and planning (Primary Element 2), there is an identified developable surface water source in Soquel Creek. Other analyses have identified inter-agency conjunctive use opportunities with the City of Santa Cruz whereby wet-period surplus surface water could be used in the Soquel-Aptos area in lieu of Purisima (and possibly some Aromas) pumpage, in exchange for dry period discharge of Soquel-Aptos ground water to meet peak Santa Cruz demands. In either case (surface water from Soquel Creek or the City of Santa Cruz system), the Soquel-Aptos area can plan to incorporate conjunctive use via in-lieu use of surface water in wet periods, which will contribute to some recovery of ground-water levels, and dry-period pumping to meet both overlying and exchange water requirements. In the Aromas Red Sands, further investigation of possible landward migration of seawater intrusion may indicate a need for redistribution of pumpage (Primary Element 5) or conjunctive use of ground water complemented by supplemental surface water. Depending on the nature of supplemental water which might be developed, conjunctive use in the Aromas could range from artificial recharge of the aquifer system to direct use of surface water in lieu of ground-water pumpage, in either case to directly or indirectly increase the gradient for subsurface outflow to control seawater intrusion.

Primary Element 7 - Continuation of Public Education and Water Conservation Programs

The Soquel Creek Water District has an ongoing community information plan aimed at informing the community of water management and conservation issues. That plan includes: 1) a School Program (instruction materials, in-service workshops, educational fairs, District library of publications, and special activities and projects), which also includes adult education classes in water conservation, landscaping, and home plumbing; 2) a Community Information and Education Program which includes brochures, bill inserts, film library, press releases, exhibits, distribution of water saving kits, and speakers at various events; 3) Media Communication including public service announcements, newspaper editorials, and press releases; 4) a Landscaping (Xeriscape)

component via newspaper articles and announcements, awards, demonstration gardens, and special programs and promotions, including video tapes for use by nurseries, landscape architects and contractors, Chambers of Commerce, and schools; and 5) Committee Participation in numerous state, local community, and school committees relative to water awareness, conservation and education.

Based on a recent review of its public education and water conservation programs, the SCWD community information program is both continuing and being updated to focus on five objectives generally related to ground-water management in the Soquel-Aptos area: assurance of high quality water for drinking; highlight drought management decisions to address both short-term drought concerns as well as long-term conservation requirements; prepare for alternative (supplemental surface water) source development in order to continue to meet increasing demand while both protecting existing sources of supply and ensuring high water quality; enhance the District's identity to clarify that the ground-water basin is the primary water supply and that a supplemental source would not be to induce growth, but rather to respond to increasing water demand while preserving ground-water resources; and determine other community water issues.

The formalization of ground-water management in this plan will continue to include public education and water conservation toward the achievement of all four Basin Goals.

Secondary Element 1 - Identification and Management of Recharge Areas and Wellhead Protection Areas

The Purisima Formation and Aromas Red Sands aquifers outcrop at the ground surface throughout the Soquel-Aptos area and, as a result, are recharged by precipitation, streamflow, and applied water throughout the area. Of note, for example, have been historical occurrences of elevated nitrate concentration in shallow ground water in part of the Aromas, apparently the result of both farming practices and individual on-site waste disposal systems in non-sewered residential areas. Although the latter has declined in recent time, rendering it of less concern to domestic water supply, ground-water management will continue to monitor land use impacts on ground-

water recharge, and will potentially lead to participation in land use planning to protect critical recharge areas.

Similarly, wellhead protection areas within which pumping of individual wells directly affects ground-water flow toward those wells will be analyzed and mapped with the intent to protect them from potentially adverse overlying land use.

Secondary Element 2 - Identification of Well Construction, Abandonment, and Destruction Policies

Well construction permitting in Santa Cruz County is administered by the County Health Department which effectively implements the State Well Standards for water wells, monitoring wells, and cathodic protection wells. One goal of this management plan for the area, protection and preservation of ground-water quality, requires that all wells be properly constructed and maintained during their operational lives, and properly destroyed after their useful lives, in order that they not adversely affect ground-water quality by, for example, serving as conduits for movement of contaminants from the ground surface and/or from a poor quality aquifer to one of good quality. Toward that end, this element is included in the overall plan to support well construction and destruction policies, and to participate in their implementation in the Soquel-Aptos area, particularly with regard to surface and inter-aquifer well sealing and proper well destruction, which are critical in coastal areas to maintain aquifer integrity.

