Appendix G: Supplemental Water Supply Information

- Monterey County 2006 Groundwater Management Plan
- DWR Bulletin 118 Central Coast Hydrologic Region

Monterey County
Water Resource Agency

Monterey County Groundwater Management Plan

May 2006

DRAFT

Monterey County Groundwater Management Plan

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List of Abbreviations

AB	Assembly Bill
AF	Acre-feet
AFY	Acre-feet per year
CSIP	Castroville Seawater Intrusion Project
DHS	California Department of Health Services
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment Program
gal/min/ft	gallon per minute per foot of head
GPD	gallons per day
gpm	gallons per minute
GWMP	Groundwater Management Plan
LUFT	Leaking Underground Fuel Tank
MCFCWCD	Monterey County Flood Control and Water Conservation District
MCHD	Monterey County Health Department
MCL	Maximum Contaminant Level
MCWD	Marina Coast Water District
MCWRA	Monterey County Water Resources Agency
MCWRP	Monterey County Water Recycling Projects
MGD	million gallons per day
mg/L	milligrams per liter
MOU	Memorandum of Understanding
MPWMD	Monterey Peninsula Water Management District
MRWPCA	Monterey Regional Water Pollution Control Agency
MSL	Mean sea level
PVWMA	Pajaro Valley Water Management Agency
RWQCB	Regional Water Quality Control Board – Central Coast Region
SB	Senate Bill
SDWA	Safe Drinking Water Act
SLIC	Spills, Leaks, Investigations and Cleanups
SVA	Salinas Valley Aquitard
SVIGSM	Salinas Valley Integrated Groundwater Surface Water Model
SVWP	Salinas Valley Water Project
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WPP	Wellhead Protection Program

Chapter 1 Introduction

In 1992, California State Legislature adopted the Groundwater Management Act (California Water Code Part 2.7, §10753), originally enacted as Assembly Bill (AB) 3030 and amended by Senate Bill (SB) 1938 in 2002. The Groundwater Management Act provided the authority to prepare groundwater management plans and encouraged local agencies to work cooperatively to manage groundwater resources within their jurisdictions and groundwater basins.

Monterey County Water Resources Agency (MCWRA), recognizing that management of its natural water resources is critical to ensuring a long-term sustainable and reliable good quality water supply, has prepared this Groundwater Management Plan (GWMP). The purpose of the GWMP is to provide a comprehensive overview of the Salinas Valley Groundwater Basin and to recommend various management strategies for the basin. Specifically, this document provides the framework for the management of groundwater resources in the Salinas Valley Groundwater Basin (exclusive of the Seaside and Paso Robles subareas) and acts as a guidance document for future groundwater projects.

While this edition of the GWMP focuses on the Salinas Valley Groundwater Basin, MCWRA is responsible for the management of the water resources for all of Monterey County. Future GWMP versions will incorporate the additional groundwater basins in the County.

This document has been prepared in accordance with existing regulations as outlined in the California Water Code (as referenced above) and was prepared in coordination with local agencies and interested residents through public outreach activities.

1.1 Legislative Requirements and Background

The Groundwater Management Act (typically referred to as AB 3030 and codified in California Water Code Section 10753) provides a systematic procedure for an existing local agency to develop a groundwater management plan. The bill language outlined the contents that can be included in a GWMP, potentially including up to twelve specific components. To an extent, a number of these groundwater management activities have been implemented in the Salinas Valley as part of an overall effort by MCWRA, in cooperation with other agencies, landowners, and water purveyors, to achieve sustainable groundwater yield for the benefit of local water supply. The potential components of a groundwater management plan, as listed in Water Code Section 10753.8, include:

- Control of seawater intrusion.
- Identification and management of wellhead protection areas and recharge areas.
- Regulation of the migration of contaminated groundwater.
- Administration of a well abandonment and well destruction program.
- Mitigation of conditions of overdraft.
- Replacement of groundwater extracted by water producers.
- Monitoring of groundwater levels and storage.
- Facilitating conjunctive use operations.
- Identification of well construction policies.
- Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- Development of relationships with state and federal regulatory agencies.
- Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

In 2002, the Legislature adopted Senate Bill 1938 (SB 1938) to amend and add to Water Code Section 10753 *et seq.* regarding the implementation of local groundwater management plans. While the provisions of SB 1938 did not alter the potential components of a local groundwater management plan as listed above, it did require a local agency to meet several additional provisions in order to qualify for funding assistance for groundwater projects or groundwater quality projects via programs administered by the California Department of Water Resources (DWR).

Of the potential groundwater management activities listed in Water Code, several are already being investigated and actively implemented as part of ongoing groundwater management in the Salinas Valley. These ongoing activities include mitigation of overdraft, implementation of conjunctive use, monitoring of groundwater levels and quality, control of seawater intrusion, analysis of basin yield for avoidance of future overdraft, and ongoing analysis and reporting on basin conditions.

Ongoing management efforts include surface and groundwater monitoring, and the compilation of this monitoring and other hydrologic data into a GIS-based management system. The MCWRA has also developed a numerical groundwater flow model of the basin for analysis of basin response to various water supply, recharge, and conjunctive use management alternatives that might be applicable for the basin. Additionally, the MCWRA has developed and is implementing a Nitrate Management Plan for the service area. Finally, strict well construction standards have been adopted to preclude new pumping from the most significantly intruded aquifer and to control potential inter-aquifer movement of intruded seawater.

This GWMP formalizes the management activities currently being conducted in the Salinas Valley Groundwater Basin, and sets forth basin management objectives to guide future management activities. As such, this plan was prepared in accordance with AB 3030 and its amending bills and was designed to be compliant with the requirements set forth in the California Water Code, but it does not follow AB 3030 to the letter. To ensure that the public has had an opportunity to participate in the formulation of this plan (in keeping with the intent of AB 3030 and SB 1938), the preparation of this plan was noticed at the MCWRA BMP Committee meeting on February 22, 2006. A draft of this plan was presented at the BMP meeting on May 4, 2006 and the public was invited to review and comment on this document at the Board of Directors meeting on May 22, 2006.

In summary, MCWRA has already begun developing and implementing important parts of a formal groundwater management program as part of developing reliable local water supply. Groundwater management activities already in place include surface water and groundwater monitoring, formulation and utilization of a database for analysis of groundwater conditions, reporting on conditions in the basin, development and utilization of groundwater flow modeling, and the ongoing conjunctive use of local surface water and groundwater supplies combined with the beneficial use of recycled municipal wastewater to augment irrigation water supplies. The groundwater management plan described herein can be envisioned as a formalization and extension of these ongoing management efforts in the Salinas Valley Groundwater Basin.

1.2 History

The first irrigation system in the state of California is credited to the padres at San Antonio de Padua in the Jolon Valley. In 1773, they constructed an aqueduct on Mission Creek and connected it to mission lands by canal. With the canal water, they were able to raise bountiful crops for which the mission became famous (Anderson, 2000). The success of this system led to the construction of other irrigation systems, including one in 1797 tapping into the Salinas River, and thus irrigated agriculture came to the Salinas Valley.

As the Salinas Valley population grew, irrigation with Salinas River water became unsatisfactory for several reasons. First, unless the irrigated lands were near the river, the elevation of the land limited the distribution system. Second, the river was normally dry in the summertime, providing an unreliable flow of water during the irrigation season, and third, periodic floods wiped out the diversion structures which were expensive to replace. As a result, farmers in the Salinas Valley turned to groundwater, beginning with a hand-dug well by Sam Alsop in 1872. Well drilling did not become a common practice to supply irrigation water until 1897 when farmers began growing sugar beets in the Salinas Valley. The success of using wells to supply water for sugar beets encouraged others to drill for water, and by 1900, wells were common. By 1919, these wells had a combined capacity of 80,000 gallons per minute (gpm), not including factory wells (Anderson, 2000). Concerns about seawater intrusion had begun in the valley by 1930. Combined with continual flooding problems in the valley, these concerns prompted the formation of the Monterey County Flood Control and Water Conservation District in 1947.

Monterey County Flood Control and Water Conservation District (MCFCWCD) became Monterey County Water Resources Agency (MCWRA) in 1991, and the agency's mandate was updated to provide for the control of flood and storm waters, conservation of such waters through storage and percolation, control of groundwater extraction, protection of water quality, reclamation of water, exchange of water, and the construction and operation of hydroelectric power facilities. MCWRA's territory covers all of Monterey County (Figure 1-1), including the Salinas Valley Groundwater Basin (Figure 1-2).

MCWRA's biggest challenge is halting seawater intrusion in the Salinas Valley Groundwater Basin. Seawater intrusion was first studied in the early 1940's, which culminated in the publication of the State of California's Department of Water Resources' *Bulletin 52* in 1946. Since the initial study of intrusion and subsequent report in 1946, seawater intrusion has progressively moved steadily inland. MCFCWCD built Nacimiento Dam in 1957 and San Antonio Dam in 1965 to control flood waters and to release water into the Salinas River for percolation to underground aquifers throughout the summer. The dams did not fully mitigate the continuing problems of seawater intrusion into the basin. In 1977, the State Water Resources Control Board (SWRCB) listed the basin as a candidate for State adjudication, however no further action was recommended at that time. Since this time, MCWRA has continued to study the seawater intrusion mechanisms and, more importantly, has selected and implemented several projects to halt the seawater intrusion.

In the 1980's, MCFCWCD began to be concerned about rising nitrate levels in the groundwater of the basin. Since then, the Agency has worked with several partners, including the SWRCB, the Monterey County Farm Bureau, and Salinas Valley cities to address the problem of nitrate contamination. In 1998, the MCWRA developed a Nitrate Management Plan that identified thirteen elements of nitrate management. Nine of these elements have been implemented, and the Nitrate Management Plan remains an important part of groundwater management in the basin.

1.3 Setting

The Salinas Valley is the largest coastal groundwater basin in Central California. It lies within the southern Coast Ranges between the San Joaquin Valley and the Pacific Ocean, and is drained by the Salinas River. Salinas Valley extends approximately 150 miles from the headwaters to the mouth of the River at Monterey Bay, draining approximately 5,000 square miles (Planert, 2005).

The climate in the Salinas Valley is Mediterranean and is moderated by the Pacific Ocean. Summers are generally mild and winters are cool. Precipitation is almost entirely rain with approximately 87 percent falling from November through April. Mean annual precipitation throughout the mountain ranges surrounding the Salinas Valley ranges from 15 to 60 inches, with about 20 inches occurring near the Gabilan Range to about 25 inches in the Santa Lucia Range. Mean annual precipitation in the valley itself ranges from 10 to 15 inches, with about 11 inches occurring in Soledad to approximately 14 inches at Nacimiento and San Antonio Reservoirs.

Major land uses in the Salinas Valley include agriculture, rangeland, forest, and urban development (Figure 1-3). In general, the forests are located on steep slopes of the surrounding ranges, the rangelands are in the rolling to steep hills, and the agriculture and urban development are located in the valley floor adjacent to Salinas River. Agriculture is the largest user of water in the Salinas Valley with mostly vegetables grown in the northern two-thirds of the Salinas Valley. Less land is cultivated south of King City, where the major crops are grains and wine grapes (USGS, 2005). Since the late 1940's, irrigated acreage within the valley has increased substantially, with steady increases in the 1940's and 1950's and more rapid increases in the 1960's and 1970's. Total irrigated acreage has remained relatively constant since the 1980's. The highest densities of urban development (residential, commercial and industrial) are clustered in the northern part of the valley, in the vicinity of Monterey Bay. Urban acreages have also experienced substantial growth, most of which has occurred in Marina, Castroville, Salinas, Gonzales, Greenfield, Soledad, and King City.

Figure 1-1:

Regional Map of Monterey County

Legend

- Monterey County
- Counties Surrounding Monterey
- Reservoirs
- Rivers
- Cities

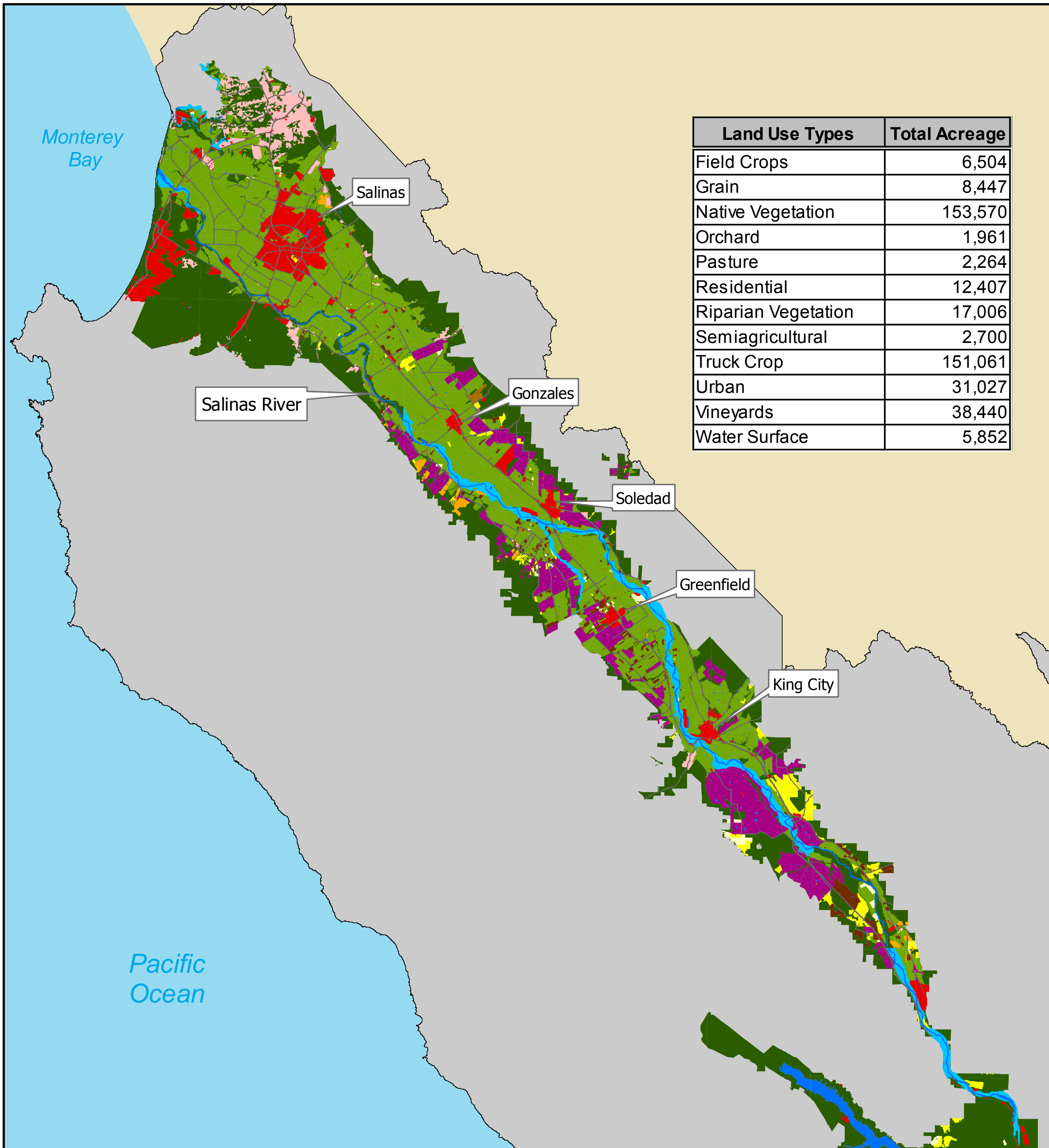
0 10 20 Miles

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for survey or design work.

Figure 1-2:

Salinas Valley Groundwater Basin Management Area

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for survey or design work.



Land Use Types	Total Acreage
Field Crops	6,504
Grain	8,447
Native Vegetation	153,570
Orchard	1,961
Pasture	2,264
Residential	12,407
Riparian Vegetation	17,006
Semiagricultural	2,700
Truck Crop	151,061
Urban	31,027
Vineyards	38,440
Water Surface	5,852

Figure 1-3:

Existing Land Uses within the Basin

Source: Dept. of Water Resources, 1997, Summer Landuse for Monterey County.

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for survey or design work.

1.4 Groundwater Management Area

The groundwater management area which is the subject of this Plan is defined as the extent of the hydrogeological boundaries as generally represented by MCWRA Zone 2C (Figure 1-2). This basin description is not completely consistent with that described by California Department of Water Resources (DWR) in *Bulletin 118, California's Groundwater* (2003), therefore, Table 1-1 has been included to aid the reader in correlating the basin hydrogeology described herein with the nomenclature used by the California Department of Water Resources (DWR) in *Bulletin 118*.

Table 1-1
Comparison of Basin Definitions

GWMP Basin Definition	DWR Basin Definition*
Pressure Area	180/400 Foot Aquifer
Eastside Area	East Side Aquifer
Forebay Area	Forebay Aquifer
Arroyo Seco Area	Forebay Aquifer
Upper Valley Area	Upper Valley Aquifer
Paso Robles Area	Paso Robles Area
Seaside Basin	Seaside Area
North County (considered part of the East Side Area)	Langley Area
Pressure Area	Corral de Tierra Area

* As defined in *Bulletin No. 52, Salinas Basin Investigation*.

1.5 Report Overview

The balance of this GWMP is organized to first establish a set of management objectives for the basin; to describe existing groundwater basin conditions, including areas of concern and identified problems; to present historical and projected water demands in the basin; and finally to present a set of groundwater management actions which, in aggregate, are the elements of this groundwater management plan.

To that end, this GWMP has been divided into the following five sections:

- **Chapter 1** is an introduction to the GWMP and the history of groundwater use in the Salinas Valley;
- **Chapter 2** presents the basin management objectives for the Salinas Valley Groundwater Basin;
- **Chapter 3** is a description of the Basin's hydrogeologic setting and its current use;
- **Chapter 4** summarizes the groundwater management plan elements; and
- **Chapter 5** is a list of references used during the preparation of this report.

Chapter 2 Basin Management Objectives

The majority of water supplies in the Salinas Valley are developed from local groundwater. A very small amount of surface water is directly diverted from the Arroyo Seco for water supply purposes, and recycled municipal wastewater is now being used to supplement local groundwater for agricultural irrigation in the northern portion of the basin. Prior to 1957, groundwater recharge in the valley occurred from a combination of precipitation, streamflow, and applied irrigation. Since 1957, beginning with the construction of Nacimiento Dam, followed a decade later by the construction of San Antonio Dam, the MCWRA has actively been managing the surface waters on two key tributaries of the Salinas River for a combination of flood control and groundwater recharge purposes, plus some ancillary recreational purposes at the reservoir locations. The primary focus of the groundwater-related management of surface water in the Nacimiento and San Antonio Reservoirs has been the regulated release of water from those reservoirs to maintain Salinas River streamflow to maximize groundwater recharge from the streambed. Most recently, since 1998, MWCRA and the Monterey Regional Water Pollution Control Agency (MRWPCA) have cooperated in the implementation of the Monterey County Water Recycling Projects (MCWRP) which include the Castroville Seawater Intrusion Program (CSIP) and the Salinas Valley Reclamation Plant (SVRP) to provide advanced treatment of municipal wastewater and deliver it to augment groundwater supplies for agricultural irrigation on about 12,000 acres in Castroville.

The development and operation of the Nacimiento and San Antonio Reservoirs and the development of recycled water use for irrigation, represent water resource and water supply management actions, aimed at what can be considered to be the overall management objectives for the Salinas Valley Groundwater Basin. In no priority, those basin management objectives are:

- Development of Integrated Water Supplies to Meet Existing and Project Water Requirements.
- Determination of Sustainable Yield and Avoidance of Overdraft.
- Preservation of Groundwater Quality for Beneficial Use.

Each of these basin management objectives is discussed in further detail below.

2.1 Basin Objective 1: Development of Integrated Water Supplies to Meet Existing and Projected Water Requirements

This objective includes the integrated use of surface water, groundwater, and recycled water, potentially augmented by desalinated brackish and/or saline water, to directly and indirectly (e.g. through groundwater recharge) meet existing and projected water requirements for agricultural, municipal, and other water supplies in the basin. Since groundwater pumping for other uses is also from the same aquifer system, as developed for large irrigation and municipal water supplies, this objective is also applicable. The CSIP project is an illustration of a supplemental water supply derived from recycled municipal wastewater that has reduced groundwater pumping in the intruded portion of the basin. The currently planned Salinas Valley Water Project (SVWP) is an illustration of another supplemental water supply, in this case derived from surface water released from Nacimiento and San Antonio Reservoirs for a combination of groundwater recharge and direct diversion for irrigation water supply. These projects, in combination with other planned projects, are intended to accomplish this first overall management objective for the basin.

2.2 Basin Objective 2: Determination of Sustainable Yield and Avoidance of Overdraft

This objective is intended to assess and analyze groundwater basin conditions as a basis for determining a range of operational yield values to minimize groundwater overdraft and the undesirable effects associated with it. In effect, this objective consists of:

- quantification of the yield of the groundwater basin with recognition to variations in the occurrence of groundwater in different geographic areas of the overall basin,
- recognition of historical impacts such as seawater intrusion near the coast and groundwater storage declines in the East Side Area, and
- implementation of existing and future management measures to address those issues.

The assessment of groundwater basin conditions and the resultant operational yields will have the primary objective of managing groundwater within perennial or sustainable yield, (i.e. correcting or avoiding overdraft and associated undesirable effects). In addition to correcting or avoiding traditional overdraft symptoms and effects (e.g. long-term groundwater level decline, loss of groundwater storage, onset of land subsidence, and groundwater quality degradation), continuing reservoir operations to maximize storage in conjunction with releasing optimal amounts of surface water to achieve downstream in-channel recharge and planned off-channel diversion is key to achieving this overall objective.

2.3 Basin Objective 3: Preservation of Groundwater Quality for Beneficial Use

Historical development of groundwater for irrigation and municipal water supply throughout the Salinas Valley has resulted in some impacts to groundwater quality. The most notable of those impacts has been the intrusion of seawater into two of the coastal aquifers, the Pressure180-Foot and Pressure 400-Foot Aquifers. Of lower profile, but of varying significance to the use of groundwater for water supply, have been the addition of dissolved minerals and the increasing concentrations of those minerals in the groundwater basin. While a large focus of supplemental water supply development has historically been on stopping seawater intrusion, the hydraulically closed basin, with an associated lack of groundwater outflow from the basin and the resultant accumulation of dissolved minerals, are also of long-term concern. In light of both groundwater quality issues, this objective for the basin reflects a desire to maintain the utility of the basin for agricultural and municipal water supply and for other beneficial uses, and to avoid any further loss of groundwater storage and associated availability for water supply. Included in this management goal will be the investigation of any groundwater contamination problems, through cooperation with responsible parties and regulatory agencies, or through independent action.

2.4 Challenges to Achieving Objectives

Conceptually, the preceding objectives translate into general preservation of groundwater levels in the basin, including fluctuations through seasonal demands and through variable local hydrologic conditions (wet and dry periods). As discussed in more detail in Chapter 3, the hydrogeologic setting in the basin has resulted in varying groundwater conditions in different parts of the basin:

- largely “full” basin conditions throughout the Upper Valley and Forebay subareas,
- nearly stable conditions through the Pressure Area, albeit somewhat buffered by intrusion from Monterey Bay, and
- declining groundwater levels in the northern East Side subarea.

In terms of the intended management as described in this GWMP, understanding these widely varying conditions is essential to achieving the basin objectives. The general stability of groundwater levels and storage in the Upper Valley and Forebay subareas indicate that groundwater is sustainable at current levels of development; however, that apparent sustainability is contingent on continuation of reservoir operations and in-stream recharge. By the same token, further development in those areas could induce additional stream recharge, intercepting stream releases intended for downstream diversion to achieve the ultimate halting of seawater intrusion and subsequent sustainability of groundwater in the Pressure Area. Integrated management actions will need to be complementary to continue to make beneficial use of groundwater while also preserving the intended conjunctive use of supplemental surface water with other supplemental water supplies for the accomplishment of all three of the basin objectives discussed above.

Chapter 3 Basin Description

3.1 Regional Geology and Stratigraphy

The Salinas Valley Groundwater Basin is located within Monterey and San Luis Obispo Counties, along the central California coast approximately 100 miles south of San Francisco. The Salinas Valley Groundwater Basin is a northwest-trending, elongated, intermontane valley formed by the Salinas River and its tributaries. The basin extends from the northwest at Monterey Bay to the southeast for about 80 miles inland, and is bound on the west by the Sierra De Salinas and Santa Lucia Range, on the east by the Gabilan and Diablo Ranges, on the northeast by the San Andreas Fault, and by a series of aligned and interconnected faults on the southwest. The Salinas Valley ranges in width from approximately 10 to 14 miles on its northwestern end near the city of Salinas, to approximately 3 miles at its southeastern end near Bradley. The altitude of the valley floor increases from zero to about 400 feet above sea level as it extends north to south from Monterey Bay to Bradley.

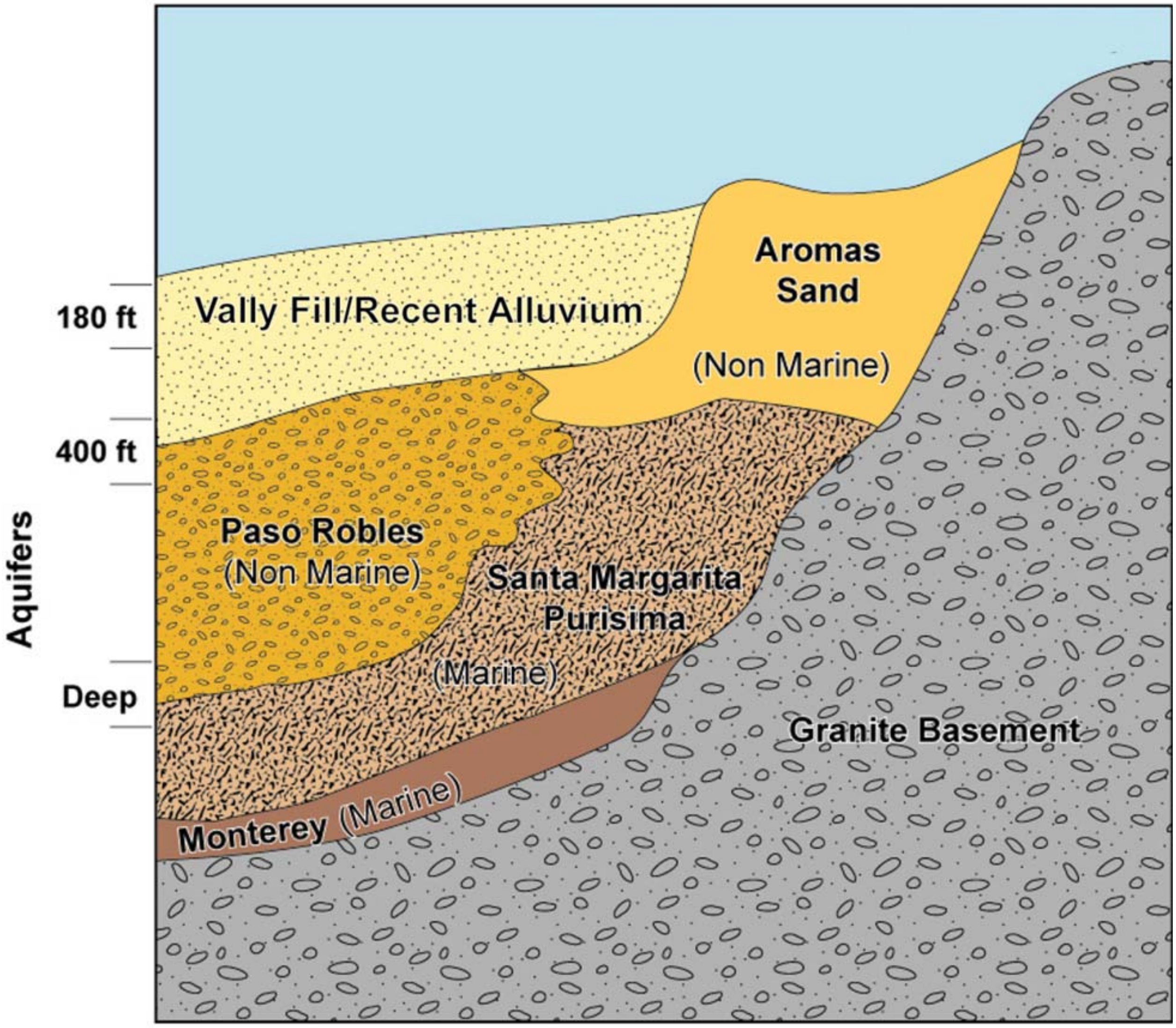
The Salinas Valley Groundwater Basin is a geologically complex area resulting from Pleistocene interactions of a fluvial-estuarian (river/estuary) depositional environment of the ancestral Salinas River with regional eolian and marine depositional environments. Major geological units are described below, from the oldest to the most recent. Figure 3-1 provides a conceptual illustration of the basin's geological stratigraphy.

The **basement rocks** in the Salinas Valley Groundwater Basin consist of Mesozoic "Salinian Block" granite that is exposed along a ridge on the western side of the Vergeles fault, approximately 5 miles northeast of Prunedale. The basement rock formation is inferred to dip at approximately 8 degrees towards the Monterey Bay, based on contoured well log data. Overlying the basement rock is the **Monterey Formation,** a Miocene-aged marine shale and mudstone generally composing the base of water-bearing sediments in the northern Salinas Valley area.

The Upper Miocene to Pliocene **Santa Margarita Formation,** consisting of friable arkosic sandstone underlies the Purisima Formation in the Seaside Basin and may directly underlie the Paso Robles formation in areas where the Purisima formation is absent. The Pliocene **Purisima Formation** overlies the Santa Margarita Formation, and is comprised of poorly consolidated marine, sandstone, siltstone, and claystone beds. Overlying the Purisima Formation is the middle to lower Pleistocene **Paso Robles Formation**. This formation consists of lenticular beds of sands, gravel, silt and clay and may indicative of an alluvial fan or braided stream depositional environment

The Pleistocene-age **Aromas Sand** unconformably overlies the Paso Robles Formation and consists mainly of cross-bedded sand with some clayey layers. This formation is a distinct red or brownish color, and typically thickens towards the coast. The Aromas Sands is locally overlain by **Valley Fill**, a unit composed of alternating interconnected, complex beds of fine-grained and coarser-grained estuarine and fluvial deposits. The Valley Fill ranges from approximately 25 feet to 100 feet thick. Overlying the Valley Fill is approximately 10 to 75 feet of **Recent Alluvium** deposited by the Salinas River. The Recent Alluvium is present in the more established drainages, and typically has low to moderate permeability. The Recent Alluvium also includes perched groundwater zones that have not generally been affected by seawater intrusion, but have, in some cases, been impacted by percolation from agriculture. DWR (1973) identifies approximately 20 feet of sandier material underlying the lower permeability zones at the base of the Recent Alluvium.

Figure 3-1: Conceptual Illustration, Salinas Valley Basin Geology



Source: Montgomery Watson, Salinas River Basin Water Resources Management Plan, (1994).

3.2 Surface Water Features

The entire Salinas River Basin is drained by the Salinas River and its tributaries except for the approximately 600 square miles of the hydrologically-separate Soda Lake watershed (located in San Luis Obispo County, southeast of the Salinas Valley). Originating in the south near Santa Margarita, the Salinas River flows to the northwest approximately 120 miles to the Pacific Ocean at Monterey Bay with the mouth of the Salinas River occurring north of the City of Marina.

The Salinas River system drains two major tributaries controlled by dams, the Nacimiento and San Antonio Rivers. The Nacimiento River watershed encompasses approximately 330 square miles, and the San Antonio River watershed covers approximately 328 square miles. Nacimiento and San Antonio reservoirs regulate flows from their corresponding rivers to the Salinas River. Nacimiento and San Antonio Rivers contribute approximately 200,000 acre-feet per year (AFY) and 70,000 AFY, respectively, to the Salinas River. In addition, there is flow in the upper Salinas River, predominantly during the winter months (MCWRA, 2001b).

Major gauged tributaries of the Salinas River within the groundwater basin include the Arroyo Seco, Gabilan Creek, El Toro Creek, and San Lorenzo Creek, with Arroyo Seco being the largest tributary. Arroyo Seco flows, as they enter the basin, annually average approximately 122,000 AFY, some of which becomes recharge before joining the Salinas River. The magnitude of this recharge has been estimated to be between 40,000 and 60,000 AFY (MCWRA, 2001b). Approximately 966 square miles of the watershed drain into the groundwater basin from many tributaries originating in the Gabilan, Santa Lucia, and Sierra de Salinas Mountains.

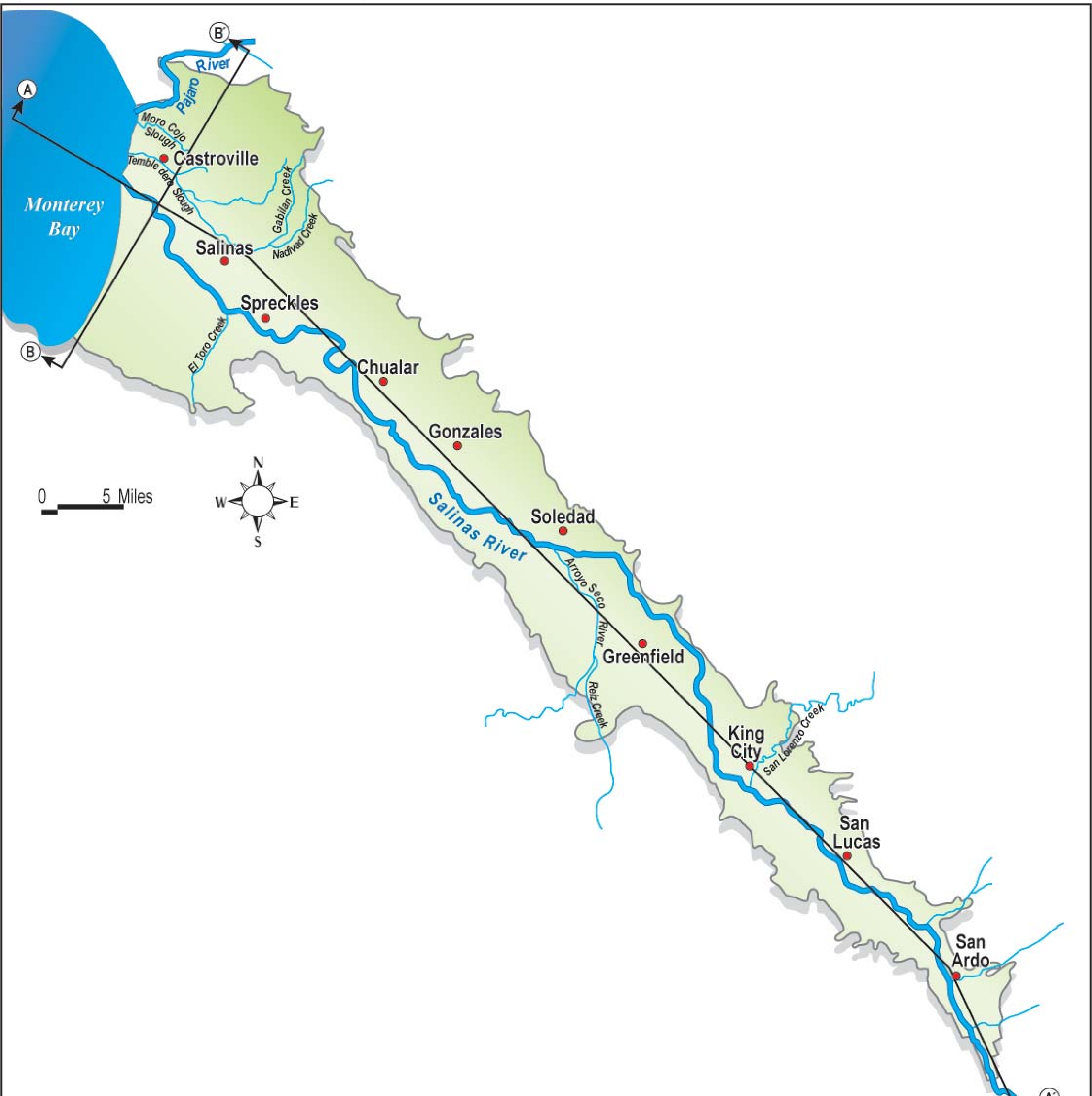
Mean annual discharge on the Salinas River ranges from 309,000 AFY at Spreckels to 343,000 AFY at Bradley (Kennedy-Jenks, 2004), with the majority of these discharges occurring during the months of November through March. During the spring and summer months, the Nacimiento and San Antonio reservoirs are operated by MCWRA to minimize the outflow to the ocean, while maximizing recharge to the groundwater basin via the Salinas River bed.

3.3 Hydrogeology

The Salinas River Basin encompasses approximately 561 square miles and generally has been separated into five hydrologically-linked subareas: the Pressure Area, East Side Area, Forebay Area, Arroyo Seco Area, and the Upper Valley Area. These areas were defined based on the sources of groundwater recharge and the nature of the stratigraphy (Figure 1-2). The Pressure Area extends from offshore beneath Monterey Bay to Gonzales. In this area, massive clay units of estuarine origin divide the unconsolidated deposits into an upper aquifer (commonly referred to as the Pressure 180-Foot Aquifer), a lower aquifer (commonly referred to as the Pressure 400-Foot Aquifer), and a deep aquifer (commonly referred to as the Deep or 900-Foot Aquifer) (Ferriz, 2001, Greene, 1970). Within the Pressure Area, all three aquifers are confined.

The East Side Area encompasses the area east of the line that joins Gonzales and Salinas, up to the base of the Gabilan Range. Groundwater in the East Side Area is typically under semi-confined conditions (Ferriz, 2001). The Forebay Area lies southeast of the Pressure and East Side Areas from Gonzales to approximately two miles south of Greenfield. The Arroyo Seco Area is located southwest of the Forebay Area and extends from the confluence of the Arroyo Seco and the Salinas River south to approximately three miles south of Greenfield, where its southern boundary meets that of the Forebay Area. The Upper Valley Area lies further southeast from where it meets the southern boundary of the Forebay and Arroyo Seco Areas (two miles south of Greenfield) southeast to Bradley. Each of these units is described in further detail below. Figures 3-2, 3-3 and 3-4 provide conceptual cross-sections of basin’s hydrogeology.

Figure 3-2: Location of Schematic Geologic Cross-Sections



Source: Montgomery Watson, Salinas River Basin Water Resources Management Plan, (1994).

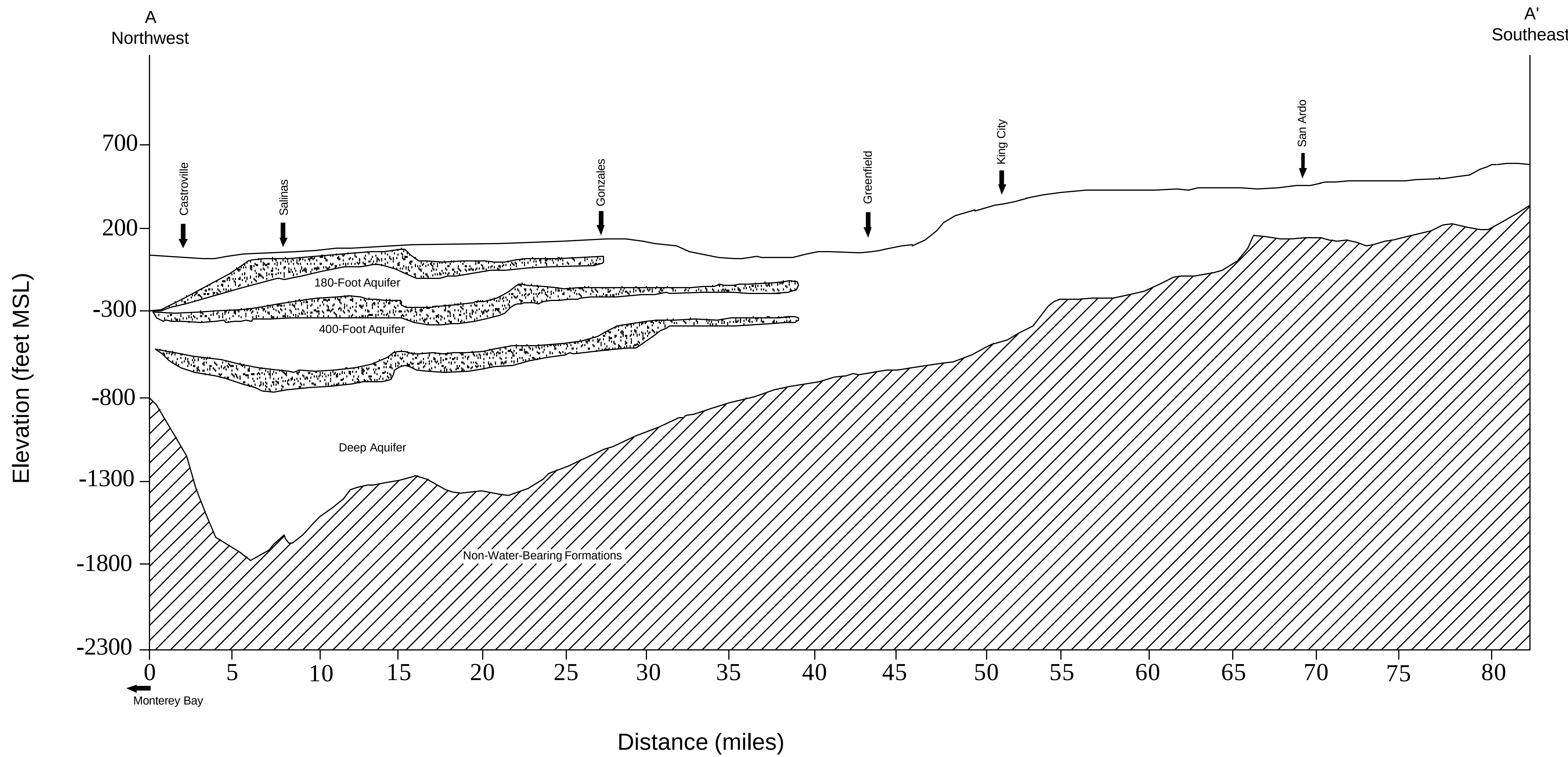


Figure 3-3
Schematic Geologic
Cross-Section A-A'

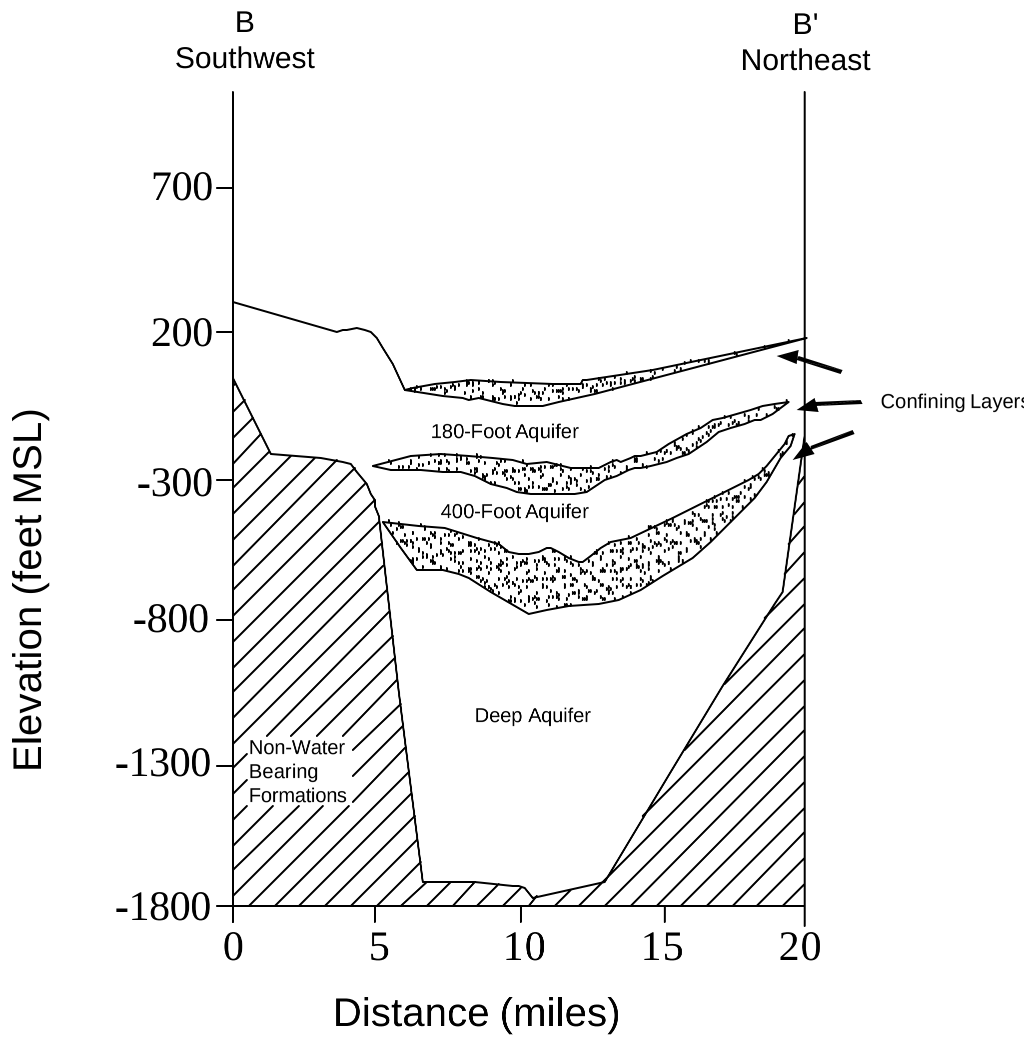


Figure 3-4
Schematic Geologic
Cross-Section B-B'

In general, groundwater flow is down the valley from the headwaters of the Salinas River to San Ardo to Monterey Bay. Between San Ardo and Monterey Bay, the average hydraulic gradient is 0.001 ft/ft, similar to the gradient of the Salinas River (Ferriz, 2001). Locally, however, pumping depression cones have significantly modified the piezometric surface. In general, specific capacity values (used to describe the productivity of wells in a formation) for wells in the Salinas Valley Groundwater Basin are smallest in the northern end of the basin and tend to increase to the south (Ferriz, 2001).

3.3.1 Basin Subareas

3.3.1.1 Pressure Area

The Pressure Area is located in the northern part of the Salinas Valley, west of the East Side Aquifer. This subarea consists of three aquifers, and the area itself is sometimes referred to by the names of these aquifers: the Pressure 180-Foot Aquifer, the Pressure 400-Foot Aquifer, and the Deep Aquifer (also referred to as the 900-Foot Aquifer).

Shallow groundwater in the Pressure Area is typically found perched on top or located within the Salinas Valley Aquitard (SVA), a blue or yellow sandy clay formation overlying and confining the Pressure 180-Foot Aquifer (Kennedy/Jenks, 2004). The SVA has been identified (Kennedy/Jenks, 2004) as scattered, thin, laterally discontinuous sandy layers typically less then 100 feet thick in the area west of Salinas, thinning to approximately 25 feet near Salinas (DWR, 1973) and pinching out east of Salinas. The formation typically extends vertically from the ground surface to approximately -100 to -150 feet mean sea level (MSL) and extends laterally from Monterey Bay south to Chualar (approximately ten miles south of Salinas) and from Fort Ord east to an irregular contact at the Pressure Area/East Side Area boundary. The SVA thins and pinches out near the Pressure Area/East Side Area boundary, and is therefore roughly the demarcation between fluvial and alluvial fan facies (Kennedy/Jenks, 2004). Two potential gaps in the SVA were identified by Kennedy/Jenks Consultants (2004). These gaps may create locally unconfined or semiconfined conditions in the Pressure 180-Foot Aquifer.