Secondary Element 3 - Development and Continuation of State and Federal Agency Relationships

The Soquel Creek Water District was originally founded as a local district to cooperate with federal agencies in studying and implementing flood control on Soquel Creek. The beginnings of local ground-water management were in a cooperative study with the US Geological Survey to define and assess hydrogeologic conditions in the Soquel-Aptos area. A numerical ground-water model of the layered Purisima aquifer system, developed by the USGS, is a potentially useful tool

in analyzing the detailed impacts of pumping practices and conjunctive use scenario on ground-water levels and coastal fresh/saline interfaces. Those agency relationships will be continued in this plan.

Questions have periodically arisen about pumping impacts on surface flows in Soquel Creek, both at the State Water Resources Control Board and the State Department of Fish and Game. Such questions have been readily answered via interpretation of SCWD's ground-water monitoring and aquifer analyses. The baseline and secondary elements of this plan will allow continuation of information transmittal to those and other state agencies as necessary.

Secondary Element 4 - Identification of Soil and Ground-Water Contamination

No inorganic or synthetic organic chemicals have impacted ground-water quality for municipal or domestic use in the Soquel-Aptos area. One possible exception might be the historical detection of locally elevated nitrate concentrations in shallow parts of the Aromas Red Sands near agricultural and unsewered community land uses. However, those conditions did not impact municipal water supply, and nitrate concentrations have subsequently declined. In the more publicized arena of toxic or other hazardous chemical contamination, there have been localized instances of impact on ground-water quality; however, these have not impacted municipal supplies. Despite those positive factors, it is part of this plan to actively monitor ground-water quality (Primary Element 1) and to actively participate with local health and other agencies as appropriate to identify spills, leaks or other threats to ground-water quality, and to participate in their control and cleanup such that ground-water quality is not impacted and does not limit water supply.

Secondary Element 5 - Provisions to Add Additional Components

The baseline and secondary elements of this local area ground-water management plan reflect the current understanding of the occurrence of ground water in the Soquel-Aptos area, and specific problems or areas of concern about that resource. Those management elements are designed to

achieve specified goals to protect and preserve ground-water quantity and quality for overlying beneficial use into the foreseeable future as water requirements are projected to increase. Ultimately, however, it is recognized that, while the ground-water management plan provides a framework for present and future actions, new data will be developed as a result of implementing the plan. That new data could define conditions which will require modifications to currently definable management actions. As a result, this plan is intended to be a flexible document which can be updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future ground-water conditions.

References

California Department of Water Resources, **California's Ground Water**, Bulletin 118, 1975.

California Department of Water Resources, **Ground Water Basins in California**, A Report to the Legislature in Response to Water Code Section 12924, Bulletin 118-80, 1980.

California Department of Water Resources, **Revisions to Department of Water Resources Bulletin 118-80 Findings In Regard To Santa Cruz - Pajaro Ground Water Basin**, 1982.

Duffy & Associates, **Land Use and Water Demand Projections, Final Report**, Soquel Creek Water District, August, 1992.

Essaid, Hedeff I., **The Computer Model SHARP, A Quasi-Three-Dimensional Finite-Difference Model to Simulate Freshwater and Saltwater Flow in Layered Coastal Aquifer Systems**, USGS Water Resources Investigations Report 90-4130, 1990.

Essaid, Hedeff I., **Simulation of Freshwater and Saltwater Flow in the Coastal Aquifer System of the Purisima Formation in the Soquel-Aptos Basin, Santa Cruz County, California**, USGS Water Resources Investigations Report 91-4148, 1992.

Faler, Jennifer, SCWD, **Private Well Location Program**, Soquel Creek Water District, April, 1992.

Greene, H. Gary, **Geology of the Monterey Bay Region**, USGS Open-File Report 77-718, 1977.

Hickey, John J., **Hydrogeologic Study of the Soquel-Aptos Area, Santa Cruz County, California**, USGS Open-File Report, April, 1968.

Luhdorff and Scalmanini, Consulting Engineers, **Review and Analysis of Reports Relating to Ground-Water Resources in the Soquel-Aptos Area, Santa Cruz County, California**, Soquel Creek Water District, September, 1981.