Underlying the SVA is the Pressure 180-Foot Aquifer, the uppermost laterally extensive aquifer in the Northern Salinas Valley. The location of this aquifer within the Salinas Valley is variable and spans more than one stratigraphic unit. DWR (1970 & 1973) correlates the aquifer to lower valley terrace deposits and upper Aromas Sands, whereas Leedshill-Herkenhoff, Inc. (1984) correlates the aquifer with the Paso Robles Formation. DWR (1973) and Harding ESE (2001) assign the aquifer to Valley Fill, and Greene (1970) places it in the lower Valley Fill – upper Aromas Sands Formations.

Consisting predominantly of sand and gravel depositions with subordinate sand/clay and gravel/clay components, the shape of the sand bodies of the Pressure 180-Foot Aquifer appear to reflect their fluvial deposition origin – lenticular shape sand in what appears to be a fluvial channel migrating and shifting over time (Kennedy/Jenks, 2004). The depth and thickness of the Pressure 180-Foot Aquifer is variable, but generally the top is encountered at about -100 feet MSL, increasing in depth slightly from southeast near Salinas to the northwest near the ocean. Individual sand bodies are typically 100 to 150 feet thick, although they range in thickness from less than 50 feet to greater than 200 feet where the Pressure 180-Foot Aquifer and the Pressure 400-Foot Aquifer appear to be in contact (Kennedy/Jenks, 2004; DWR, 1970 and 1973).

The Pressure 180-Foot Aquifer is recharged where SVA pinches out (e.g., Forebay Area) and is exposed on the floor of the Monterey Bay (Todd, 1989). Generally consisting of hydraulically-connected sand and gravel beds with intervening clay layers (Harding ESE, 2001; Greene, 1970, Kennedy/Jenks, 2004), the Pressure 180-Foot Aquifer is sometimes separated into the Lower 180-Foot Aquifer, which is considered confined under the SVA, and the Upper 180-Foot Aquifer which is also called the uppermost-perched zone or Shallow Groundwater Aquifer and is unconfined. Specific capacities of wells completed in the Pressure 180-Foot Aquifer are reported to be on the order of 60 gal/min/ft.

Underlying the Pressure 180-Foot Aquifer is the 180/400-Foot Aquitard. This aquitard separates the Pressure 180-Foot Aquifer and Pressure 400-Foot Aquifer and consists of clay or clay and sands layers. The aquitard is widespread in the Salinas Valley basin and varies in thickness and quality from thick layers of blue clay to thin layers of brown clay (MCFCWCD, 1960). The aquitard is rarely as much as 200 to 250 feet thick and more commonly 50 to 100 feet thick (Kennedy/Jenks, 2004). MCFCWCD (1960) describes two "holes" in the aquitard, one under the Salinas River near Blanco and the other under the old Salinas River bed near the coast. The Pressure 180-Foot Aquifer and Pressure 400-Foot Aquifer also appear to be interconnected in places between Salinas and Chualar and south of Chualar (MCFCWCD, 1960). Brown (1986) describes the aquitard as generally lenticular in shape and discontinuous in places, notably near the mouth of the Salinas River and near Fort Ord. Todd (1989) indicates several areas between Castroville and the coast where the aquitard is thin or absent.

The Pressure 400-Foot Aquifer underlies the 180/400-Foot Aquitard and is an areally extensive layer of coarse- and fine-grained sand and gravel typically encountered between 270 and 470 feet bgs. The top of the aquifer is typically encountered at -300 to -350 feet MSL (Kennedy/Jenks, 2004), however the depth of the top of the aquifer, thickness of the aquifer and degree of complex interbedding with clay layers is quite variable (Thorup, 1976) with more variability in depth, thickness and discontinuity from the southeast to the northwest (i.e., in the downstream direction). This transition may be due to transition from a higher-energy fluvial depositional environment near the present location of the city of Salinas to a lower-energy environment toward the Monterey coast (Kennedy/Jenks, 2004). DWR (1970, 1973) indicates that near Salinas, the aquifer consists of a single thick permeable bed approximately 200 feet thick which, northwest towards Castroville, divides into two 25-foot thick sandy beds and one 100-foot thick sandy bed separated by clay layers. The uppermost beds of the aquifer merge and interfinger with the lower beds of the Pressure 180-Foot Aquifer in some areas (DWR, 1970, 1973) where the intervening aquitard thins or pinches out. DWR (1970, 1973) and Greene (1970) suggest that the upper portion of the Pressure 400-Foot aquifer correlates to the Aromas Sands and the lower portion correlates to the Paso Robles Formation. Thorup (1976) correlates this aquifer with the Paso Robles Formation.

The term Deep Aquifer is typically used to describe the 800-Foot Aquifer, 900-Foot Aquifer, 1,000-Foot Aquifer, and the 1,500-Foot Aquifers (Harding ESE, 2001) which Thorup (1976) also correlates with the Paso Robles Formation. The Deep Aquifer and Pressure 400-Foot Aquifer are separated by an aquitard that can be several hundred feet thick (Kennedy/Jenks, 2004).

3.3.1.2 East Side Area

The East Side Area is located in the northeast portion of the Salinas Valley from approximately Santa Rita to Gonzales, east of the Pressure Area. This area is generally bounded by the foothills of the Gabilan Range on the northeast and State Highway 101 on the southwest (Kennedy/Jenks, 2004). Hydrogeologically, this area is characterized by a series of connected alluvial fans that are built up by small streams draining the Gabilan Range, creating a sloping, fan-shaped topography that is visible today (Kennedy/Jenks, 2004). DWR originally defined this area in 1946 as the area bounded by the Pressure Area on the west and the Forebay Area on the south, containing unconfined groundwater that is typically recharged by streams draining the Gabilan Range and directly from precipitation during wet years.

The East Side Area generally consists of a poorly bedded sequence of gravel, sand, silt, and sandy and gravelly clay (MCFCWCD, 1960). On the outwash slopes of the present-day alluvial fans, red and yellow clays are currently being formed in discontinuous lenses by the decomposition of alluvial gravels (MCFCWCD, 1968). These alluvial fan (Quaternary) sediments grade into and interfinger with fluvial sediments deposited by the ancient Salinas River that flowed northwestward toward Monterey Bay (Kennedy/Jenks, 2004).

The sands and gravel beds of the East Side area are generally thinner and less continuous than in the Pressure Area, and typically do not correlate well between boreholes due to the relatively thin-bedded nature of the gravel and sand, the discontinuity of beds in both the lateral and down-dip direction, and the complex erosional nature of streams feeding the alluvial fans resulting in complex records of sediment deposition (Kennedy/Jenks, 2004). The principal blue clay beds that are found in the Pressure Area are rare in the East Side Area. Studies in the area suggest that the blue clay onlaps and pinches out onto alluvial fan facies in the East Side Area (Kennedy/Jenks, 2004).

The Pressure 180-Foot and Pressure 400-Foot Aquifer zones are not observed in the East Side Area, however, the East Side sediments can be time-stratigraphically correlated to equivalent zones (Kennedy/Jenks, 2004). The designation of these stratigraphic zones has been used to analyze the lateral connectivity between the aquifers of the Pressure and East Side Areas. Earlier studies (e.g., MCFCWCD, 1960; SGD, 1990; Hall, 1992; and J.M. Montgomery Engineers, 1993) have designated the East Side Area aquifers as the East Side Shallow Zone and the East Side Deep Zone. As reported by DWR in 1946, the aquifers in this area are generally unconfined with some localized areas of slight pressure due to local confinement. Specific capacities of wells completed in the East Side Area have been reported to be on the order of 26 gal/min/ft.

3.3.1.3 Forebay Area

The Forebay Area is located in the center of the Salinas Valley and extends from the town of Gonzales in the north to approximately three miles south of Greenfield. The Forebay Area is bounded by the Pressure and East Side Areas on the northwest, the Arroyo Seco Area on the southwest, and the Upper Valley Area on the southeast. The area is bounded on the west by the contact of Quaternary terrace deposits of the subarea with Mesozoic metamorphic rocks (Sur Series) or middle Miocene marine sedimentary rocks (Monterey Shale) of the Santa Lucia Range, and to the east by contact of Quaternary terrace deposits or alluvium with granitic rocks of the Gabilan Range. Along the southern margins of the Forebay Area, the Pancho Rico Formation is the equivalent of the Purisima Formation. The depth to the base of fresh water in the subarea ranges from about 200 feet at the eastern valley margin to 2,200 feet at the western margin (Durbin, 1978) with a sharp rise from about 2,000 to 1,000 feet at the southern subarea margin (DWR, 2004).

The primary water-bearing units in the Forebay Area are the same (stratigraphically-equivalent layers) as those found in the Pressure and East Side Areas; however the near-surface confining unit and SVA do not extend into the Forebay Area. Groundwater in this area is unconfined and occurs in lenses of sand and gravel that are interbedded with massive units of finer grained material (DWR, 2004). The Deep or 900-Foot Aquifer found in the Pressure and East Side Areas is also present in the Forebay Area. This deeper aquifer consists of alternating layers of sand-gravel mixtures and clays rather than a distinct aquifer and aquitard (Montgomery Watson, 1994). Specific capacities for wells in the Forebay Area have been reported to be on the order of 100 gal/min/ft.

The Forebay Area is so named as it is the primary zone for recharge of the Pressure and East Side Areas of the Salinas Valley Groundwater Basin. This occurs primarily due to the pinching out of the SVA at the southern end of the Pressure and East Side Areas and the northern end of the Forebay Area. The principal sources of groundwater replenishment in the Forebay Area are percolation from the Salinas River (and its tributaries) and groundwater outflow from the Upper Valley Area and the Arroyo Seco Area (DWR, 1946).

3.3.1.4 Arroyo Seco Area

Although considered a separate area in this GWMP, the Arroyo Seco Area is an area sometimes considered to be within the Forebay Area. The Arroyo Seco Area is considered herein as a separate area due to a different (non-Salinas River) source of water replenishment.

The Arroyo Seco Area encompasses approximately 22,000 acres on the west side of the Salinas Valley between Mission Soledad and the bluff line about two miles south of Greenfield (DWR, 1946). This area is the alluvial fan of the Arroyo Seco, and adjoins the Forebay Area on the north and east and the Upper Valley Area on the south. The principal source of replenishment for the Arroyo Seco Area is the percolation from the channels of the Arroyo Seco and its tributary Reliz Creek (DWR, 1946). The primary water-bearing units of the Arroyo Seco Area consist of alluvial fill with a predominant heavy strata of boulders and coarse gravels to depths of 500 to 700 feet. Moderate layers of coarse sand and reddish yellow clay are also found within the fill (DWR, 1946).

3.3.1.5 Upper Valley Area

The Upper Valley Area is located in the southernmost portion of the Salinas Valley and shares its northwest boundary with the Forebay Area. The Upper Valley Area extends from approximately three miles south of Greenfield to about six miles south of the town of San Ardo. The area is bounded to the west by the contact of the Quaternary Paso Robles Formation or Quaternary terrace deposits with middle Miocene marine sedimentary rocks (Monterey Shale) of the Santa Lucia Range. To the east, the boundary is the contact of the Paso Robles Formation or of the Quaternary terrace deposits or alluvium with the Early to Middle Pliocene Pancho Rico Formation of the Gabilan Range (DWR, 2004). This boundary also represents a constriction of the Valley floor caused by encroachment from the west by the composite alluvial fan of the Arroyo Seco and Monroe Creek. The southern boundary is the Sargent Creek drainage and its projection across the valley. The narrow constriction of the Salinas Valley at this location generally separates the upper and lower Salinas River drainage basins.

The primary aquifer in this area is unconfined and generally considered a single unit. This aquifer consists of unconsolidated to semi-consolidated and interbedded gravel, sand, and silt of the Paso Robles Formation, alluvial fan, and river deposits. Deposits west of the Salinas River tend to be coarser grained than those to the east. These deposits represent the lateral equivalents of the 180-Foot and 400-Foot Aquifers found in the lower Salinas Valley (Pressure and East Side Areas) (DWR, 2004). However, no aquitard comparable to those separating the aquifers in those areas exists in the sedimentary sequence of the Upper Valley Area. As shown in Figure 3-3, the Deep Aquifer is not present in the Upper Valley Area due to the southward shallowing of the basement complex (DWR, 2004). Specific capacities for wells completed in the Upper Valley Area are reported to be on the order of 150 gal/min/ft.

3.3.2 Groundwater Recharge and Discharge Areas

In general, recharge in the lower basin portion of the Salinas Valley is largely by infiltration along the channel of the Salinas River (~30% of total recharge) and its tributaries (~20% of total recharge). The second major source of recharge is irrigation return water (~40%). The remaining recharge is from infiltration and percolation of precipitation over the valley floor, subsurface inflow, and seawater intrusion (Ferriz, 2001).

Outflow from the basin is dominated by pumping (~95% of outflow) and evapotranspiration by riparian vegetation (~5% of outflow). DWR (1995) estimated basin inflow at 532,000 AFY and basin outflow at 550,000 AFY. As documented in the *Draft Environmental Impact Report/Environmental Impact Statement for the Salinas Valley Water Project* (MCWRA, 2001b), basin overdraft has averaged approximately 19,000 AFY during the 1949 to 1994 hydrologic period, with an average annual seawater intrusion rate of 11,000 AF. Current uses of groundwater in the basin are for peak irrigation supply within the CSIP area (to supplement recycled water supplies), primary agricultural irrigation outside the CSIP area, and municipal supply.

3.3.2.1 Pressure Area

Based on investigations by Montgomery Watson (1998) and MCWRA, in areas north of Salinas, 90% of groundwater pumping occurs from the Pressure 400-Foot Aquifer with 5% pumping occurring from the Deep Aquifer and smaller amounts from Pressure 180-Foot Aquifer. In areas south of Salinas, 60% of pumping is from the Pressure 400-Foot Aquifer while 40% of pumping is from Pressure 180-Foot Aquifer. Use of the Pressure 400-Foot Aquifer is most limited in the vicinity of Chualar to Gonzales (MCWRA, 2001b). Due to the impermeable nature of the clay aquitard above the Pressure 180-Foot Aquifer, direct recharge is insignificant. Recharge for the Pressure 180-Foot Aquifer is from underflow originating in southeastern basin areas such as the Arroyo Seco Area and the Salinas River bed adjacent to the East Side Area (DWR, 2004) or Forebay Area. Recharge for the Pressure 400-Foot Aquifer is reported to occur in the Arroyo Seco Area and Forebay Area (Harding ESE, 2001).

3.3.2.2 East Side Area

Most of the groundwater extractions (~40%) occurring from the East Side Area are from the East Side Shallow Zone, with remaining extractions from the intermediate East Side Deep Zone. The East Side Area appears to have been one the natural sources of recharge to the adjacent Pressure Area, however, historical groundwater level declines in the East Side Area have caused an apparent reversal of groundwater gradient from the Pressure Area to the East Side Area.

Groundwater recharge in East Side Area is through percolation from small streams that flow from the Gabilan Range and, to a lesser degree, from precipitation recharge (DWR, 1946; Kennedy/Jenks, 2004).

3.3.2.3 Forebay Area

The majority of the pumping occurring in the Forebay Area is from the shallow aquifer zone of the Forebay Area; however deeper wells are believed to be pumping from a deeper Forebay aquifer zone. Although the Deep Aquifer, as defined in the Pressure and East Side Areas, is presumed to extend into the Forebay Area, fewer wells are known to be pumping from this aquifer in the Forebay Area.

Recharge in this area is from the alluvial fan of the Arroyo Seco and its major tributary Reliz Creek, from other stream flows in the area, from Nacimiento and San Antonio Rivers as well as the Salinas River and the reservoirs. About half again as much recharge results from applied irrigation water (Montgomery Watson, 1998). Recharge from direct precipitation is minor and probably occurs only in wet years. Subsurface flow from the Upper Valley subarea and subsurface flow from the east and west subarea boundaries account for the remainder of the recharge (DWR, 2004).

3.3.2.4 Arroyo Seco Area

Pumping occurring in the Arroyo Seco Area is from the single unconfined aquifer, and recharge in the area is predominantly from the Arroyo Seco and its primary tributary, Reliz Creek. Soils in the Arroyo Seco Area are characterized by coarse texture, 85% of which are deep, uniform, and highly permeable. The Arroyo Seco streambed is also characterized by permeable sediments, described by DWR as a broad gravel wash between the head of the wash, or cone, and its confluence with the Salinas River near the outer fringe of the unit, eight miles to the north.

3.3.2.5 Upper Valley Area

Most wells in the Upper Valley Area are relatively shallow and lie along the course of the Salinas River. Groundwater recharge in the Upper Valley Area is primarily from percolation through channel deposits of the Salinas River and tributary drainages (DWR, 1946a). A lesser volume of recharge results from the percolation of precipitation along the valley margins and from applied irrigation water (LHI, 1985). Subsurface flow from precipitation recharged through the Pancho Rico Formation east of the subarea and minimal subsurface flows from drainages along the Salinas River account for the remainder of the recharge (DWR, 2004).

3.3.3 Groundwater Levels

Groundwater levels in the Salinas Valley basin have been measured regularly by MCWRA in monitoring and production wells. (See Appendix A for detailed information on the current groundwater monitoring program). Historical groundwater elevations reflect drawdown and depressed groundwater levels during the summer irrigation season followed by recovery of groundwater elevations in the winter. Figure 3-5 shows the general direction of groundwater flow in the Salinas Valley Groundwater Basin. Figure 3-6 shows changes in average groundwater levels as measured in selected wells in the Pressure, East Side, Forebay and Upper Valley Areas over the period of record.

Legend

- Cities
- Rivers
- Reservoirs
- GW Flow Direction

Subareas

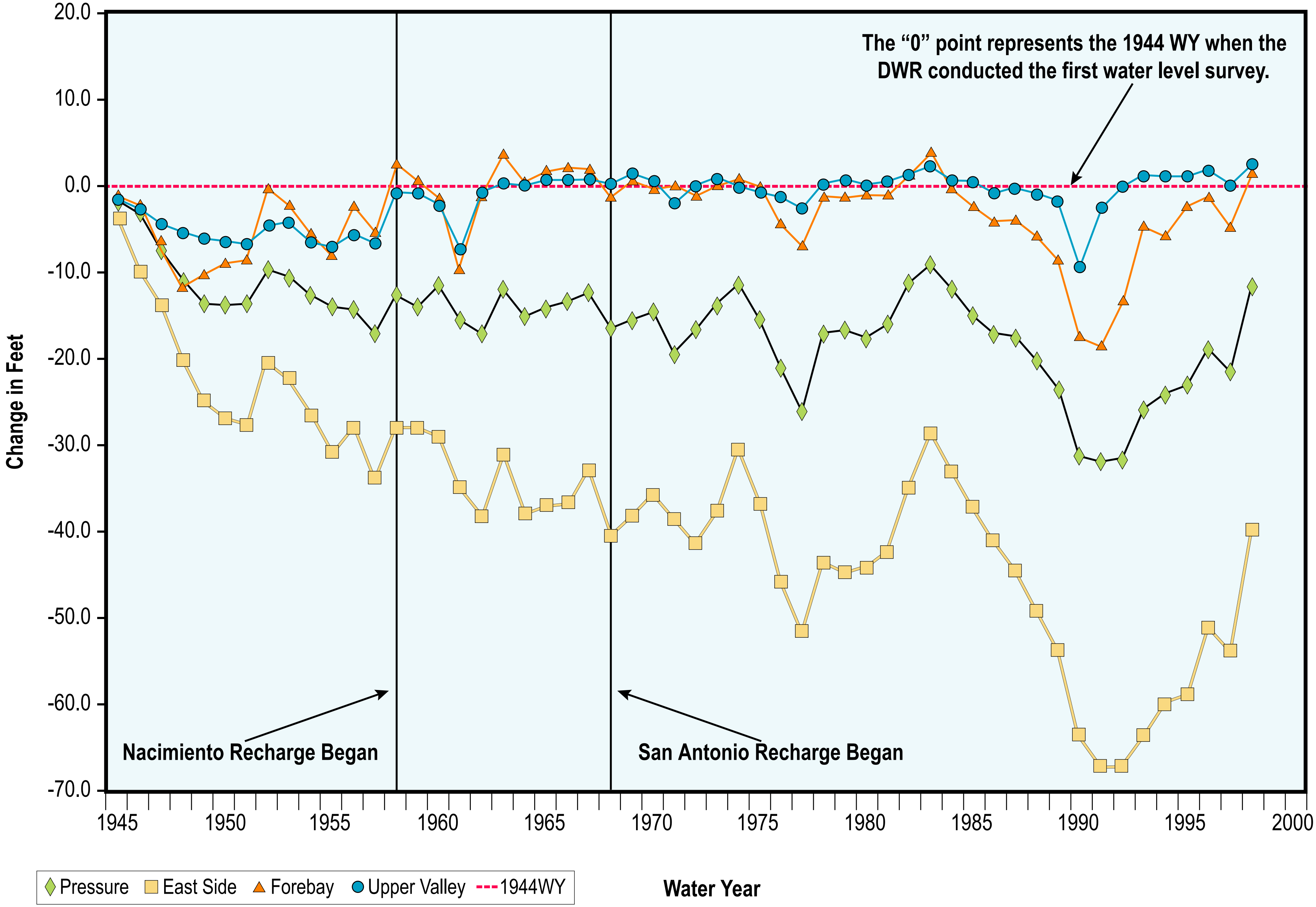
- Pressure
- East Side
- Upper Valley
- Forebay
- Arroyo Seco
- Region Boundary

0 10 20 Miles

Figure 3-5

General Regional Groundwater Flow

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for survey or design work.



Note: Data after 1995 is preliminary and subject to change

Figure 3-6:
Changes in Groudwater Levels
(1945-1998 Annual Average)

Urban demands are typically the highest in the summer months due to landscaping requirements, whereas agricultural demands are high due to the growing season for most crops. Based on Figure 3-6, it can be seen that recharge from releases from the Nacimiento and San Antonio Reservoirs have kept the Forebay and Upper Valley water levels relatively stable while the East Side Area has experienced the greatest decrease in water levels since the 1930's. Water levels in the Pressure Area have appeared to be relatively stable, however, the appearance of stability can be deceiving. The Pressure Area abuts the ocean, which provides a huge seawater reservoir of water for inflow (seawater intrusion). What Figure 3-6 does not show is that, over time, as freshwater was extracted from the Pressure 180-Foot Aquifer, seawater has intruded into the aquifer replacing freshwater providing relatively stable water levels but degrading water quality in the aquifer. Groundwater elevations in both the Pressure 180-Foot Aquifer and Pressure 400-Foot Aquifer have had below sea level groundwater elevations for many years, and the differences between the elevations in these two aquifers have been fairly consistent. Both Todd (1989) and Harding ESE (2001) indicate that, although the aquitard between the two aquifers is discontinuous in places, it is sufficient to consistently support a vertical head difference. However, the consistent below sea-level groundwater elevations in both aquifers create a situation that promotes seawater intrusion.

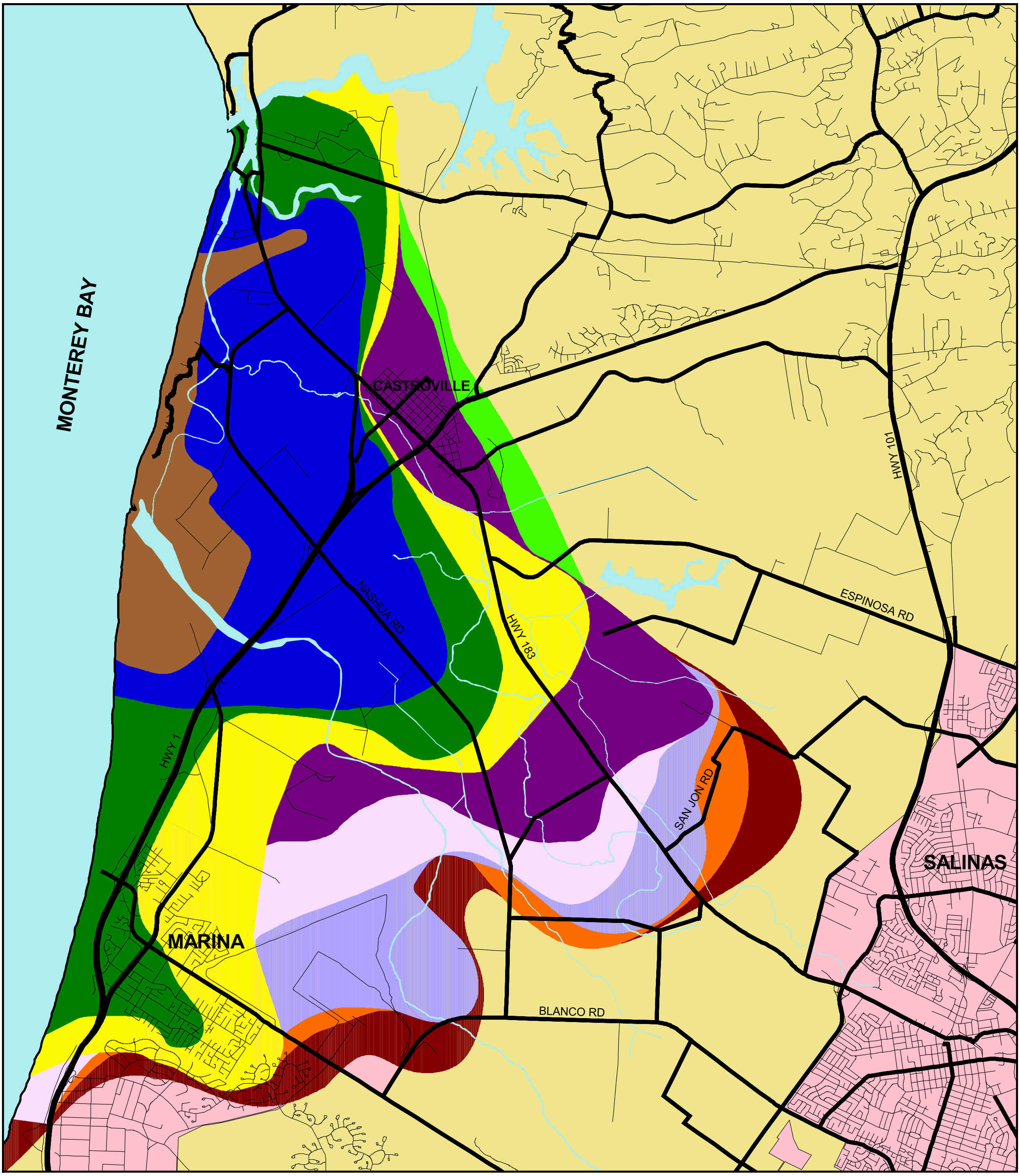
3.4 Groundwater Quality

For the most part, groundwater quality in the Salinas Valley is acceptable for most uses, being typically characterized as Class I or II irrigation water by the California Department of Water Resources (DWR) standards (Rancho San Juan, 2004). Sources of groundwater contamination typically include both point and nonpoint sources of contaminants. Domestic and industrial wastewater disposal discharges are typically point sources. Nonpoint sources represent isolated, scattered, and/or mobile discharges or sources of contamination and may include agriculture and ranching operations, natural mineralization, automobile emission byproducts and urban runoff.

The *Central Coast Regional Water Quality Control Plan* (RWQCB, 1994) establishes groundwater quality objectives for Central Coast groundwater basins that are necessary for the reasonable protection of beneficial uses and for the prevention of nuisance in the Salinas Basin. Parameters for which groundwater objectives are established include total dissolved solids (TDS), nitrate, bacteria, organic chemicals, chemical constituents, and radioactivity. Available water quality data indicate two potential groundwater quality problems in the Salinas Valley Groundwater Basin: TDS (resulting predominantly from seawater intrusion) and nitrate. Recently, there are groundwater quality impacts by VOCs, MTBE, PERC, and TCE in the former Ft. Ord area. All other areas of general water quality, including chemical constituents and radioactivity, are considered to be within reasonable ranges for protection of beneficial uses within the Salinas Basin.

3.4.1 Seawater Intrusion

Seawater intrusion was first noted in the upper-most aquifer of the Pressure Area in the 1930's and led to the abandonment of several wells screened in the Pressure 180-Foot Aquifer. By 1946, seawater intrusion was noted to extend approximately one mile inland and underlay approximately 4,200 acres of land. This degradation led to the development of the Pressure 400-Foot Aquifer, which also became impacted by seawater by the late 1960's. By 1970, seawater intrusion extended four miles inland in the Pressure 180-Foot Aquifer and two miles inland in the Pressure 400-Foot Aquifer. MCWRA uses the Secondary Drinking Water Standard upper limit of 500 mg/L concentration for chloride to determine the seawater intrusion front. As of 2005, an estimated 25,676 acres of land overlie groundwater containing 500 mg/L of chloride or greater in the Pressure 180-Foot Aquifer. Approximately 11,823 acres of land overlie the Pressure 400-Foot Aquifer where it contains chloride concentrations of 500 mg/L or greater (MCWRA, 2001b). Figures 3-7 and 3-8 show the most recent extent of seawater intrusion in the Pressure 180-Foot and Pressure 400-Foot Aquifers in the Pressure Area.



Historic Seawater Intrusion Map

Pressure 180-Foot Aquifer - 500 mg/L Chloride Areas

Figure 3-7

Legend:

Seawater Intruded Areas By Year

- 1944
- 1965
- 1975
- 1985
- 1993
- 1997
- 1999
- 2001
- 2003
- 2005

- Major Roads
- Minor Roads
- Incorporated Areas
- Monterey County
- Water Bodies

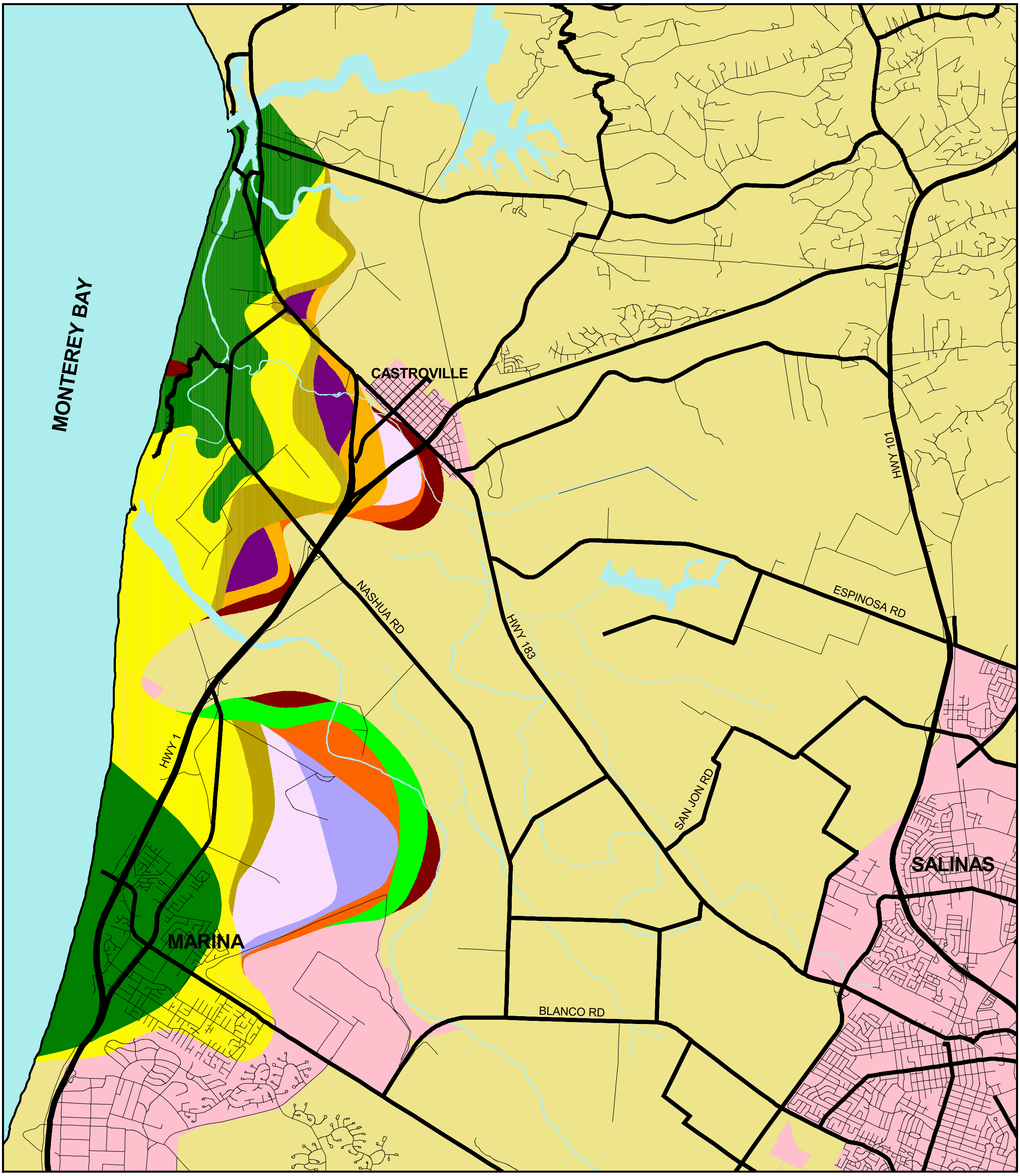
N E S W

1 0 1 2 Miles

Source: MCWRA, 2005 Water Quality Data

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: February 27, 2006



Historic Seawater Intrusion Map

Pressure 400-Foot Aquifer - 500 mg/L Chloride Areas

Figure 3-8

Legend:

Seawater Intruded Areas By Year

- 1959
- 1975
- 1985
- 1990
- 1993
- 1995
- 1997
- 1999
- 2001
- 2003
- 2005

- Major Roads
- Minor Roads
- Incorporated Areas
- Monterey County
- Water Bodies

1 0 1 2 Miles

Source: MCWRA, 2005 Water Quality Data

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: February 27, 2006

Groundwater in the Pressure 180-Foot Aquifer is typically calcium sulfate to calcium sodium bicarbonate sulfate in nature (JSA, 1990 and DWR, 2004). Where seawater has intruded into this aquifer, groundwater is typically characterized by sodium chloride to calcium chloride with TDS values ranging from 223 to 1,013 mg/L, with an average value of 478 mg/L (DHS, 2000). Seawater intrusion in this aquifer was occurring at a rate of approximately 14,000 AFY prior to initiation of operations of the MCWRP in April of 1998. The MCWRP delivers recycled water as irrigation water in lieu of groundwater pumping, thereby slowing the annual rate of seawater intrusion.

3.4.2 Nitrate

Locally-elevated nitrate contamination has been documented throughout the Salinas Basin by MCWRA. Although nitrate occurs naturally in groundwater, elevated groundwater nitrate concentrations can result from overlying agricultural practices, animal confinement facilities, sewage treatment plants, individual septic tank systems, and municipal and industrial runoff.

Table 3-1

2001 Summary of Nitrate-NO_3 Concentrations for 349 Water Quality Study Wells in the Salinas Valley Basin.

Aquifer / Subarea	Number of Wells Sampled	Mean Average Nitrate as NO_3 (mg/L)	Number of Wells Greater than DWS*	Percent of Wells Greater than DWS*	Minimum Concentration Nitrate as NO_3 (mg/L)	Median Concentration Nitrate as NO_3 (mg/L)	Maximum Concentration Nitrate as NO_3 (mg/L)
Pressure 180-Foot	67	41	17	25%	Less than 1.0	13	458
Pressure 400-Foot	93	10	6	6%	Less than 1.0	3	102
Pressure 180- and 400-Foot	160	22	23	14%	Less than 1.0	4	458
East Side	53	83	24	45%	1.0	39	465
Forebay	88	59	47	53%	Less than 1.0	52	230
Upper Valley	48	64	26	54%	Less than 1.0	48	226
Locations Without P-400 Ft.	**256**	**60**	**114**	**45%**	**Less than 1.0**	**37**	**465**
All Locations	**349**	**47**	**120**	**34%**	**Less than 1.0**	**19**	**465**

(Source: Monterey County Water Resources Agency, March 24, 2003)

* DWS = Drinking Water Standard (45mg/L Nitrate as NO_3)

The Pressure 400-Foot Aquifer has lower nitrate concentrations due the clay aquitard (intervening clay layers between the Pressure 180-Foot and Pressure 400-Foot Aquifers) that limit nitrated from percolating deeper into the basin (MCWRA, 2001b).

3.4.3 Other

Overall, groundwater in the Salinas Valley Groundwater Basin remains of good quality. In localized areas, the basin does experience lower quality groundwater, typically resulting from the recharge of poor quality surface water. For example, recharge from drainages along the western slope of the Gabilan Range have created poor quality groundwater (>2000 μmhos/cm) along the eastern boundary. This results in elevated concentrations of sulfate, boron, TDS, and conductivity in many areas (DWR, 1969). Additionally, the Salinas area has experienced poorer groundwater quality due to organic chemical releases and/or elevated arsenic concentrations. Poor surface water quality in San Lorenzo Creek and the other streams which drain the east side of the Diablo Mountain Range, and irrigation water which has leached through soils containing a high concentration of salts, also contribute to elevated groundwater mineral content in the East Side and Upper Valley Areas. Furthermore, many wells in the Arroyo Seco Area also showed high levels of sulfate concentrations.

The Salinas Valley Groundwater Basin has also experienced isolated groundwater plumes resulting from the release of toxic substances to the environment. Sites overseen by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) are maintained on the Hazardous Waste and Substances Site List, typically known as the Cortese List. The former Fort Ord military base is currently the only active site in Monterey County where groundwater contamination is suspected or has been identified. The recent closure of Fort Ord and its conversion has resulted in active investigations of groundwater impacts in several areas, including at three inactive landfills, two fire drill areas, the motor pool area, the 707th Maintenance Facility, and 14 other miscellaneous areas. The California Regional Water Quality Control Board, Central Coast Region (RWQCB) maintains both the SLIC (Spills, Leaks, Investigation and Cleanup) list and the LUFT (Leaking Underground Fuel Tank) list, listing sites at which toxic substances have been released to soil and/or groundwater. A current search on these lists indicates that there are 24 open SLIC cases and approximately 280 open LUFT cases in Monterey County.

3.5 Groundwater Use

Groundwater is the source for almost all agricultural and municipal water demands in the Salinas Valley. Agricultural water use represents approximately 90% of all water use in the Salinas Valley. The two existing water supplies that do not rely upon groundwater are a small amount of surface water diverted from the Arroyo Seco for agricultural uses and, beginning in 1998, approximately 13,000 AFY of recycled water application in the MCWRP/CSIP service area. Water use in any given year is a function of land use, water use efficiencies, as well as hydrologic and meterologic conditions.

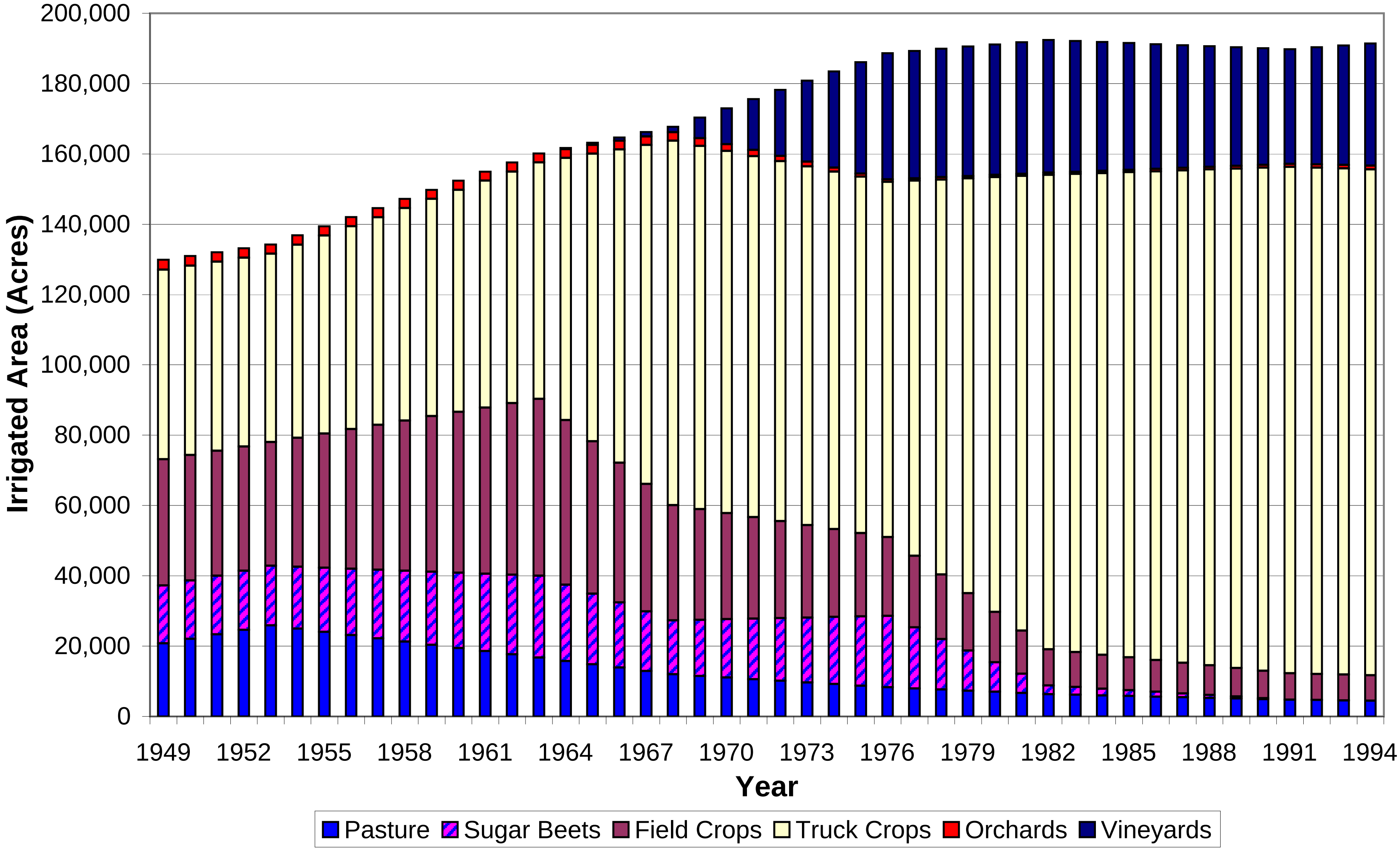
The primary land use in the Salinas Valley is agriculture. Since the late 1940's, irrigated acreage within the valley has increased substantially with steady increases in the 1940's and 1950's and rapid increases in the 1960's and 1970's. Total irrigated acreage has remained relatively constant since the 1980's. Urban acreage, however, is experiencing continued growth predominantly in the Castroville, Gonzales, Greenfield, King City, Marina, Salinas, and Soledad areas (Figure 3-9).

Estimated historical groundwater use (as determined via groundwater use reporting, anecdotal records and groundwater modeling) were summarized in the *Draft Environmental Impact Report/Environmental Impact Statement for the Salinas Valley Water Project* (MCWRA, 2001) and are shown in Figure 3-10.

Groundwater use in the Salinas Valley peaked in the early 1970's, and has been generally declining since. Projections of groundwater use within the Salinas Valley show a continuing decline due primarily to changes in crop patterns, continued improvements in irrigation efficiency, and some conversion of agricultural lands to urban land uses. The proposed SVWP will provide approximately 9,700 AFY of diverted Salinas River water that will replace the remaining groundwater pumping in the CSIP area. In addition, there is consideration for expansion of the use of recycled water for agricultural and other irrigation needs. The City of Soledad is presently implementing a water recycling project.

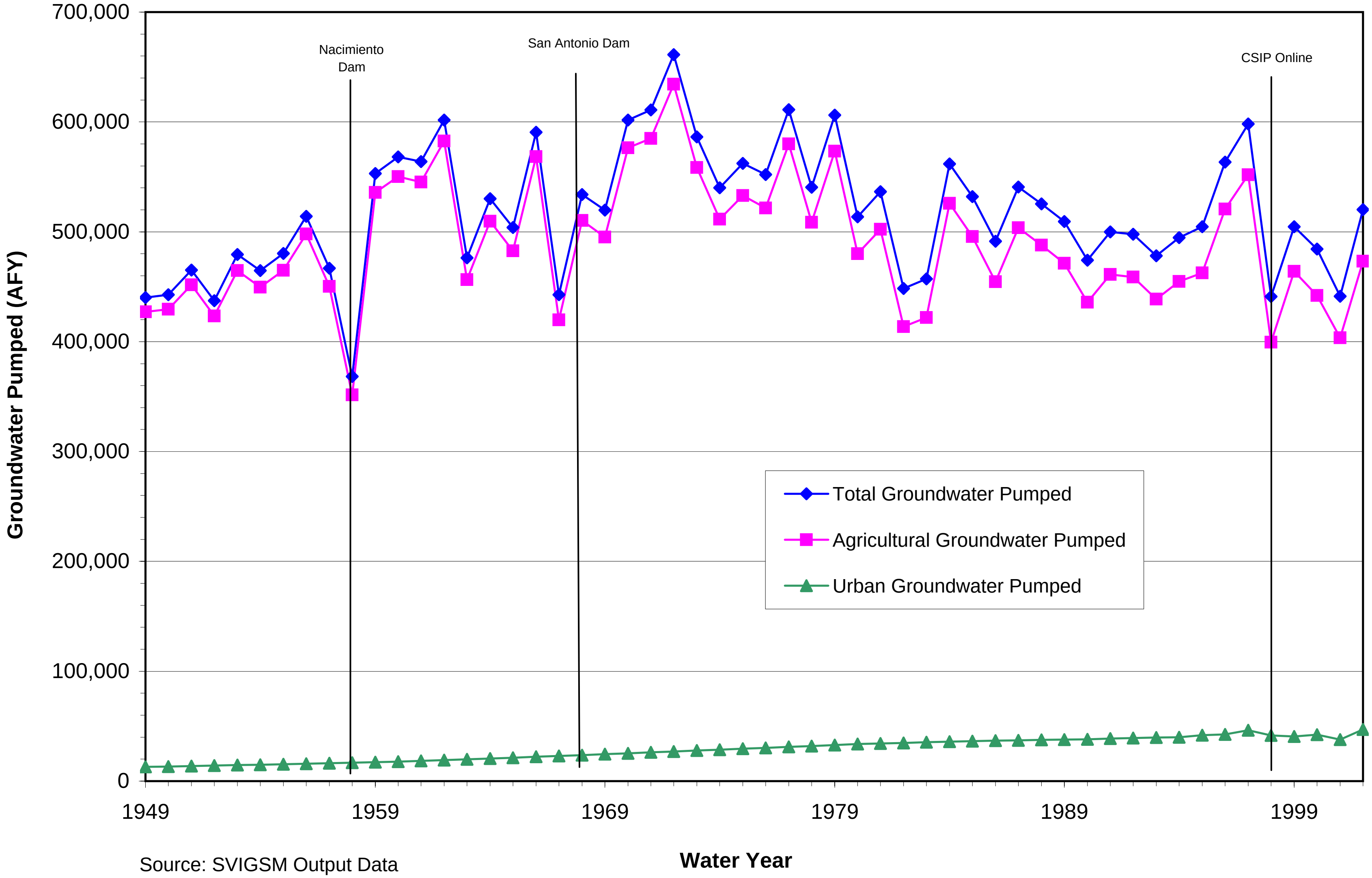
Urban water use has been increasing, as shown in Figure 3-10. These increases in urban water use, particularly on non-irrigated lands in the northern portion of the Salinas Valley, will place additional pressure on groundwater pumping. As a result, alternative sources of urban water supplies and relocation of groundwater pumping are being evaluated and implemented. Marina Coast Water District (MCWD) is presently implementing the Water Augmentation Project that provides recycled water for turf irrigation and desalinated ocean water for other municipal and industrial uses. Similar projects are being evaluated for other northern Salinas Valley communities, including a regional desalination facility at Moss Landing. Such alternative sources of supply will be necessary to meet the increasing urban water supply needs while protecting groundwater resources.