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Resources and Management Report, 1983, Soquel Creek Water District**, January, 1984.

References (cont.)

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Resources and Management Report, 1984, Soquel Creek Water District**, April, 1985.

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Monitoring and Management, Aromas Red Sands**, Soquel Creek Water District, October, 1987.

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Resources and Management Report, 1988**, Soquel Creek Water District, April, 1989.

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Monitoring and Management 1990 Update, Aromas Red Sands**, Soquel Creek Water District, July, 1990.

Luhdorff and Scalmanini, Consulting Engineers, **User's Guide for REGMDL.WQ1, Spreadsheet for Purisima Regression Models**, Soquel Creek Water District, July, 1991.

Luhdorff and Scalmanini, Consulting Engineers, **User's Guide: Water Level Model Spreadsheet/Water Quality Data Base**, Soquel Creek Water District, September, 1994.

Luhdorff and Scalmanini, Consulting Engineers, **Ground-Water Resource and Management Including Conjunctive use Alternatives**, Soquel Creek Water District, September, 1994.

Montgomery, James M., Consulting Engineers, Inc., **Soquel Creek County Water District, Comprehensive Plan for Water System Development**, January, 1976.

Muir, K.S., **Seawater Intrusion and Potential Yield of Aquifers in the Soquel-Aptos Area, Santa Cruz County, California**, USGS Water-Resources Investigations, October, 1980.

APPENDIX

Ground-Water Monitoring Network
Soquel-Aptos Area

TABLE A1
SUMMARY OF PURISIMA WELLS
SOQUEL CREEK AND CENTRAL WATER DISTRICTS

PRODUCTION WELLS

PRODUCTION WELLS	SURFACE ELEVATION (FT-MSL)	TOTAL DEPTH (FT.)	SCREENED INTERVAL (DEPTH-FT.)	DEPTH ZONE (SUBUNIT)	PERIOD OF RECORD	PUMP CAPACITY (GPM)
MAIN STREET	53.50	664	232-246, 280-376, 424-448, 472-496, 544-652	A/AA	2/88-pres.	1450
ROSEDALE	131.22	570	210-240, 266-310, 324-336, 350-400, 438-494, 530-560	A/AA	4/84-pres.	600
OPAL (#1)	81.40	211	109-211?	A	7/66-pres.	250
MAPLETHORPE	135.14	628	368-628	A	7/66-pres.	225
TANNERY	123.52	614	340-600	A	1/71-pres.	670
MONTEREY	112.56	398	240-391	A	7/66-pres.	375
ESTATES	144.30	930	305-390, 440-510, 660-920	A/B/C/D	5/86-pres.	1000
MADELINE	192.08	680	480-570, 600-670	B/C	7/73-pres.	250
LEDYARD	190.41	880	640-850	B	2/86-pres.	230
APTOS CREEK	26.22	713	243-713	B/C/D/E	7/66-pres.	485
T. HOPKINS	120.49	600	240-300, 340-380, 400-525, 535-545, 565-585	B/C/D/E	9/90-pres.	400
HILLCREST*	144.64	(330)	(55-185?)	(C/D/E)	7/66-9/87	--
SEACLIFF*	111.06	(300)	(0-289?)	(D/E/F)	7/66-4/87	--
OPAL #4**	81.40	300	210-290	A	9/81-8/84	--
OPAL #3**	~80				7/66-9/81	--
CWD 2**	300	261	105-245		9/66-1-85	120
CWD 3	290	300	172-292		1/66-pres.	150
CWD 5	318	272	199-272		1/66-pres.	220

* Abandoned (former depths and screen intervals shown in parentheses)