Figure 3-9
Irrigated Acreage in the Salinas Valley



Source: SVIGSM

Figure 3-10
Estimated Groundwater Pumping in the Salinas Valley



Source: SVIGSM Output Data

Chapter 4 Groundwater Management Plan Elements

To continue historical groundwater management activities and to address identified concerns and issues related to water supplies in the Salinas Valley, this GWMP has been developed to provide a framework for present and future actions. As has been the case for the groundwater management activities by MCWRA and other local entities over the past 50 years, it is expected that this GWMP will be updated as new data are developed, particularly in light of the key role that groundwater monitoring (water levels and quality) has played, and will continue to play, in defining groundwater conditions and aquifer response to management actions.

The basin management objectives for the Salinas Valley Groundwater Basin (as described in Chapter 2 of this document) include the following:

Objective 1: Development of Integrated Water Supplies to Meet Existing and Projected Water Requirements

Objective 2: Determination of Sustainable Yield and Avoidance of Overdraft

Objective 3: Preservation of Groundwater Quality for Beneficial Use

To accomplish these objectives, with recognition of the opportunities encouraged by Water Code Section 10750 *et seq*. for local agency management of groundwater resources, this GWMP incorporates a number of components which are divided into a set of 14 elements. The Plan elements formally recognize the effectiveness of a number of ongoing water resource management activities. They further recognize the need for additional activity, such as expanded conjunctive use of supplemental surface water and recycled water, with groundwater. They also reflect the wider focus on groundwater management, such as continuing cooperation with the municipal water purveyors and other groundwater users in the basin to address the impacts of regional resource opportunities and/or challenges. In summary, this GWMP will enable MCWRA, landowners, and municipal water purveyors to continue use of groundwater for regular water supply, to expand their use of groundwater during dry periods or emergencies, and to work with each other and with other agencies via implementation of the following management plan elements.

Plan Element 1: Monitoring of Groundwater Levels, Quality, Production, and Subsidence

Plan Element 2: Monitoring of Surface Water Storage, Flow, and Quality

Plan Element 3: Determination of Basin Yield and Avoidance of Overdraft

Plan Element 4: Development of Regular and Dry Year Water Supply

Plan Element 5: Continuation of Conjunctive Use Operations

Plan Element 6: Short-Term and Long-Term Water Quality Management

Plan Element 7: Continued Integration of Recycled Water

Plan Element 8: Identification and Mitigation of Groundwater Contamination

Plan Element 9: Identification and Management of Recharge Areas and Wellhead Protection Areas

Plan Element 10: Identification of Well Construction, Abandonment, and Destruction Policies

Plan Element 11: Continuation of Local, State and Federal Agency Relationships

Plan Element 12: Continuation of Public Education and Water Conservation Programs

Plan Element 13: Groundwater Management Reports

Plan Element 14: Provisions to Update the Groundwater Management Plan

Each of these plan elements is discussed in detail in the following sections.

4.1 Plan Element 1: Monitoring of Groundwater Levels, Quality, Production and Subsidence

MCWRA operates multiple programs to monitor groundwater levels in the Salinas Valley Groundwater Basin. These programs are as follows:

- One set of 80 Salinas Valley wells are measured monthly for groundwater elevations.
- Groundwater levels from approximately 130 wells in the northern Salinas Valley are collected during a single 12-hour period each August to monitor groundwater level during a time of high pumping stress.
- Each December, approximately 280 Salinas Valley wells are measured for groundwater elevations.

Quarterly groundwater level figures are also prepared for each subarea and are posted on MCWRA's website at http://www.mcwra.co.monterey.ca.us/.

MCWRA tests 90 wells in the seawater intrusion zone (Pressure and East Side Areas) during the summer months for a subset of chloride, nitrate, conductivity, calcium, magnesium, potassium, pH, sodium, sulfate, and alkalinity. Over 300 additional wells are also tested yearly for the same constituent set, with wells sampled on a rotating basis. Additionally, whenever MCWRA samples an agricultural well, the water quality results, including nitrate concentrations, are reported back to the well owner. Nitrate is reported as pounds per acre-inch of water which allows growers to adjust fertilizer application accordingly.

Agricultural, urban, and industrial operators of wells located in Zones 2A and 2B with a discharge pipe having an inside diameter of at least three inches are required by ordinance to report groundwater extractions to MCWRA on an annual basis. MCWRA publishes extraction data reports summarizing extractions by subarea, and water use. MCWRA maintains the Water Resources And Information Management System (WRAIMS) database in which groundwater elevation, quality, and extraction data are stored.

Additional information on current groundwater monitoring and reporting programs in the Salinas Valley can be found in Appendix A.

It should be noted that there is a lack of historical subsidence in the Salinas Valley and a low potential for it to occur due to a combination of geologic conditions and lack of depressed groundwater levels, as discussed in Chapter 3 above. Consequently, no formal subsidence monitoring is planned (i.e. no extensometers, fixed-point ground surveys or remote sensing). However, as part of the implementation of this Plan, if the analysis of any groundwater supply concept indicates the potential for subsidence attributable to lower groundwater levels, this Plan will be expanded to incorporate subsidence monitoring or other appropriate action (e.g. re-distributed or reduced pumping) to avoid unacceptable results of inelastic subsidence.

4.2 Plan Element 2: Monitoring of Surface Water Storage, Flow and Quality

The geologic and hydrologic configuration of the Salinas Valley Groundwater Basin and the Salinas River system that overlies the basin is such that the Salinas River and its tributaries can directly interact with the aquifer in many parts of the basin. The net result of the overall river-aquifer configuration is that groundwater is readily recharged by periodic natural surface water flows and by regulated reservoir releases that maintain stream flow to recharge the aquifers beyond the rainfall/runoff season and through the irrigation season.

Recognition of the importance of supplemental surface water is essential toward the overall management of groundwater as described and developed in this GWMP. Knowledge of surface water storage, stream flows, and surface water quality is essential to continued incorporation of surface water into management of the aquifer system. Thus, monitoring of reservoir storage, reservoir releases, surface water flows and surface water quality will be part of this GWMP; and the resultant data will be incorporated in the database that results from implementation of this element and Plan Element 1. Surface water monitoring protocols (including monitoring locations, types of measurements, frequencies, etc.) are included in Appendix A of this document.

Continuation of managed stream flows for groundwater recharge and for planned diversion to augment water supplies in the western portion of the basin is a logical component of ongoing groundwater management. Thus, reservoir storage, releases, stream flow and surface water quality directly relate to groundwater basin yield and avoidance of overdraft (Plan Element 3), development of regular and dry-year water supply (Plan Element 4), continuation of conjunctive use operations (Plan Element 5) and salinity management (Plan Element 6).

This Plan Element is included in the overall groundwater management plan to address surface water storage, flows and quality in concert with analysis and management of groundwater levels and quality. The implementation of this plan element will be essential to accomplish of all three management objectives for the basin.

4.3 Plan Element 3: Determination of Basin Yield and Avoidance of Overdraft

In order to accomplish all the objectives for the basin, it will be essential to have an understanding of the yield that can be supported by the basin on both a regular and intermittent (dry period) basis. Such determinations of basin yield will be made to accomplish the main objective of operating within the yield of the groundwater basin and avoidance of overdraft. While a large part of the overall basin has experienced nearly constant historical groundwater conditions, to a large extent, as a result of the proactive recharge of the basin with releases from surface storage in Nacimiento and San Antonio Reservoirs, there have been historical short-term declines in groundwater levels and storage during extended dry periods when there has been less water to release for groundwater recharge. Such conditions are not uncommon in any conjunctive use setting. In the Salinas Valley, groundwater storage is sustained by supplemental recharge during wet and normal periods, but groundwater is removed from storage during dry years or dry periods. The observation of those historical groundwater conditions, in combination with knowledge of pumping from the aquifer system, has led to current operational practices as well as general expectations regarding the approximate yield of parts of the overall groundwater basin.

Generally, more notable than the preceding have been two historic problems in the basin: seawater intrusion in the western edge of the basin, and lowered groundwater levels and reduced storage in the northern East Side Area. Observation of these conditions has led to the long-term study of those problems, consideration of various alternative solutions, and initial implementation of a two-part effort to stop seawater intrusion. That effort incorporates existing recycled water use (Plan Element 7) and planned conjunctive use operations (Plan Element 5) to deliver supplemental water for irrigation in the Castroville area, thus allowing the land to remain in production while reducing local groundwater pumping. The historical groundwater decline in the East Side Area remains to be addressed via implementation of this Plan.

As described in other parts of this GWMP, MCWRA has developed and used an integrated numerical surface water and groundwater model to analyze both surface water and groundwater response to existing and planned management actions that involve reservoir operations, groundwater recharge, and delivery of both recycled water and supplemental surface water to be used in-lieu of groundwater pumping. To date, the primary use of that model has been to analyze the effectiveness of the combined CSIP and SVWP programs to stop seawater intrusion in the greater Castroville area. It is expected that the model will be updated, as appropriate, and used in the implementation of this Plan Element to assess the yield of the basin under existing and future land use conditions as well as future ranges of surface water availability, groundwater development, recycled water use, and other potential supplemental water supply availability through varying hydrologic conditions (i.e. wet and dry periods that affect both surface water availability and groundwater recharge).

The ultimate intent of this Plan Element is to develop an understanding and quantification of the yield of the basin under varying hydrologic conditions and developing local cultural conditions so that groundwater development and use can be managed in such a way as to meet an appropriate fraction of total water demand while avoiding levels of groundwater use that would result in overdraft conditions. Thus, implementation of this Plan Element is essential to accomplishing the first and second management objectives for the basin.

4.4 Plan Element 4: Development of Regular and Dry Year Water Supply

Historical observation of basin operations, most notably since the addition of surface water conservation and reservoir operations for groundwater recharge in the 1950's and 1960's, has shown that a large portion of the groundwater basin, primarily through the Upper Valley and Forebay Areas, can be maintained at a near-full level through wet and normal hydrologic years that provide sufficient surface water to sustain in-stream groundwater recharge. Historical observations also show that reservoir storage can sustain high groundwater levels in those parts of the basin (Upper Valley and Forebay) through the early part of a dry period; however, extended dry conditions that ultimately decrease reservoir storage also reduces groundwater recharge resulting in potentially significant decreases in groundwater levels and storage. Beyond the Forebay Area, analysis of the planned SVWP indicates that supplemental surface water can be expected to be available from reservoir releases through wet and normal conditions and into the early stages of a dry cycle. However, as with in-stream recharge, extended dry conditions can be expected to result in decreases of supplemental surface water for irrigation. While SVWP planning analysis has been done to conclude that groundwater pumping can be increased in the Pressure Zone during extended dry periods without inducing further seawater intrusion, implementation of this Plan Element is intended to examine management actions that might be taken to 'solidify' dry period groundwater supply when in-stream recharge is necessarily reduced. Toward that objective, the model described in Plan Element 3 is intended to be used to analyze projected results (i.e. groundwater levels, reservoir storage and stream flow impacts) in order to design groundwater pumping scenarios that will sustain water supply through dry, as well as normal, hydrologic conditions. The results of the modeling will facilitate water supply planning and proactive groundwater recharge activities to augment basin yield as necessary. Thus, implementation of this Plan Element, within the confines of Plan Element 3 to avoid overdraft, will be essential to accomplishment of the first management objective (goal) for the basin.

4.5 Plan Element 5: Continuation of Conjunctive Use Operations

As described in other parts of this GWMP, MCWRA effectively began conjunctive use operations in the late 1950's after construction of Nacimiento Dam and Reservoir; and it expanded those operations in the late 1960's after construction of San Antonio Dam and Reservoir. Since then, conjunctive use of surface water and groundwater has been non-traditional in that surface water has not been directly used for irrigation or other water supply in the basin; rather, surface water has been indirectly used by dedicating regulated releases from the reservoirs for maintenance of Salinas River flow through most of the basin, promoting groundwater recharge from the stream channel. The results of those operations can be seen in the sustained high groundwater levels through the Upper Valley and Forebay Areas in all but a couple of dry years at the end of a multi-year drought. The currently-planned SVWP will expand historical conjunctive use operations into the realm of direct diversion of surface water from the Salinas River to augment groundwater and recycled water supplies for irrigation in the intruded area of the Pressure Area around Castroville. The maintenance of regulated releases to achieve diversions at the planned SVWP diversion will also continue historical conjunctive use operations by conveying surface water through the historical stream channel recharge areas.

Conjunctive use of local groundwater and imported surface water will continue to be a key element in meeting all the objectives for the basin, most notably utilizing groundwater for water supply while stopping the historical seawater intrusion problem without overdrafting the basin. Historical experience with groundwater pumping and aquifer response to varying hydrologic conditions has shown that the groundwater basin can support pumping through normal and short-term dry hydrologic periods as long as supplemental recharge is maintained through in-stream flows maintained by releases from reservoir storage, but the basin cannot support pumping at rates high enough to meet total water demand through extended dry periods or without supplemental recharge. Similarly, expanded conjunctive operations, in combination with continued use of recycled water, are projected to stop seawater intrusion. In conjunction with that effort, it is recognized that aquifer recharge during delivery of supplemental surface water will afford a degree of additional dry period water supply by allowing short-term increased groundwater pumping in the absence of full supplemental water supplies without causing a recurrence of intrusion. Thus, utilization of conserved surface water in conjunction with groundwater is essential to the management of groundwater in a way that will stop historical seawater intrusion while providing water supply without overdrafting the basin.

As part of conjunctively using surface water and groundwater, it is recognized that there will be variations in the amount of available surface water supply from year to year. Similarly, there are expected to be variations in groundwater conditions as a function of local hydrologic conditions which affect, among other things, the natural recharge to the groundwater basin from year to year. Thus, conjunctive use management is necessary to ensure that the groundwater basin is maintained to meet a regular component of water supply and to also provide a larger component of water supply during dry periods when supplemental surface water availability is reduced. Conjunctive use management is similarly important to ensure that groundwater can be replenished during periods of wet/normal surface water availability. In light of all the preceding, implementation of this Plan Element is essential to accomplishing all the management objectives for the basin.

4.6 Plan Element 6: Short-Term and Long-Term Water Quality Management

In general, groundwater quality in the basin is such that groundwater supplies meet standards for beneficial uses, most of which is for agricultural use but an increasing amount of which is for municipal (domestic) use and some other irrigation (non-domestic) use. While there have been no significant historical trends of general groundwater quality degradation in much of the basin over time, there are two groundwater quality issues that are notable with regard to the resource in general and its future utility as a water supply. One of the most significant of the groundwater quality issues is seawater intrusion in the northern portion of the basin where the inflow of seawater has degraded groundwater quality (as most commonly measured by increased concentrations of total dissolved minerals, or conductivity, and chloride). The historical advance of seawater intrusion in the Pressure 180-Foot and Pressure 400-Foot Aquifers is described in Chapter 3 of this document. The other important groundwater quality issue is increased nitrate concentrations, generally considered to be the result of historical land use practices in many parts of the basin. This water quality issue is also described in Chapter 3 of this document.

In addition to the seawater intrusion and nitrate issues, a potential longer-term groundwater quality issue arises from recognition of a number of geologic and hydrologic factors which suggest that dissolved mineral concentrations could increase over time. Notable among those geologic and hydrologic factors are: 1) the largely "closed" nature of the aquifer system at the western end of the basin as a result of the inflow of seawater in the intruded portion of the basin; 2) the predominant groundwater flow direction in the basin toward the west, where outflow has effectively been "blocked" by intrusion; and 3) ongoing "recirculation" of water through groundwater pumping, consumptive use of water for various beneficial uses on overlying land, and deep percolation of some of the applied water containing a resultant increased concentrations of dissolved minerals. The combination of the preceding factors suggests that, on a long-term basis, there could be an accumulation of dissolved minerals in the aquifer system if salinity is not managed in a way to avoid undesirable groundwater quality degradation. Contaminants of concern in this category are MTBE, perchloroethylene, and trichloroethylene.

Given the historical significance of the seawater intrusion problem in the basin, the short-term water quality focus of this GWMP is to complete the integration of the operational CSIP project and the planned SVWP project in order to stop the advance of seawater intrusion via conjunctive use of surface water and recycled water with groundwater in the greater Castroville area. Short-term actions to address nitrate concentrations include the continued implementation of MCWRA's Nitrate Management Plan.

In light of both short-term and long-term considerations noted above, this Plan Element is included in the overall groundwater management plan to include the interpretation of groundwater quality data (Plan Element 1) and to incorporate groundwater quality as an important consideration in the implementation of the other elements of the Plan, most notably Continuation of Conjunctive Use Operations (Plan Element 5), Continued Integration of Recycled Water (Plan Element 7), and Identification and Mitigation of Groundwater Contamination (Plan Element 8). The Short-Term and Long-Term Salinity Management element of the Plan is essential to accomplishing the third management objective (goal) of preserving groundwater quality for beneficial use in the basin.

4.7 Plan Element 7: Continued Integration of Recycled Water

Implementation of the Castroville Seawater Intrusion Project in the late 1990's added recycled water as a component of overall water supply in the basin by adding tertiary treatment at the Monterey Regional Water Pollution Control Agency wastewater treatment plant near the northwestern end of the basin and delivering the treated water to growers in the greater Castroville area as a supplemental water supply to decrease groundwater pumping in the intruded area of the basin. At present, deliveries of recycled water amount to about 11,400 acre-feet per year, expected to increase to about 21,000 acre-feet per year as the combined CSIP and Salinas Valley Water Project are fully implemented. Thus, as described in other parts of this GWMP, the solution to seawater intrusion will be the continued use of recycled water combined with supplemental water to be derived from direct diversion from the Salinas River.

The planned SVWP recognizes that careful monitoring and interpretation of groundwater quality data in combination with groundwater level data will be necessary to determine if intrusion has actually been stopped, or if additional expansions of planned delivery of supplemental water may be required. If the latter is required, it can be envisioned that there may be some expansion of the area where both recycled water and supplemental surface water are delivered. As municipal water use increases over time (resulting in increased wastewater flows and thus potentially increased availability of recycled water), this Plan Element recognizes both 1) the intent to continue delivery of recycled water as part of the integrated CSIP and SVWP projects to stop seawater intrusion; and 2) the potential for additional use of recycled water for agricultural irrigation and possibly for other non-potable uses, as part of the overall water supplies in the basin.

In light of the effective implementation of recycled water as part of the overall water supply in the basin, and, in particular, as a supplemental water supply to relieve some pumping in the intruded part of the basin, this Plan Element is included in the overall GWMP to include the continued beneficial use of recycled water for agricultural irrigation and other non-potable uses. Continued use of recycled water is recognized as an important component of overall groundwater management in the basin, most notably as a key component of supplemental water supply to stop seawater intrusion. Thus, this Plan Element is included as an important consideration in the implementation of the other elements of the Plan, most notably the Determination of Basin Yield and Avoidance of Overdraft (Plan Element 3), Development of Regular and Dry Year Water Supply (Plan Element 4), Continuation of Conjunctive Use Operations (Plan Element 5), Short-Term and Long-Term Salinity Management (Plan Element 6), and Identification and Mitigation of Groundwater Contamination (Plan Element 8). The Continued Integration of Recycled Water element of the Plan is essential to accomplishing all three of the management objectives for the basin.

4.8 Plan Element 8: Identification and Mitigation of Groundwater Contamination

Water quality is a significant factor in water supply because it determines what uses available water is suited for. The three primary uses of water in the Salinas Valley are agricultural, municipal, and industrial/commercial. Depending on the type and degree of contamination, certain uses may not be viable when water supplies become degraded. Water unfit for drinking may often be acceptable for irrigation, but because domestic supplies typically are drawn from the same groundwater basin as irrigation water, the quality of groundwater must be maintained at drinking water standards. This importance is reaffirmed by the fact that water resources are limited. Once a water supply is contaminated it cannot be easily replaced. Maintenance of groundwater quality is also necessary because of the hydrologic continuity of the Salinas Valley subareas. Contamination of one subarea may lead to contamination of others (Monterey County, 1996).

Groundwater contamination in the Salinas Valley can generally be put into three categories: seawater intrusion, nitrate contamination, and other contamination. Seawater intrusion and nitrate contamination are not considered as part of this Plan Element as they are addressed in Element 6. Contamination addressed in this Plan Element stems predominantly from the release of toxic substances to soil and groundwater (e.g., through leaking underground storage tanks) as a result of urbanization and industrialization, as well as the release of chemical constituents to groundwater via natural processes.

The Monterey County Health Department (MCHD), regulates water systems with 2 to 200 connections. All water systems of 200 or more connections are permitted and monitored by the State Department of Health Services. Groundwater contamination resulting from releases of toxic substances to the environment are typically managed by the local Regional Water Quality Control Board (RWQCB-Central Coast Region in the case of the Salinas Valley), and the local government designee. For Monterey County, the MCHD is also responsible for managing toxic releases to the environment. While MCHD, RWQCB and the California Department of Toxic Substances Control routinely take the lead in the investigation and remediation of contaminated sites, MCWRA typically coordinates with these and other state and local agencies to prevent the release of toxic substances to the environment, and to minimize the potential for contaminant migration.

Implementation of this Plan Element must be completed in conjunction with Plan Element 9 (Identification and Management of Recharge Areas and Wellhead Protection Areas), Element 10 (Identification of Well Construction, Abandonment and Destruction Policies) and Element 11 (Continuation of Local, State and Federal Agency Relationships) in order to be successful. Active management of the Salinas Valley Groundwater Basin will require knowing the location and extent of groundwater contamination plumes in order to avoid the migration of the plumes both laterally and vertically, to protect sensitive ecological and recharge areas, and to minimize any potential impacts of chemical plumes on groundwater extractions. Real-time sharing of data will ensure that all entities involved in the management and use of the groundwater basin have the most up-to-date data on which to base their decisions.

4.9 Plan Element 9: Identification and Management of Recharge Areas and Wellhead Protection Areas

The 1986 Amendments to the federal Safe Drinking Water Act (SDWA) established a new Wellhead Protection Program (WPP) to protect groundwater that supplies drinking water wells for public water systems. Each state was required to prepare a WPP and submit it to the United States Environmental Protection Agency (USEPA) by June 19, 1989. California, however, did not develop an active state-wide program at that time. Subsequently, in 1996, reauthorization of the SDWA established a related program called the Source Water Assessment Program. In 1999, the California Department of Health Services (DHS), Division of Drinking Water and Environmental Management developed its Drinking Water Source Assessment Program (DWSAP) which was subsequently approved by USEPA. The overall objective of the DWSAP is to ensure that the quality of drinking water sources is protected.

Although only listed as a potential component of a groundwater management plan in the most recently amended version of Water Code Section 10753.8, the wellhead protection component "identification and management of wellhead protection areas and recharge areas" is now essentially required as a result of the 1996 SDWA reauthorization.

In California, the DWSAP satisfies the mandates of both the 1986 and 1996 SDWA amendments. The California DWSAP includes delineation of the areas (i.e., protection areas or Groundwater Protection Zones) surrounding an existing or proposed drinking water source where contaminants have the potential to migrate and reach that source. The program includes preparation of an inventory of activities that may lead to the release of contaminants within these zones. The activities, referred to in the DWSAP as Potentially Contaminating Activities, include such land uses as gas stations and dry cleaners as well as many other land uses. The activities also include known contaminant plumes regulated by local, state, and federal agencies. The zones, which are calculated based on local hydrogeological conditions and well operation and construction parameters, represent the approximate area from which groundwater may be withdrawn during 2-, 5-, and 10-year time periods. These zones also represent the areas in which contaminants released to groundwater could migrate and potentially affect the groundwater extracted by wells located within the designated zones. The DWSAP assessment also includes a risk or vulnerability ranking based on a combined numerical score that results from points assigned to various evaluations conducted as part of the DWSAP process. This ranking provides a relative indication of the potential susceptibility of drinking water sources to contamination.

Although DHS is responsible for conducting drinking water source assessments for systems existing prior to the adoption of the California program, DHS has encouraged purveyors to perform their own assessments. Assessments for existing systems were due at the end of 2002; however, DHS extended the final date for assessment completion to May 2003. Permitting of a new water supply well requires that a DWSAP be completed as part of the permit process and is the responsibility of the permit applicant.

The results of the DWSAPs can be used as a planning tool to guide land use development in the vicinity of water sources. The DWSAPs prepared for water sources in the basin should be reviewed every five years and updated more frequently as appropriate. The collective DWSAP information can also be integrated with other management activities including the siting of new wells and well permitting ordinances administered by the County's Health Department. This Plan Element is included to incorporate the DWSAP efforts into the groundwater management plan. Compliance with state DHS requirements is a key part of accomplishing the third Basin Management Objective.

4.10 Plan Element 10: Identification of Well Construction, Abandonment and Destruction Policies

Well construction permitting in the Salinas Valley Groundwater Basin is administered by the Monterey County Health Department (MCHD) as the primary regulator with the MCWRA providing technical review. MCHD implements the State Well Standards for water wells, monitoring wells, and cathodic protection wells. Permitting of municipal supply wells is also within the purview of the Sate Department of Health Services. The fundamental state standards are augmented in the Salinas Valley by *Specifications for Wells in Zone 6 of the Monterey County Flood Control and Water Conservation District*, which were adopted by the County Health Department in 1988 to protect groundwater quality and prevent corrosion of well casing caused by seawater intrusion in the coastal (Zone 6) portion of the basin. These specifications are included in Appendix B of this document. The MCWRA maintains a well log library for investigative purposes.

Other ordinances have been passed for groundwater protection purposes in the basin. Monterey County Ordinance 3709 was passed in 1993 to stop the development of wells in the Pressure 180-Foot Aquifer and slow the rate of seawater intrusion. Monterey County Ordinance 04011 was established to prevent installation of any wells that might access contaminated groundwater or interfere with remedial activities at the former Fort Ord.

One goal of this GWMP for the Salinas Valley Groundwater Basin, preservation of groundwater quality for beneficial use, requires that all wells be properly constructed and maintained during their operational lives, and properly destroyed after their useful lives so that they not adversely affect groundwater quality. Improperly destroyed or abandoned wells can serve as conduits for the movement of contaminants from the ground surface and/or from a poor quality aquifer (e.g. intruded) to one of good quality. Toward that end, this element is included in the overall plan to recognize and support well construction and destruction policies, and to participate in their implementation in the Salinas Valley. Full policy implementation is critical, particularly with regard to inter-aquifer well sealing and proper well destruction, for the management of a multiple aquifer system that has some connection with the Salinas River and its tributaries, and, more importantly, that has historically been affected by seawater intrusion to varying extent near the Monterey Bay coast.

4.11 Plan Element 11: Continuation of Local, State and Federal Agency Relationships

Although MCWRA's jurisdiction encompasses all of Monterey County, MCWRA regularly works with many other entities within the Salinas Valley and beyond. These entities include:

- Marina Coast Water District
- Monterey Regional Water Pollution Control Agency
- Pajaro Valley Water Management Agency
- Monterey Peninsula Water Management District
- U.S. Army
- U.S. Army Corp of Engineers
- NOAA Fisheries
- California Department of Water Resources
- Monterey County

Additionally, there are several agreements presently in place between MCWRA and other entities for specific projects or basin management operations. These agreements include:

- Zone 2/2A annexation agreements between MCWRA, the US Army, and MCWD;
- An MOU between MCWRA and the Monterey County Health Department Division Of Environmental Health for water monitoring;
- CSIP project agreement between MCWRA and MRWPCA;

- Memoranda of Understanding (MOUs) between MCWRA and MPWMD and between MCWRA and PVWMA outlining areas of responsibilities in overlapping areas; and
- the Tri-Agency MOU between MCWRA, MPWMD, and Pajaro Valley Water Management Agency (PVWMA) outlining the management of water resources in the Monterey Bay area.

MCWRA is also involved in several advisory committees including the Agricultural Water Advisory Committee, the Monterey County Water Awareness Committee, and the Fort Ord Technical Review Committee.

Through its project work and annual monitoring and reporting programs (as described in Plan Elements 1 and 2), MCWRA also maintains regular working relationships with both federal and state agencies such as the U.S. Army Corp of Engineers, U.S. Bureau of Reclamation, U.S. Geological Survey, California Department of Water Resources, California Department of Health Services, State Water Resources Control Board and the California Regional Water Quality Control Board – Central Coast Region. As previously noted, MCWRA also works with Monterey County, and through its regular public board of director and committee meetings, the local public and other local agencies (such as the City of Marina and the California American Water Company). Additional public outreach activities conducted MCWRA include an Internet website located at http://www.mcwra.co.monterey.ca.us/index.html on which the agency provides regular quarterly activity and annual reports, as well as reservoir, precipitation, streamflow, and groundwater elevation and extraction reports for public use and public workshops on water supply and quality projects and issues.

Implementation of this Plan Element is critical to minimizing potential conflicts over water supply in the Salinas Valley Groundwater Basin, to avoid state-initiated adjudication, and to ensure unified basin management to optimize and protect existing water resources to meet both current and future demands. This cooperative approach to groundwater basin management allows MCWRA and other overlying agencies to strive towards their objectives for water supply, balance of the basin, maintenance of streamflows for fish migration and other environmental benefits, and demonstrate the overall benefits to be gained, environmentally, politically, and fiscally, from regional water management.

4.12 Plan Element 12: Continuation of Public Education and Water Conservation Programs

As part of its groundwater basin management, MCWRA provides an array of public education opportunities and information to the public. The agency publishes on their website, and makes available to the public, an array of data (reservoir, precipitation, streamflow, and groundwater elevation and extraction reports) as well as fact sheets on managing nitrates, information on the agency's flood warning system, and national flood insurance program and disaster preparedness information. Although MCWRA no longer maintains a conservation coordinator (due to funding issues), MCWRA does require that all new construction include low-flow water use plumbing fixtures and drought-tolerant landscaping with water-efficient irrigation systems. Additionally, per MCWRA Ordinance No. 3932, all water use plumbing fixtures must be retrofitted to low-flow/water conserving fixtures at the time of ownership change. Finally, the agency does have several other mandatory urban water conservation regulations in their charge, including:

- Remodeling which adds a bathroom or increases the existing square footage by at least 25% must include plumbing retrofits for the entire structure.
- Plumbing leaks must be repaired within 72 hours of their discovery.
- Any hose used for washing vehicles or the outside of any building must have an automatic shutoff nozzle.
- No water may be used wastefully or without reasonable purpose.

- Hosing off sidewalks, driveways, etc. is prohibited, except in matters of public health or safety.
- Allowing water to spill into the streets, curbs or gutters, in excess of beneficial use, is prohibited.
- Emptying and refilling pools and spas is prohibited except where necessary to prevent or repair structural damage or to comply with public health regulations.
- Fountains may only use water recycled within the system.
- Repeated violations may result in fines.

In the early 1990's, MCWRA worked with growers in the Salinas Valley on the Irrigation Mobile Laboratory for irrigation and coordinated conferences on irrigation efficiency with the University of California on irrigation and nutrient management.

While MCWRA currently has not implemented any formal agricultural conservation programs, the valley's growers themselves have carried out water conserving efforts simply because it saves them money. Farmers in the region have begun irrigating at night to avoid water being blown away from the fields by the valley's winds, and many have installed drip irrigation systems to efficiently water certain crops. These conservation efforts are reflected in the annual GEMS Reports.

Implementation of this Plan Element is essentially to ensuring that all persons living with the Salinas Valley are doing their part to protect their water resources and to use them to their greatest beneficial use.

4.13 Plan Element 13: Groundwater Management Reports

Over the last 60 years, groundwater in the Salinas Valley has been the subject of innumerable analyses and reports, the great majority of which have addressed seawater intrusion and alternative potential solutions of the intrusion problem. An extensive listing of historical reports and other references is included as Chapter 5 of this Plan.

As part of implementing this Plan, in particular as part of continuing agency relationships (Plan Element 11) and continuing public education (Plan Element 12), it is intended that future reporting will be in the form of a combination of ad-hoc technical reports and annual summaries of overall basin conditions. In addition to regular summaries to describe overall surface water and groundwater conditions in the basin, the various elements of this GWMP will logically result in a number of technical reports on such topics as: ongoing utilization of recycled water for irrigation water supply (the CSIP Project); the planned integration of reservoir reoperation and surface water diversions to augment CSIP recycled water deliveries via the Salinas Valley Water Project (SVWP); and further development of supplemental water supplies for both agricultural and municipal water requirements through expansion of the SVWP and/or other potential sources (e.g. desalination).

4.14 Plan Element 14: Provisions to Update the Groundwater Management Plan

The elements of this GWMP reflect the current understanding of the occurrence of groundwater in the Salinas Valley Groundwater Basin and specific problems or areas of concern about that resource. The Plan elements are designed to achieve specified objectives to develop local groundwater for regular and emergency water supply while both protecting and preserving groundwater quantity and quality as well as surface water resources that are directly related to groundwater. While the Groundwater Management Plan provides a framework for present and future actions, new data will be developed as a result of implementing the Plan Elements. That new data could define conditions which will require modifications to currently definable management actions. As a result, this GWMP is intended to be a living document which can be updated to modify existing elements and/or incorporate new elements as appropriate in order to recognize and respond to future groundwater and surface water conditions. Although not intended to be a rigid schedule, review and updating of this GWMP will initially be conducted in five years, with subsequent updates to be scheduled as appropriate.

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Appendix A - Groundwater Monitoring Protocol and Data Management

1 Introduction

Monterey County Water Resources Agency (MCWRA) was formed to provide for the control of flood and storm waters, conservation of such waters through storage and percolation, control of groundwater extraction, protection of water quality, reclamation of water, exchange of water, and the construction and operation of hydroelectric power facilities. In order to fulfill the water supply and protection portion of their charter, the MCWRA regularly monitors groundwater elevations and extractions, surface water flows, and groundwater/surface water quality. The purpose of this technical memorandum is to document the monitoring programs currently conducted by MCWRA, describe the methods used to manage the data collected, and outline the types of data reporting conducted by the agency on a regular basis. Additionally, this memorandum summarizes the groundwater and surface water monitoring programs conducted by other agencies overlying the Salinas Valley Groundwater Basin.

2 Monterey County Water Resources Agency

2.1 Existing Monitoring Programs

Table 1 summarizes the MCWRA's monitoring programs for surface water, groundwater, and other hydrologic parameters.

2.1.1 Surface Water Monitoring

MCWRA monitors surface water flows and related parameters in order to gather sufficient data to effectively manage Salinas Valley surface water flows to provide for the environment and to maximize groundwater percolation through stream beds. Additionally, the agency regularly monitors surface water quality in order to ensure that Basin Plan water quality objectives are being met for the valley.

Precipitation

MCWRA uses the Salinas Municipal Airport Station as their source of precipitation data. The Salinas Municipal Airport Station is maintained by the National Oceanic and Atmospheric Administration (NOAA).

Evaporation

MCWRA monitors pan evaporation at Nacimiento and San Antonio Reservoirs on a daily basis. Pan evaporation data is used by the Reservoir Operations Committee when determining the reservoirs' release schedules (Johnson, 2006).

Evapotranspiration

There are five active automated weather stations in the MCWRA service area. These stations are managed as part of the California Irrigation Management Information System (CIMIS) run by the Department of Water Resources, Office of Water Use Efficiency. These stations record evapotranspiration (ETo) every hour. The periods of record vary between the stations with the longest beginning in 1982. CIMIS is available online at www.cimis.water.ca.gov.

Streamflow

The United States Geological Survey (USGS) maintains streamflow gauging stations on Nacimiento River, Salinas River, San Antonio Creek, San Lorenzo Creek, and Arroyo Seco. Streamflows on these water bodies are measured daily. Figure 1 shows the USGS streamflow gauging stations.

Surface Water Quality

There are several water quality monitoring programs being conducted concurrently in the Salinas Valley, each with its own goals and objectives.

MCWRA collects dissolved oxygen, nutrient, and general mineral data annually from Nacimiento and San Antonio Reservoirs in May and September. Water quality samples to be analyzed for nutrients and general minerals are collected from just below the surface and just above the bottom of the reservoirs. Dissolved oxygen (DO) data are collected to generate a DO profile for each reservoir (Thomasberg, 2006). MCWRA also collects dissolved oxygen data from below Nacimiento Dam to meet Federal Energy Regulation Commission (FERC) permit requirements (Thomasberg, 2006).

Two additional surface water quality programs are also in the Elkhorn Slough National Estuarine Research Reserve (ESNERR) to track water quality specifically in the Elkhorn Slough area. These programs are the Elkhorn Slough Foundation (ESF) volunteer program and the National Estuarine Research Reserve (NERR) system-wide program. Figure 2 shows the locations of water quality monitoring stations in Elkhorn Slough for both programs.

The ESF manages a local surface water quality monitoring volunteer program. The program was established in 1988 and is partially funded by MCWRA. ESF volunteers collect monthly surface water data from twenty-four locations in Elkhorn Slough and the Salinas River. Water samples are analyzed for temperature, salinity, dissolved oxygen, pH, turbidity, nitrate, ammonium, and dissolved inorganic phosphate (ESF, 2005).

The Elkhorn Slough National Estuarine Research Reserve (ESNERR) collects data at four stations in Elkhorn Slough as part of the National Estuarine Research project. These stations are located at Vierra's near the mouth of the slough, in South Marsh and North Marsh on the Reserve, and at Azevedo Pond in the upper Slough. Water temperature, salinity, dissolved oxygen, water depth, pH, and turbidity data are collected every half hour at these stations. Additionally, nutrient data are collected monthly at these four stations (ESF, 2005).

Reservoir Elevation and Releases

MCWRA collects reservoir elevation, depth, storage, percent of capacity, length of lake and lake surface area data daily from both Nacimiento and San Antonio Reservoirs. These data, along with the USGS streamflow data, are used to operate the Nacimiento and San Antonio Reservoirs.

2.1.2 Groundwater Monitoring

Groundwater supplies a substantial portion of water demands in the Salinas Valley. Accordingly, MCWRA regularly collects data on groundwater levels, groundwater quality and extraction rates in order to actively manage the groundwater basin to meet all beneficial uses.

Well Inventory

MCWRA requires registration of all groundwater extraction facilities that are both located in the Agency Zones 2, 2A or 2B, and have a discharge pipe with an inside diameter greater than or equal to three inches. In addition to registration forms, MCWRA requires a copy of any geophysical log(s) made during drilling of wells to be submitted to the agency and that all wells meet county code for well construction, abandonment and destruction (MCWRA, 2005). Figure 3 shows MCWRA Zones 2, 2A and 2B.

Groundwater Levels

MCWRA conducts an extensive groundwater elevation monitoring program, monitoring different wells on different schedules to optimally capture essential information. The MCWRA groundwater elevation monitoring program is summarized as follows:

- On a monthly basis, MCWRA monitors 80 wells throughout the Salinas Valley for groundwater elevation data;
- Annually in December, MCWRA samples approximately 280 additional wells for groundwater elevation data; and
- In the northern Salinas Valley, MCWRA runs the "August Trough Program." In this program, groundwater elevation data are collected from approximately 140 wells during a single 12-hour period each August. The program's objective is to monitor how groundwater extraction affects groundwater elevation. The program is conducted in August to provide MCWRA with groundwater elevation data during a time with high pumping stress on the aquifer (RMC, 2005).

Groundwater Extraction and Water Conservation

Operators of wells in Zones 2, 2A and 2B with a discharge pipe having an inside diameter of at least three inches are required to report groundwater extractions annually to MCWRA. Well operators can report water well extractions via either water flowmeter, electrical meter, or hour meter (timer) data. MCWRA requires regular pump efficiency testing to ensure the accuracy of data reported (MCWRA, 2005). This is an ordinance driven program.

Groundwater Quality

During the months of June, July, and August, MCWRA collects groundwater samples for water quality monitoring from approximately 90 wells behind and in front of the seawater intrusion area in the Salinas Valley. The seawater intrusion zone is defined by the 500 mg/L chloride contour. MCWRA analyzes all the water samples for conductivity, chlorides, and nitrate. Samples from a third of the wells are also analyzed for calcium, magnesium, potassium, sulfate, and pH. The set of wells receiving the full analysis rotates such that every well has two partial and one complete analysis over the summer sampling period (Thomasberg, 2006).

Over 300 Salinas Valley wells are monitored by MCWRA on a yearly basis. All samples are analyzed annually for conductivity, chlorides, and nitrate. Samples from a third of the wells are also analyzed for additional constituents including calcium, magnesium, potassium, sulfate, and pH. The subset of wells which receive the full suite of analyses rotates such that every well has two partial and one complete analysis in a three-year period (Thomasberg, 2006).

2.1.3 Other

Recycled Water Production

The Monterey Regional Water Pollution Control Agency (MRWPCA) and MCWRA partnered to develop the Castroville Seawater Intrusion Project (CSIP), a program designed to mitigate the effects of seawater intrusion in the groundwater basin by providing recycled water to local agriculture to use as irrigation in lieu of groundwater pumping. MRWPCA operates the Salinas Valley Reclamation Plant (SVRP) near Marina where wastewater is treated to meet the requirements of Title 22 for use as recycled water. This Title 22-compliant recycled water is then distributed to agricultural irrigators via the CSIP system managed by MCWRA. MRWPCA is responsible for monitoring the production and quality of recycled water, and provides production information to MCWRA on a regular basis.

2.2 Existing Data Management

2.2.1 Database

Groundwater Database

Groundwater elevations, well construction, surface and groundwater quality data are stored in the Water Resources and Information Management Systems (WRAIMS) database maintained by MCWRA (RMC, 2005).

The Groundwater Extraction Management System (GEMS) is a portion of WRAIMS that compiles the information received from over 160 well operators required to report groundwater extraction data and agricultural and urban conservation plans (MCWRA, 2005). GEMS is an ORACLE-based database, and is currently being integrated with another existing ORACLE database through the new WRAIMS database.

Surface Water Database

Surface water quality samples collected by ESF volunteers are sent to Monterey County Consolidated Chemistry Laboratory in Salinas, and reported analytical data are stored in the laboratory database called Laboratory Information Management System (LIMS). A selected set of data from the LIMS database is transferred to MCWRA at the end of each year (RMC, 2005).

2.2.2 Reporting

MCWRA publishes data collected as part of their regularly monitoring programs on their website located at http://www.mcwra.co.monterey.ca.us/. Published data include reservoir data (described above), the reservoir release schedule, historic reservoir elevations, precipitation data, USGS streamflow data, and quarterly groundwater levels, groundwater extraction and water conservation summary reports. The Agency also published several reports and figures as described below.

Water Quality Data

Surface water quality data collected by the ESF volunteer program is available upon request from the foundation (ESF, 2005). Surface water quality data collected in Elkhorn Slough by the ESNERR for the National Estuarine Research project is posted on their website and can be downloaded from the National Estuarine Research Reserve System Centralized Data Management Office website at http://cdmo.baruch.sc.edu/.

Groundwater quality data collected by MCWRA is maintained in an agency database (described in Section 2.2.1 above). Groundwater quality data collected from wells are also reported to the well operator.

Maps documenting the approximate historic seawater intrusion fronts in the Pressure 180- and 400-Foot Aquifers in the Salinas Groundwater Basin are updated every few years by MCWRA and are available using the Salinas Valley Water Project tab of the Agency's website, located at: www.mcwra.co.monterey.ca.us/welcome_svwp_n.htm.

Report on Salinas Valley Water Conditions

Reports on the status of water conditions in the Salinas Valley are prepared quarterly for the MCWRA Board of Directors' information. The reports summarize precipitation, reservoir elevations, and groundwater trends. Copies of the latest reports are available on the MCWRA website located at www.mcwra.co.monterey.ca.us. Past reports are available upon request from the Agency.

Groundwater Elevation Figures

MCWRA publishes figures depicting groundwater elevation data by month. Each figure contains information on one of the four major subareas, with separate figures for the Pressure 180- and 400-Foot Aquifers. The four major subareas for which groundwater elevation figures are prepared are the East Side Area, Forebay Area, Upper Valley Area, and Pressure Area. The groundwater elevation figures are also used as backup for reports on Salinas Valley Water Conditions, and are available on the MCWRA website at www.mcwra.co.monterey.ca.us.

Groundwater Extraction and Water Conservation Reports

MCWRA publishes Groundwater Summary Extraction Reports based on the information reported by well users in Zones 2, 2A and 2B. Reports are available by year. Copies of the reports are available digitally on MCWRA's website at www.mcwra.co.monterey.ca.us or hardcopy by request from the Agency.

Activity Reports

MCWRA publishes Quarterly Activity Reports summarizing major projects and their progress. These reports include new data that have been collected for specific projects and information on how the public can access the data. Activity Reports are available on MCWRA's website at www.mcwra.co.monterey.ca.us.

3 Monitoring Programs by Other Agencies

3.1 Marina Coast Water District

Table 2 summarizes the monitoring program currently being implemented by Marina Coast Water District (MCWD). Water quality and groundwater production collected by MCWD are summarized and published in annual Consumer Confidence Reports by the District.

3.2 Additional Data Reports

Various water-related studies have been conducted within the Salinas Valley groundwater basin and are available as references to MCWRA and other entities working in the basin. These studies were done as part of one-time research activities to collect data for a specific purpose or project and do not reflect ongoing monitoring studies. Table 3 summarizes the available reports, including year conducted and data captured.