** Off-Line

TABLE A1 (con't)
SUMMARY OF PURISIMA WELLS
SOQUEL CREEK AND CENTRAL WATER DISTRICTS

MONITORING WELLS

MONITORING WELLS	SURFACE ELEVATION (FT-MSL)	TOTAL DEPTH (FT.)	SCREENED INTERVAL (DEPTH-FT.)	DEPTH ZONE (SUBUNIT)	PERIOD OF RECORD
SC-1A	72.33	320	109-320	A	1/83-1-94
SC-1B	72.33	320	50-80	B	1/83-1/94
SC-3A	97.15	510	277-510	A	1/83-1/94
SC-3B	97.15	510	113-240	B	1/83-1/94
SC-3C	97.15	510	52-95	C	1/83-1/94
SC-5A	120.48	765	520-765	A	1/83-1/94
SC-5B	120.48	765	306-475	B	1/83-1/94
SC-5C	120.48	765	215-284	C	1/83-1/94
SC-5D	120.48	765	80-190	D	1/83-1-94
SC-5E	120.48	765	20-44	E	1/83-12/85
SC-8A	10.64	1100	825-1100	A	1/83-5/92
SC-8B	10.64	1100	611-780	B	1/83-5/92
SC-8C	10.64	1100	516-580	C	1/83-5/92
SC-8D	10.64	1100	363-490	D	1/83-5/92
SC-8E	10.64	1100	230-335	E	1/83-5/92
SC-8F	10.64	1100	20-200*	F	1/83-5/92
SC-9A	13.49	900	625-900	A	1/83-1/94
SC-9B	13.49	900	400-575	B	1/83-1/94
SC-9C	13.49	900	316-380	C	1/83-1/94
SC-9D	13.49	900	184-290	D	1/83-1/94
SC-9E	13.49	900	25-140	E	1/83-1/94
SC-10AA	86.25	436	296-436	AA	1/83-1/94
SC-10A	86.25	436	30-173	A	1/83-1/94
SC-13A	81.40	820	451-820	A/AA	2/85-7/90
SC-14A	192.08	1140	819-1100*	A	1/86-7/90
SC-14B	192.08	1140	620-680*	B	1/86-7/90
SC-14C	192.08	1140	460-520*	C	1/86-7/90
SC-16A	142.63	980	660-970*	A/B	11/86-7/90
SC-16B	142.63	980	305-465*	C/D	12/86-7/90
SC-17A	186.52	1240	1000-1210*	A	9/86-7/90
SC-17B	186.52	1240	640-840*	B	10/86-7/90
SC-17C	186.52	1240	430-550*	C	10/86-7/90
SC-17D	186.52	1240	210-350*	D	10/86-7/90

* Total Screened Interval - Intermittent Blank Sections Present

TABLE A2
SUMMARY OF AROMAS RED SANDS WELLS
SOQUEL CREEK AND CENTRAL WATER DISTRICTS

PRODUCTION WELLS

PRODUCTION WELLS	SURFACE ELEVATION (FT-MSL)	TOTAL DEPTH (FT.)	SCREENED INTERVAL (DEPTH-FT.)	PERIOD OF RECORD	PUMP CAPACITY (GPM)
COUNTRY CLUB	197.13	495	254-302, 326-350, 374-398, 422-495	7/66-pres.	400
SELLS	110.52	440	200-260, 300-340, 410-430	6/84-pres.	550
ALTIVO	165.56	480	320-350, 385-425, 440-470	1/80-pres.	650
SEASCAPE	176.54	550	310-340, 370-390, 410-440, 530-550	7/66-pres.	820
BONITA	231.17	740	330-364, 380-410, 442-486, 518-542, 560-580, 600-634, 666-728	5/84-pres.	960
SAN ANDREAS	164.50	620	268-348, 394-454, 510-610	6/92-pres.	1090
APTOS (thru 10/86)**	210.09	460	10-250	7/66-9/86	
CLIFF (thru 10/85)*	63.25	(400)	(194-394)	7/66-10/85	
LA SELVA2 (thru 7/83)*	~130			7/66-7/83	
LA SELVA1*	~122			7/66-11/79	
CWD 4	150	350	144-344	1/66-pres.	150
CWD 10	156	285	160-180, 220-240, 255-265	1/66-pres.	400

* Abandoned (former depths and screen intervals shown in parentheses)