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Appendix A Table 1: Monterey County Water Resources Agency's Water Monitoring Programs

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Precipitation	Salinas Airport Station	Bucket	Jul 1893	Daily/NOAA	Data from 1928 to present available online through NWS.
Evaporation	Nacimiento & San Antonio Reservoirs	Pan	1957/1965	Daily/MCWRA	
Evapotranspiration	Castroville (#19)	Automated active weather station	Nov 1982	Hourly/CIMIS	Online data available through CIMIS
	Salinas South (#89)	Automated active weather station	Sep 1992	Hourly/CIMIS	Online data available through CIMIS
	Salinas North (#116)	Automated active weather station	Jun 1993	Hourly/CIMIS	Online data available through CIMIS
	Arroyo Seco (#114)	Automated active weather station	Jun 1993	Hourly/CIMIS	Online data available through CIMIS
	King City- Oasis Rd. (#113)	Automated active weather station	Jun 1993	Hourly/CIMIS	Online data available through CIMIS

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Streamflow	Salinas River near Bradley (#11150500)	15-minute recording	Oct 1948	Daily/USGS	
	Salinas River at Soledad (#11151700)	15-minute recording	Oct 1968	Daily/USGS	
	Salinas River near Chular (#11152300)	15-minute recording	Oct 1976	Daily/USGS	
	Salinas River at Paso Robles (#11147500)	15-minute recording	Nov 1939	Daily/USGS	
	Salinas River near Spreckels (#11152500)	15-minute recording	Oct 1929	Daily/USGS	
	Nacimiento River BL Sapaque near Bryson (#11148900)	15-minute recording	Sep 1971	Daily/USGS	
	Nacimiento River BL Nacimiento Dam near Bradley (#11149400)	15-minute recording	Oct 1957	Daily/USGS	
	San Antonio River near Lockwood (#11149900)	15-minute recording	Oct 1965	Daily/USGS	
	San Lorenzo Creek BL Bitterwater Creek near King City (#11151300)	15-minute recording	Oct 1958	Daily/USGS	
	Arroyo Seco near Greenfield (#11151870)	15-minute recording	Oct 1961	Daily/USGS	Daily streamflow record ends in Sep 1986. Currently only measures Peak streamflow.
	Arroyo Seco near Soledad (#11152000)	15-minute recording	Jan 1901	Daily/USGS	
	Arroyo Seco BL Reliz Creek near Soledad (#11152050)	15-minute recording	Jan 1994	Daily/USGS	

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Surface Water Quality	24 stations along Elkhorn Slough and Salinas River	Salinity, DO, pH, turbidity, NO_3^-, ammonium, dissolved inorganic phosphate	1988	Monthly/ESF	MCWRA provides partial funding to ESF for this program.
	4 stations along Elkhorn Slough	30-minutes- temp, salinity, DO, depth, pH, turbidity, nutrients	1995	Daily/ESNERR	Nutrient data is only sampled monthly at these stations
	Nacimiento & San Antonio Reservoirs	DO, nutrients, general mineral	1957/1965	Annually/May & Sep/ MCWRA	Column sample of DO and top and bottom reservoir samples for nutrients/general mineral.
	Nacimiento Dam	DO	1957	Bi-monthly/ MCWRA	Twice monthly sampling began in 2004.
Reservoir Elevation & Releases	Nacimiento & San Antonio Reservoirs	% capacity, elevation, depth, storage, rate of release, lake surface area, length of lake	1957/1965	Daily/MCWRA	Nacimiento Reservoir was completed in 1957. San Antonio Reservoir was completed in 1965.
Well Inventory	4000-5000 wells	Well Location, log, type, capacity, water use, etc. stored in WRAIMS	1947	MCWRA ongoing	Well records include active, repaired, or destroyed wells.
Groundwater Levels	~280 Salinas Valley wells	Depth to water	1957	Yearly/MCWRA	
	80 Salinas Valley wells	Depth to water	1957	Monthly/MCWRA	
	~140 Northern Salinas Valley wells	Depth to water	1960s	Yearly/MCWRA	August Trough Program
Groundwater Extraction	1700+ Salinas Valley wells	Flowmeter Electrical	Nov 1992	Yearly/MCWRA	Ordinance driven report in Zones 2, 2A and 2B
Groundwater Quality	90 Seawater Intrusion zone wells	Ca^{+2}, Mg^{+2}, K^+, SO_4^{-2}, pH, conductivity, Cl^-, NO_3^-, Na, alkalinity	1980	Jun, Jul & Aug/ MCWRA	Partial sampling (conductivity, Cl^-, NO_3^- only) occurs 2 of the 3 months on a rotating basis.
	300+ Salinas Valley wells	Ca^{+2}, Mg^{+2}, K^+, SO_4^{-2}, pH, conductivity, Cl^-, NO_3^-, Na, alkalinity		Yearly/MCWRA	Partial sampling (conductivity, Cl^-, NO_3^- only) occurs 2 of every 3 years on a rotating basis.

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Recycled Water Production / Distribution	Monterey County Water Recycling Project		1998	MRWPCA	MRWPCA operates the water recycling facility. MCWRA operates the distribution system.

Table 2: Marina Coast Water District's Water Monitoring Programs

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Groundwater Quality	Nacimiento Reservoir and Surrounding Areas	Mercury	Early 1990s	Once/RWQCB	One time study of Mercury
	Nacimiento and San Antonio Reservoirs	MTBE		Once/invelstigation	One time study of MTBE in reservoirs
	Salinas River Lagoon	Assorted			Done as part of the Salinas River Lagoon Management Plan
	Salinas Valley Groundwater Basin	Assorted	Jun 2004N/A	varies	Agricultural Discharge Waiver
Surface Water Quality	2 Marina water reservoirs	Color, odor, turbidity, temp, pH, conductivity, free chlorine residual, sulfides	N/A	Weekly/MCWD	Some samples are also tested for over 110 constituents including minerals, metals, organic chemicals
	Marina Desalination Plant seawater intake well	Coliforms, free chlorine residual, pH, turbidity, conductivity, TDS, Cl^-, sulfate, alkalinity, hardness, corrosive index	N/A	MCWD	Some samples are also tested for over 110 constituents including minerals, metals, organic chemicals
Desalinated Water Production	Marina Desalination Plant final product	Coliforms, free chlorine residual, pH, turbidity, conductivity, TDS, Cl^-, sulfate, alkalinity, hardness, corrosive index	N/A	MCWD	Some samples are also tested for over 110 constituents including minerals, metals, organic chemicals

N/A – Not Available

Table 3: Other Studies, Terminated Programs, etc. in the Salinas Valley Groundwater Basin

Monitoring Type	Location	Measurement Type	Date Started	Frequency/ Maintainer	Notes
Surface Water Quality	Salinas Valley	Mercury	Early 1990s	Once/RWQCB	One time study of Mercury in Salinas Valley
	Nacimiento and San Antonio Reservoirs	MTBE	N/A	Once	One time study of MTBE in reservoirs
	Salinas River Lagoon	Samples	N/A	Once	Done as part of the Salinas River Lagoon Management Plan
	Salinas Valley Agricultural sites		N/A	Very frequent/Region 3	Agricultural Discharge Waiver as part of CSIP

N/A – Not Available

WATER RESOURCES DATA — CALIFORNIA, WATER YEAR 2004

SALINAS RIVER BASIN

Salinas River at Paso Robles (d) 1114750 47
Nacimento River below Sapaque Creek, near Bryson (ds) 1114890 49
Nacimiento River below Nacimiento Dam, near Bradley (d) 1114940 53
San Antonio River near Lockwood (ds) 1114990 54
Salinas River near Bradley (d) 1115050 58
San Lorenzo Creek below Bitterwater Creek, near King City (d)........1115130 60
Salinas River at Soledad (d) 1115170 62
Arroyo Seco near Greenfield (d)...1115187 428
Arroyo Seco near Soledad (d) 1115200 63
Arroyo Seco below Reliz Creek, near Soledad (d)..............................1115205 65
Salinas River near Chualar (dcs) 1115230 67
Salinas River near Spreckels (d) 1115250 71

Figure 1: USGS Streamflow Gaging Stations in the Salinas Valley

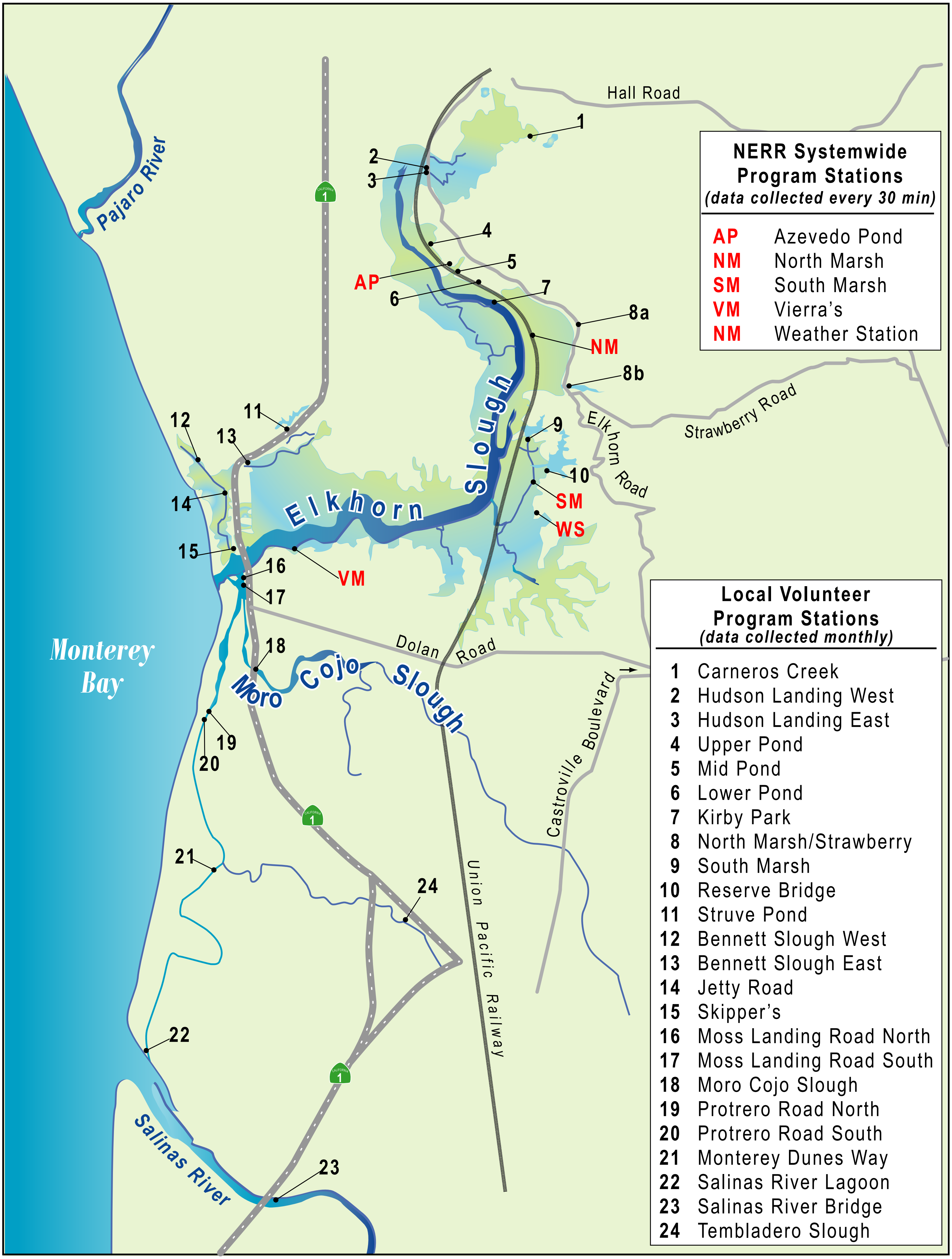

Fig 2 Elkhorn Slough WQ Moniter Stations_2-28-06

Figure 2: ESF Elkhorn Slough Water Quality Monitoring Sations (March 2004)

Appendix B - Specifications for Wells in Zone 6 of the Monterey County Flood Control and Water Conservation District

SPECIFICATIONS FOR WELLS IN ZONE 6 OF THE MONTEREY COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

Adopted: 4/19/88

Monterey County Health Department
Division of Environmental Health

The purpose of these specifications is to protect groundwater quality and prevent corrosion of the well casing caused by seawater intrusion in Zone 6 of the Monterey County Flood Control and Water Conservation District.

SECTION A: For wells drilled in Zone 6 the following is required prior to obtaining a water well drilling permit from the Health Officer:

1) Plans and specifications for the construction of the well, to include but not limited to: sealing materials and procedures, drilling fluids, description of casing, and proposed use of electrical logs.

2) The application shall be reviewed and approved by the Monterey County Flood Control and Water Conservation District.

SECTION B: For wells drilled in Zone 6, the following standards shall apply in addition to Bulletin 74-81.

(1) Cable tool construction into the 400' aquifer:

a) Well construction shall consist of at least a double cased well: a conductor or outer casing which must be lodged at least 10 feet into the clay lense separating the P-180 and P-400 Aquifers, and a production casing.

b) The conductor casing shall be a minimum of 4 inches in diameter larger than the production casing.

c) The annular space between the conductor casing and the production casing shall be pressure grouted from the bottom to the top in one continuous operation. The sealing material and pumping equipment shall as specified in Section E & F below.

(2) Cable tool construction into the deep aquifer:

a) Well construction shall consist of a double cased well: a conductor or outer casing which must be lodged at least 10 feet into the clay lense separating the P 400 and deep aquifer, and a production casing.

b) The conductor casing shall be a minimum of 6 inches in diameter larger than the production casing.

c) The annular space between the conductor casing and the production casing shall be pressure grouted from the bottom to the top in one continuous operation. Sealing material and pumping equipment shall be as specified in Section E & F below.

(3) Rotary construction into the 400' aquifer:

a) Prior to drilling a pilot hole, a conductor casing shall be set in clay to minimum of 60 feet. The conductor shall have a minimum wall thickness of 1/4", shall be made of steel, with welded steel collars. The borehole shall be a minimum of 4 inches in diameter larger than the conductor casing.

b) The annular space between the conductor casing and the borehole shall be pressure grouted from the bottom to the top in one continuous operation. The sealing material shall be specified in Section E & F below.

c) The minimum thickness of the production casing shall be 1/4". The casing shall be steel and manufactured in accordance with ASTM standards with welded steel collars.

d) Centralizers shall be installed between the conductor and production casing to maintain alignment.

e) The conductor casing shall be a minimum of 8 inches in diameter larger than the production casing.

f) The annular space between the conductor casing and the production casing shall be pressure grouted from a depth of 10 feet minimum below the clay layers separating the P-180 and P-400 aquifers to ground level. The grouting shall be done in one continuous operation using sealing material and pumping equipment as specified in Sections E and F below.

(4) Rotary construction into the deep aquifer:

a) Prior to drilling a pilot hole, a conductor casing shall be set a minimum of 10 feet into the clay layer separating the P-180 and P-400 aquifers. The conductor shall have a minimum wall thickness of 1/4", shall be made of steel, with welded steel collars. The borehole shall be minimum of 4 inches in diameter larger than the conductor casing.

b) The annular space between the conductor casing and the borehole shall be pressure grouted from the bottom to the top in one continuous operation. The sealing material and equipment shall be specified in Section E and F below.

c) The minimum thickness of the production casing shall be 5/16". The casing shall be steel and manufactured in accordance with ASTM standards with welded or threaded steel collars.

d) Centralizers shall be installed between the conductor and production casing to maintain alignment.

e) The production borehole shall be a minimum of 8 inches in diameter larger than the production casing.

f) The annular space between the production borehole and the production casing shall be pressure grouted from a depth of 10 feet minimum below the clay layers separating the P-400 and deep aquifers to ground level. The grouting shall be done in one continuous operation using sealing material and pumping equipment as specified in Section E and F below.

(5) In rotary drilled wells, in order to determine appropriate well construction to protect the quality of water within separate aquifers, the following well logs shall be provided by the well driller in addition to the State "report of completion" required under Sections 13751 of the California Water Code:

a) An electric log of the test hole consisting of a multiple electrode resistivity log and spontaneous potential log for reviewing water quality, bed thickness, and formation porosity.

b) A caliper log of the final hole in order to determine appropriate quantities of sealing materials and gravel pack and to detect any abnormalities in the drill hole walls.

c) Any additional logs which may be required by the Health Officer or his authorized representative to determine appropriate well seal placements.

d) If required by the Health Officer or his authorized representative, the applicant shall provide a hydrologist, geologist, or engineer at the applicant's expense to identify strata containing poor water quality and recommend the location of the seal or seals needed to prevent the entrance of poor quality water.

SECTION C: When the rotary method of drilling is employed, the well driller shall conduct drilling on a 24 hour, 7 day a week basis until well has been gravel packed and the seals are set in place.

SECTION D: The drilling fluid for direct rotary construction shall be made up of high quality bentonite clays and/or organic polymer additives, in common usage in the water well industry, and shall possess such characteristics as to maintain borehole integrity.

SECTION E: Sealing and grouting materials shall be limited to the following:

1) Neat cement grout

2) A blended mix of 50% neat cement and 50% pozzolan plus polymer additives.

3) Or as approved by the Health Officer.

SECTION F: Equipment for placing seals shall have the following capabilities:

1) On site, continuous mixing of sealing materials from dry bulk form to liquid form.

2) Continuous operation sealing supplied from continuous mixing equipment.

3) Continuous monitoring of material density and quantities being placed with visible dial or gauge read-out.

4) Positive pressure pumping equipment capable of 300 to 2,000 PSI shall be used for the placement of the seal.

SECTION G: The driller shall keep the Health Officer or this authorized representative appraised of progress on the well and shall provide, at least 24 hours in advance, an estimate of the date and time when the conductor casing will be set, the gravel pack will be completed, and the seals will be pumped.

SECTION H: Upon completion of the well, the driller shall submit a report to the Health Officer and the Monterey County Flood Control and Water Conservation District which includes, but not limited to, as built plans, the State report of completion, electric logs, spontaneous potential logs, and caliper logs.

SECTION I: The following well destruction standards will apply for wells penetrating the P-400 aquifer within Zone 6 of the Monterey County Flood Control and Water Conservation District, in addition to Bulletin 74-81.

1) The location of the clay layers between the P-180, P-400 and deep aquifers must be determined and the casing opposite the separating clay lense must be perforated prior to placement of the sealing material.

2) Sealing material and equipment for placement of seals shall be as specified above in Sections E and F.

3) Upon completion of the abandonment, the driller shall submit a detailed record of the procedure and materials used on the State report of completion.

SECTION J: During well construction in Zone 6, the Health Officer or his authorized representative shall be available during normal office hours and on "standby" duty after normal office hours to:

1) Review the location of the conductor casing and cement seals prior to well construction.

2) Inspect the gravel pack elevation prior to cementing.

3) Witness and inspect the cement sealing processes.

During well reconstruction or destruction in Zone 6 the Health Officer or his authorized representative shall be available during the normal office hours to:

a) Review reconstruction and destruction procedures and well data.

b) Witness and inspect the cement sealing processes.

AF:krf

11/10-1

APPROVED AS
TO FORM

MAR 3 0 1988

J.R. Ramos

J.R. RAMOS
SENIOR DEPUTY COUNTY COUNSEL

MONTEREY COUNTY WATER RESOURCES AGENCY
1947

Central Coast Hydrologic Region

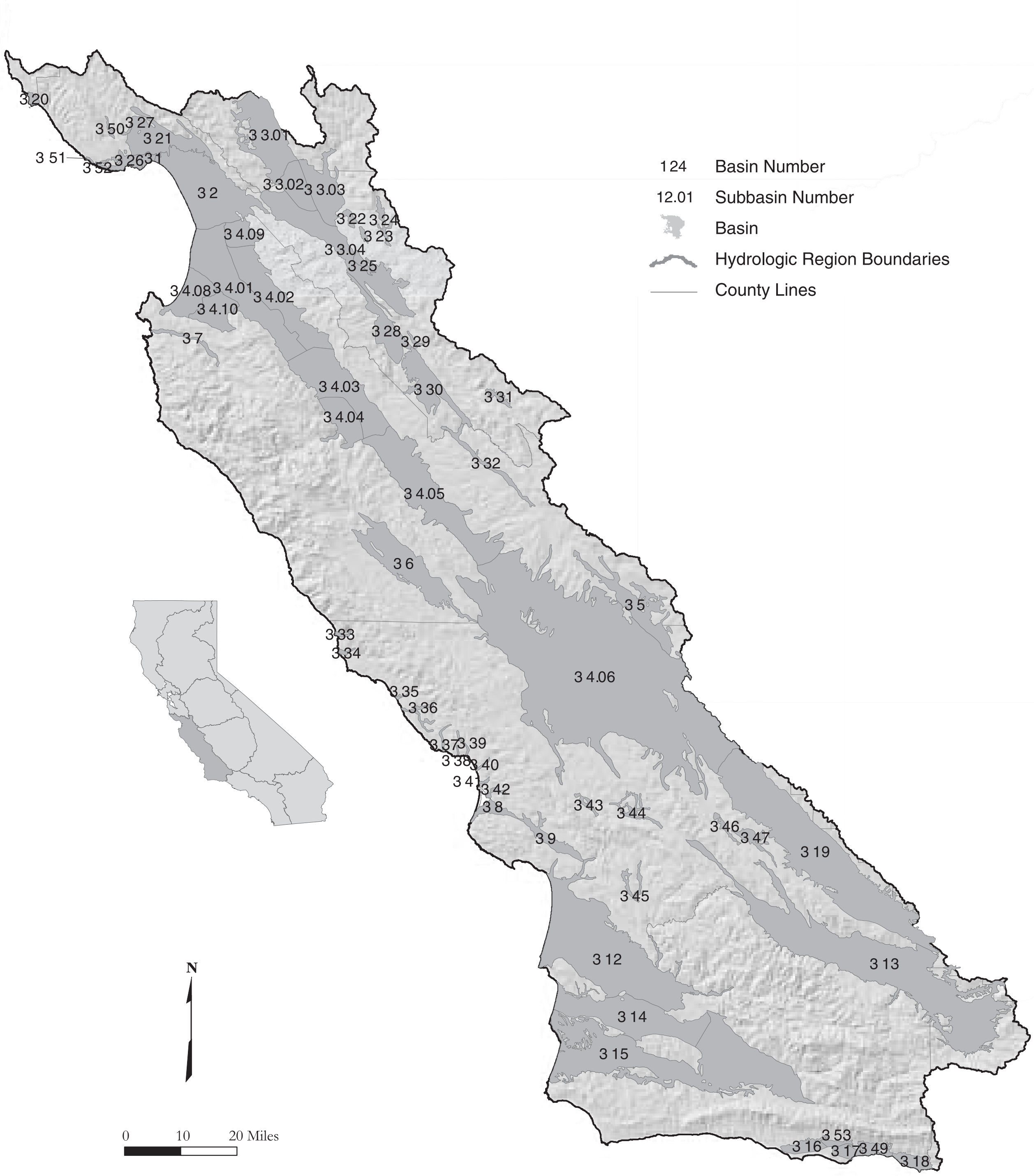

Figure 29 Central Coast Hydrologic Region

Basins and Subbasins of Central Coast Hydrologic Region

RegionBasin/ subbasin	Basin name
3-1	Soquel Valley
3-2	Pajaro Valley
3-3	Gilroy-Hollister Valley
3-3.01	Llagas Area
3-3.02	Bolsa Area
3-3.03	Hollister Area
3-3.04	San Juan Bautista Area
3-4	Salinas Valley
3-4.01	180/400 Foot Aquifer
3-4.02	East Side Aquifer
3-4.04	Forebay Aquifer
3-4.05	Upper Valley Aquifer
3-4.06	Paso Robles Area
3-4.08	Seaside Area
3-4.09	Langley Area
3-4.10	Corral de Tierra Area
3-5	Cholame Valley
3-6	Lockwood Valley
3-7	Carmel Valley
3-8	Los Osos Valley
3-9	San Luis Obispo Valley
3-12	Santa Maria River Valley
3-13	Cuyama Valley
3-14	San Antonio Creek Valley
3-15	Santa Ynez River Valley
3-16	Goleta
3-17	Santa Barbara
3-18	Carpinteria
3-19	Carrizo Plain
3-20	Ano Nuevo Area
3-21	Santa Cruz Purisima Formation
3-22	Santa Ana Valley
3-23	Upper Santa Ana Valley
3-24	Quien Sabe Valley
3-25	Tres Pinos Valley
3-26	West Santa Cruz Terrace
3-27	Scotts Valley
3-28	San Benito River Valley
3-29	Dry Lake Valley
3-30	Bitter Water Valley
3-31	Hernandez Valley
3-32	Peach Tree Valley
3-33	San Carpoforo Valley
3-34	Arroyo de la Cruz Valley

RegionBasin/ subbasin	Basin name
3-35	San Simeon Valley
3-36	Santa Rosa Valley
3-37	Villa Valley
3-38	Cayucos Valley
3-39	Old Valley
3-40	Toro Valley
3-41	Morro Valley
3-42	Chorro Valley
3-43	Rinconada Valley
3-44	Pozo Valley
3-45	Huasna Valley
3-46	Rafael Valley
3-47	Big Spring Area
3-49	Montecito
3-50	Felton Area
3-51	Majors Creek
3-52	Needle Rock Point
3-53	Foothill

Description of the Region

The Central Coast HR covers approximately 7.22 million acres (11,300 square miles) in central California (Figure 29). This HR includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura counties. Significant geographic features include the Pajaro, Salinas, Carmel, Santa Maria, Santa Ynez, and Cuyama valleys; the coastal plain of Santa Barbara; and the Coast Range. Major drainages in the region include the Salinas, Cuyama, Santa Ynez, Santa Maria, San Antonio, San Lorenzo, San Benito, Pajaro, Nacimiento, Carmel, and Big Sur Rivers.