** Off-Line

TABLE A2 (cont'd)
SUMMARY OF AROMAS RED SANDS WELLS
SOQUEL CREEK AND CENTRAL WATER DISTRICTS

MONITORING WELLS

MONITORING WELLS	SURFACE ELEVATION (FT-MSL)	TOTAL DEPTH (FT.)	SCREENED INTERVAL (DEPTH-FT.)	DEPTH ZONE	PERIOD OF RECORD
SC-A1A	64.76	530	460-520*	A	7/86-1/94
SC-A1B	64.76	530	260-395*	B	7/86-1/94
SC-A1C	64.76	530	170-190	C	7/86-1/94
SC-A1D	64.76	530	100-120	D	7/86-1/94
SC-A2A	127.24	490	460-480	A	7/86-1/94
SC-A2B	127.24	490	420-440	B	7/86-1/94
SC-A2C	127.24	490	140-160	C	7/86-1/94
SC-A3A	103.09	320	290-310	A	7/86-1/94
SC-A3B	103.09	320	230-270*	B	7/86-1-94
SC-A3C	103.09	320	125-145	C	7/86-1/94
SC-A4A	185.89	550	520-540	A	7/86-1/94
SC-A4B	185.89	550	480-500	B	7/86-1/94
SC-A4C	185.89	550	230-410*	C	7/86-1/94
SC-A4D	185.89	550	220-240	D	7/86-1/94
SC-A5A	175.32	680	650-670	A	7/86-1/94
SC-A5B	175.32	680	580-600	B	7/86-1/94
SC-A5C	175.32	680	310-430*	C	7/86-1/94
SC-A5D	175.32	680	210-230	D	7/86-1/94
CWD-12	160	520	126-146 226-246 326-346	A B C	1989-1995

* Total Screened Interval - Intermittent Blank Sections Present

TABLE A3
GROUND-WATER MONITORING FREQUENCY
SOQUEL CREEK AND CENTRAL WATER DISTRICTS

WELL NAME	STATE WELL NUMBER	DEPTH (FEET)	WATER LEVEL	TDS & Cl	NO_3	MAJOR IONS
PURISIMA WELLS						
ROSEDALE	11S/1W-10J	570	B	A	A	A
MAPLETHORPE	11S/1W-11L1	628	B	A	A	A
TANNERY	11S/1W-11L2	614	B	A	A	A
MONTEREY	11S/1W-11N1	398	B	A	A	A
MADELINE	11S/1W-12K1	680	B	A	A	A
ESTATES	11S/1W-12P	930	B	A	A	A
OPAL 1	11S/1W-15L1	211	B	A	A	A
LEDYARD	11S/1E-18D	880	B	A	A	A
APTOS CREEK	11S/1E-18F1	713	B	A	A	A
MAIN STREET	11S/1W-10K	664	B	A	A	A
T. HOPKINS	11S/1E-18F	600	B	A	A	A
SC-1	11S/1W-15P*	320	M	S	A	-
SC-3	11S/1W-14E*	510	M	S	A	-
SC-5	11S/1W-14B*	765	M	S	A	-
SC-8	11S/1E-18N*	1,100	M	S	A	-
SC-9	11S/1W-13F*	900	M	S	A	-
SC-10	11S/1W-3B*	436	M	S	A	-
SC-13	11S/1W-15	820	-	-	-	-
SC-14	11S/1W-12K*	1,140	-	-	-	-
SC-16	11S/1W-12P*	980	-	-	-	-
SC-17	11S/1E-18D*	1,240	-	-	-	-
CWD 2	11S/1E-4Q2M	300	-	-	-	-
CWD 3	11S/1E-4Q3M	290	M	-	-	-
CWD 5	11S/1E-4Q5M	318	M	-	-	-
* Multiple Completion Purisima Monitoring Well						
AROMAS RED SANDS WELLS						
COUNTRY CLUB	11S/1E-20G1	495	B	A	A	A
BONITA	11S/1E-21F1	740	B	A	A	A
SEASCAPE	11S/1E-28D1	550	B	A	A	A
ALTIVO	11S/1E-28R3	480	B	A	A	A
SELLS	11S/1E-28R	440	B	A	A	A
SAN ANDREAS	11S/1E-21L	620	B	A	A	A
CWD-4	11S/1E-16N2M	350	M	A	A	A
CWD-10	11S/1E-17R1M	285	M	A	A	A
SC-A1	11S/1E-20E+	530	Q	Q	S	A
SC-A2	11S/1E-29H+	490	Q	Q	S	A
SC-A3	11S/1E-33E+	320	Q	Q	S	A
SC-A4	12S/1E-3C+	550	Q	Q	S	A
SC-A5	11S/1E-28D+	680	Q	Q	S	A
CWD-12		520	Q	-	S	A
+ Multiple Completion Aromas Red Sands Monitoring Well						

B - Bimonthly M - Monthly Q - Quarterly S - Semi-Annually A - Annually