Population data from the 2000 Census suggest that about 1.4 million people or about 4 percent of the population of the State live in this HR. Major population centers include Santa Barbara, Santa Maria, San Luis Obispo, Gilroy, Hollister, Morgan Hill, Salinas, and Monterey.

The Central Coast HR has 50 delineated groundwater basins. Within this region, the Gilroy-Hollister Valley and Salinas Valley groundwater basins are divided into four and eight subbasins, respectively. Groundwater basins in this HR underlie about 2.390 million acres (3,740 square miles) or about one-third of the HR.

Groundwater Development

Locally, groundwater is an extremely important source of water supply. Within the region, groundwater accounted for 83 percent of the annual supply used for agricultural and urban purposes in 1995. For an average year, groundwater in the region accounts for about 8.4 percent of the statewide groundwater supply and about 1.3 percent of the total state water supply for agricultural and urban needs. In drought years, groundwater in this region is expected to account for about 7.2 percent of the statewide groundwater supply and about 1.9 percent of the total State water supply for agricultural and urban needs (DWR 1998).

Aquifers are varied and range from large extensive alluvial valleys with thick multilayered aquifers and aquitards to small inland valleys and coastal terraces. Several of the larger basins provide a dependable and drought-resistant water supply to coastal cities and farms.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Several reservoirs including Hernandez, Twitchell, Lake San Antonio, and Lake Nacimiento are operated primarily for the purpose of groundwater recharge. The concept is to maintain streamflow over a longer period than would occur without surface water storage and thus provide for increased recharge of groundwater. Seawater intrusion is a major problem throughout much of the region. In the Salinas Valley Groundwater Basin, seawater intrusion was first documented in the 1930s and has been observed more than 5 miles inland.

Groundwater Quality

Much of the groundwater in the region is characterized by calcium sulfate to calcium sodium bicarbonate sulfate water types because of marine sedimentary rock in the watersheds. Aquifers intruded by seawater are typically characterized by sodium chloride to calcium chloride, and have chloride concentrations greater than 500 mg/L. In several areas, groundwater exceeds the MCL for nitrate.

Water Quality in Public Supply Wells

From 1994 through 2000, 711 public supply water wells were sampled in 38 of the 60 basins and subbasins in the Central Coast HR. Analyzed samples indicate that 587 wells, or 83 percent, met the state primary MCLs for drinking water. One-hundred-twenty-four wells, or 17 percent, have constituents that exceed one or more MCL. Figure 30 shows the percentages of each contaminant group that exceeded MCLs in the 124 wells.

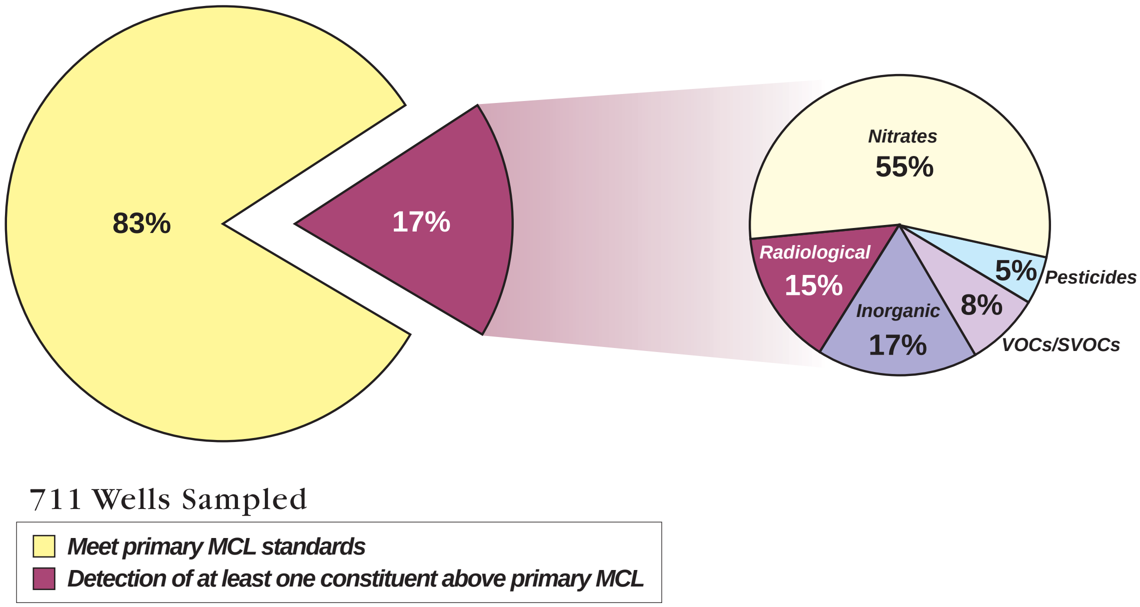

Figure 30 MCL exceedances in public supply wells in the Central Coast Hydrologic Region

Table 19 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region

Contaminant group wells	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of
Inorganics – Primary	Antimony – 6	Aluminum – 4	Chromium (Total) – 4
Inorganics – Secondary	Iron – 145	Manganese – 135	TDS – 11
Radiological	Gross Alpha – 15	Radium 226 – 3	Uranium – 3
Nitrates	Nitrate (as NO_3) – 69	Nitrate + Nitrite – 24	
Pesticides	Heptachlor – 4	Di (2-Ethylhexyl) phthalate – 2	
VOCs/SVOCs	TCE – 3	3 are tied at 2 exceedances	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC= Semivolatile Organic Compound

Changes from Bulletin 118-80

Four new basins have been defined since Bulletin 118-80. They are Felton Area, Majors Creek, Needle Rock Point, and Foothill groundwater basins. Additionally, new subbasins have been broken out in both the Gilroy-Hollister Valley Groundwater Basin (3-3) and the Salinas Valley Groundwater Basin (3-4) (Table 20).

Table 20 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region

Subbasin name	New number	Old number
Llagas Area	3-3.01	3-3
Bolsa Area	3-3.02	3-3
Hollister Area	3-3.03	3-3
San Juan Bautista Area	3-3.04	3-3
180/400 Foot Aquifer	3-4.01	3-4
East Side Aquifer	3-4.02	3-4
Upper Forebay Aquifer	3-4.04	3-4
Upper Valley Aquifer	3-4.05	3-4
Pismo Creek Valley Basin	3-12	3-10
Arroyo Grande Creek Basin	3-12	3-11
Careaga Sand Highlands Basin	3-12 and 3-14	3-48
Felton Area	3-50	
Majors Creek	3-51	
Needle Rock Point	3-52	
Foothill	3-53	

Pismo Creek Valley Basin (3-10) and Arroyo Grande Creek Basin (3-11) have been merged into the Santa Maria River Valley Basin (3-12). Careaga Sand Highlands Basin (3-48) has been merged into the Santa Maria River Valley Basin (3-12) and San Antonio Creek Valley Basin (3-14).

Table 21 Central Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-1	SOQUEL VALLEY	2,500	C	1,421	665	6	6	16	482	270-990
3-2	PAJARO VALLEY	76,800	A	2,000	500	185	185	149	580-910	300-30,000
3-3	GILROY-HOLLISTER VALLEY									
3-3.01	LLAGAS AREA	55,600	C	-	-	-	-	95	-	-
3-3.02	BOLSA AREA	21,000	A	-	400	11	<11	3	-	400-1800
3-3.03	HOLLISTER AREA	32,700	A	-	400	42	<42	35	-	400-1600
3-3.04	SAN JUAN BAUTISTA AREA	74,300	A	-	400	37	<37	40	-	460-1700
3-4	SALINAS VALLEY									
3-4.01	180/400 FOOT AQUIFER	84,400	A	-	-	166	218	82	478	223-1,013
3-4.02	EAST SIDE AQUIFER	57,500	A	-	-	74	67	53	450	168-977
3-4.04	FOREBAY AQUIFER	94,100	A	-	-	89	91	35	624	300-1,100
3-4.05	UPPER VALLEY AQUIFER	98,200	A	4,000	-	36	37	17	443	140-3,700
3-4.06	PASO ROBLES AREA	597,000	A	3,300	-	183	-	58	614	165-3,868
3-4.08	SEASIDE AREA	25,900	B	3,500	1,000		7	24	400	200-900
3-4.09	LANGLEY AREA	15,400	B	1,570	450	-	-	52	-	52-348
3-4.10	CORRAL DE TIERRA AREA	22,300	C	948	450	-	3	26	-	355-679
3-5	CHOLAME VALLEY	39,800	C	3,000	1,000	1	-	1	-	-
3-6	LOCKWOOD VALLEY	59,900	C	1,500	100	-	-	9	-	-
3-7	CARMEL VALLEY	5,160	C	1,000	600	50	23	12	260-670	220-1,200
3-8	LOS OSOS VALLEY	6,990	A	700	230	-	-	10	354	78-33,700
3-9	SAN LUIS OBISPO VALLEY	12,700	A	600	300	-	-	11	583	278-1,949
3-12	SANTA MARIA RIVER VALLEY	184,000	A	2,500	1,000	286	10	108	598	139-1,200
3-13	CUYAMA VALLEY	147,000	A	4,400	1,100	17	2	8	-	206-3,905
3-14	SAN ANTONIO CREEK VALLEY	81,800	A	-	400	30	-	9	415	129-8,040
3-15	SANTA YNEZ RIVER VALLEY	204,000	A	1,300	750	163	21	76	507	400-700
3-16	GOLETA	9,210	A	800	500	49	11	17	755	617-929
3-17	SANTA BARBARA	6,160	A	625	560	75	36	5	-	217-385
3-18	CARPINTERIA	8,120	A	500	300	41	41	4	557	317-1,780
3-19	CARRIZO PLAIN	173,000	C	1,000	500	-	-	1	-	-
3-20	ANO NUEVO AREA	2,032	C	-	-	-	-	2	-	-
3-21	SANTA CRUZ PURISIMA FORMATION	40,200	C	200	20	-	-	39	440	380-560
3-22	SANTA ANA VALLEY	2,720	C	130	-	-	-	-	-	-
3-23	UPPER SANTA ANA VALLEY	1,430	C	-	-	-	-	-	-	-
3-24	QUIEN SABE VALLEY	4,710	C	122	122	-	-	-	-	-
3-25	TRES PINOS VALLEY	3,390	C	1,225	-	-	-	3	-	-
3-26	WEST SANTA CRUZ TERRACE	7,870	C	550	200	-	-	7	480	378-684
3-27	SCOTTS VALLEY	774	C	410	100-900	26	7	7	360	100-980
3-28	SAN BENITO RIVER VALLEY	24,200	C	2,000	-	-	-	3	-	-
3-29	DRY LAKE VALLEY	1,420	C	-	-	-	-	-	-	-
3-30	BITTER WATER VALLEY	32,200	C	-	-	-	-	-	-	-
3-31	HERNANDEZ VALLEY	2,860	C	160	58	-	-	-	-	-

Table 21 Central Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
3-32	PEACH TREE VALLEY	9,790	C	117	84	-	-	-	-	-
3-33	SAN CARPOFORO VALLEY	200	C	-	-	-	-	-	-	217-385
3-34	ARROYO DE LA CRUZ VALLEY	750	C	-	-	-	-	-	-	211-381
3-35	SAN SIMEON VALLEY	620	A	170	100	-	-	4	413	46-2,210
3-36	SANTA ROSA VALLEY	4,480	A	708	400	-	-	2	-	298-2,637
3-37	VILLA VALLEY	980	C	-	-	-	-	-	-	260-1,635
3-38	CAYUCOS VALLEY	530	C	166	100	-	-	-	-	815-916
3-39	OLD VALLEY	750	C	335	200	-	-	-	-	346-2,462
3-40	TORO VALLEY	721	C	500	0	-	-	-	-	458-732
3-41	MORRO VALLEY	1,200	C	442	300	-	-	6	1150	469-5,100
3-42	CHORRO VALLEY	3,200	C	700	200	-	-	6	656	60-3,606
3-43	RINCONADA VALLEY	2,580	C	0	0	-	-	-	-	-
3-44	POZO VALLEY	6,840	C	230	100	-	-	5	-	287-676
3-45	HUASNA VALLEY	4,700	C	0	0	-	-	-	-	-
3-46	RAFAEL VALLEY	2,990	C	0	0	-	-	-	-	-
3-47	BIG SPRING AREA	7,320	C	0	0	-	-	-	-	-
3-49	MONTECITO	6,270	A	1,000	750	88	2	4	700	600-1,100
3-50	FELTON AREA	1,160	C	825	244	6	-	2	-	69-400
3-51	MAJORS CREEK	364	C	50	38	-	-	-	-	-
3-52	NEEDLE ROCK POINT	480	C	450	320	-	-	-	-	-
3-53	FOOTHILL	3,120	A	-	-	-	8	7	828	554-1,118

gpm - gallons per minute
mg/L - milligram per liter
TDS -total dissolved solids

Salinas Valley Groundwater Basin, 180/400 Foot Aquifer Subbasin

- Groundwater Subbasin Number: 3-4.01
- County: Monterey
- Surface Area: 84,400 acres (132 square miles)

Basin Boundaries and Hydrology

The Salinas Valley Groundwater Basin– 180/400-Foot Aquifer Subbasin includes the lower reaches and mouth of the Salinas River. The southwestern basin boundary is the contact of Quaternary Alluvium or Terrace Deposits with the granitic basement of the Sierra de Salinas. Further north along the western Salinas Valley margin the basin boundary is the contact with the Quaternary Paso Robles Formation or Aromas Red Sands of the Corral de Tierra Area Subbasin. The extreme northwest boundary of the subbasin is shared with the Salinas Valley - Seaside Area Subbasin along the seaward projection of the King City Fault. This fault may act a groundwater flow barrier between subbasins beneath a cover of Holocene sand dunes (Durbin and others 1978). The Subbasin is bounded by Monterey Bay to the northwest. The northern subbasin boundary is shared with the Pajaro Valley Groundwater Basin and coincides with the inland projection of a 400-foot deep, buried and clay-filled paleodrainage of the Salinas River. This acts as a barrier to groundwater flow between these subbasins (DWR 1969a; Durbin and others 1978). The northeastern boundary is shared throughout most of its length by the adjacent Salinas Valley – Eastside Subbasin, and to the north with a shorter length of common boundary with the Salinas Valley – Langley Area Subbasin. The northeastern subbasin boundary generally coincides with the northeastern limit of confining conditions in the 180/400-Foot Aquifer Subbasin (DWR 1946a) and with the location of State Highway 101. The southeastern boundary (near the City of Gonzales) is shared with the adjacent Salinas Valley – Lower Forebay Subbasin and is the approximate limit of confining conditions in an up-valley direction (DWR 1946a). The 180/400 Foot Aquifer Subbasin boundaries generally coincide with those of the Pressure Subarea of the Monterey County Water Resources Agency (MCWRA).

Hydrogeologic Information

The Salinas Valley is surrounded by the Gabilan Range on the east, by the Sierra de Salinas and Santa Lucia Range on the west, and is drained by the Salinas River, which empties into Monterey Bay on the north. The King City (Rinconda-Reliz) Fault generally follows the western margin of the Valley from King City in the south to Monterey Bay in the north (Durbin and others 1978). Valley-side down, normal movement along the fault allowed the deposition of an asymmetric, westward thickening alluvial wedge. The Salinas Valley has been filled with 10,000 to 15,000 feet of Tertiary and Quaternary marine and terrestrial sediments that include up to 2,000 feet of saturated alluvium (Showalter and others 1984). Above the generally non-water bearing and consolidated granitic basement, Miocene age Monterey and Pliocene age Purisima Formations are water bearing strata within the Plio-Pleistocene age Paso Robles Formation and within Pleistocene to Holocene alluvium.

Water Bearing Formations

The 180/400-Foot Aquifer Subbasin contains two main water-bearing units that are the basis for the subbasin's name – the 180-Foot Aquifer and the 400-Foot Aquifer – so named for the average depth at which they occur. A near-surface water-bearing zone also exists but it is a relatively minor source of water due to its poor quality. The 180-Foot Aquifer only occurs in this subbasin, as its confining blue clay layer (the Salinas Aquitard) thins and disappears east of the boundary with the adjacent Eastside Subbasin and south of the town of Chualar (MW 1994; LHI 1985). This Salinas Aquitard ranges in thickness from 25 feet near Salinas to more than 100 feet near Monterey Bay. The thickness of the 180-Foot Aquifer varies from 50 to 150 feet, with an average 100 feet (MW 1994; DWR 1970). This unit consists of a complex zone of interconnected sands, gravels and clay lenses (Durbin 1978). The aquifer may be in part correlative to older portions of Quaternary terrace deposits or the upper Aromas Red Sands. The 180-Foot Aquifer is separated from the 400-Foot Aquifer by a zone of discontinuous aquifers and aquitards ranging in thickness from 10 to 70 feet; the major aquitard in this sequence is also a marine blue clay.

The 400-foot aquifer has an average thickness of 200 feet and consists of sands, gravels, and clay lenses (LHI 1985). The upper portion of the aquifer may be correlative with the Aromas Red Sands and the lower portion with the upper part of the Paso Robles Formation (MW 1994).

An additional, deeper aquifer (also referred to as the 900-Foot Aquifer or the Deep Aquifer) is present in the lower Salinas Valley. A blue marine clay aquitard also separates this aquifer from the overlying 400-Foot Aquifer. This deeper aquifer consists of alternating layers of sand-gravel mixtures and clays (up to 900 feet thick), rather than a distinct aquifer and aquitard (MW 1994). The Deep Aquifer has experienced little development except near the coast where it is used to replace groundwater from the 180- and 400-Foot Aquifers rendered unusable by seawater intrusion. Water quality and yield data are scarce.

Because of the confined nature of the aquifers in the subbasin, an estimate of specific yield is not quite applicable. However, Yates (1988) estimated a storage coefficient of 0.018 in the northern Subbasin and 0.015 in the southern subbasin. A value of 0.075 was estimated for the central subbasin area. MW (1994) estimated specific yields for the three main aquifers in the Salinas Valley for their Integrated Ground and Surface Water Model (IGSM). The estimated values for the 180-Foot, 400-Foot, and Deep Aquifers were 8-16 percent, 6 percent, and 6 percent, respectively.

Heavy pumping of the 180- and 400-Foot Aquifers has caused significant seawater intrusion into both these aquifers, which was first documented in 1930s (DWR 1946a). Groundwater flow in the northernmost subbasin has been directed from Monterey Bay inland since at least this time. By 1995, seawater had intruded over five miles inland through the 180-Foot Aquifer, including the area beneath the towns of Castroville and Marina. Seawater has also intruded over two miles into the 400-Foot Aquifer by 1995.

Along with water quality issues associated with seawater intrusion, long-term agricultural production in the Salinas Valley has contributed to an extensive non-point source nitrate problem. Nitrate concentrations in many wells in the Valley exceed drinking water standards (DWR 1970; MCWRA 1997), including areas of the subbasin between Marina and Salinas, and to the northwest of Gonzales.

Recharge Areas

Due to the impermeable nature of the clay aquitard above the 180-Foot Aquifer, subbasin recharge (including that from precipitation, agricultural return flows, or river flow) is nil. Instead, recharge is from underflow originating in upper valley areas such as the Arroyo Seco Cone and Salinas River bed or the adjacent Eastside Subbasin, and more recently, from seawater intrusion. Historically, groundwater flowed from subbasins to the south and east through the subbasin and seaward to discharge zones in the walls of the submarine canyon in Monterey Bay (Durbin and others 1978; Greene 1970). With increased pumping in the adjacent Eastside Subbasin since the 1970s, groundwater flow is dominantly northeastward in the central and southern subbasin.

Groundwater Level Trends

Between 1964 and 1974, the amount of groundwater in storage has increased by 38,100 af. This increase continued from 1974 to 1984 with a rise of 8,200 af. This trend reversed itself between 1984 and 1994, when there was a decrease of 62,600 af in the amount of groundwater stored (MW 1998).

Groundwater Storage

Calculations done by DWR (2000) estimate the total storage capacity of this subbasin to be 7,240,000 af. As of 1998, there was 6,860,000 af of groundwater in storage (MW 1998).

Groundwater Budget (Type A)

A detailed groundwater budget for this subbasin was calculated for 1994 (MW 1998). Natural recharge into the aquifer was estimated to be 117,000 af. There is no artificial recharge. Applied water recharge is approximately 11,000 af, but because this recharge is caused by seawater intrusion, it is not included in the total basin inflow estimate. Subsurface inflow is estimated to be 21,000 af. Annual urban and agricultural extractions total approximately 130,000 af. There are no other extractions. Subsurface outflow is approximately 8,000 af.

Groundwater Quality

Characterization. The 180-Foot Aquifer is characterized by calcium sulfate to calcium sodium bicarbonate sulfate groundwaters (JSA 1990). Where this aquifer is intruded by seawater, the water is typically characterized by sodium chloride to calcium chloride. TDS values range from 223 to 1,013 mg/L, with an average value of 478 mg/L (based on 187 analyses; DHS 2000). TDS values from 30 public supply wells were reported as ranging from 233 to 996 mg/L, with an average value of 556 mg/L. EC values for this subbasin range from 320 to 1,526 µmhos/cm, with an average value of 741 µmhos/cm.

Impairments. Of 194 wells sampled during 1995 for nitrate in both the 180-Foot and 400-Foot Aquifers, 21 exceeded the drinking water standard. The average nitrate values for these aquifers were 35 and 9 mg/L, respectively (MCWRA 1997). Approximately 20,000 acres of the 180-Foot Aquifer and 10,000 acres of the 400-Foot Aquifer had been intruded by seawater (defined by chloride levels above 500 mg/L) by 1995 (MCWRA 1997).

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	33	0
Radiological	36	3
Nitrates	33	2
Pesticides	41	0
VOCs and SOCs	41	4
Inorganics – Secondary	33	7

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Production characteristics

	Well yields (gal/min)	
Municipal/Irrigation		
	Total depths (ft)	
Domestic		
Municipal/Irrigation	Range: 150 - 886	Average: 464 (74 Well Completion Reports)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
MCWRA	Groundwater levels	166 Varies (Geomatrix 2001)
MCWRA	Mineral, nutrient, & minor element.	218 Annually (Geomatrix 2001)
Department of Health Services (incl. Cooperators)	Title 22 water quality	82 Varies

Basin Management

Groundwater management:	MCWRA requires annual extraction reports form all agricultural and municipal well operators; and has researched, developed and/or constructed projects to reduce seawater intrusion, manage nitrate contamination in the ground water, provide adequate water supplies to meet current and future needs, and to hydrologically balance the ground water basin in the Salinas Valley.
Water agencies	
Public	Monterey County Water Resources Agency; Castroville CWD; City of Gonzales
Private	California Water Service Co. (CWS)–Salinas; CWS – Oak Hills

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Errata

Changes made to the basin description will be noted here.

Salinas Valley Groundwater Basin, Eastside Aquifer Subbasin

- Groundwater Basin Number: 3-4.02
- County: Monterey
- Surface Area: 57,500 acres (90 square miles)

Basin Boundaries and Hydrology

The Eastside Aquifer subbasin extends from approximately five miles north of the city of Salinas to twenty-five miles south to the town of Gonzales along the eastern side of the lower Salinas Valley. The subbasin is bounded to the north by the Pleistocene Aromas Red Sands of the Salinas Valley – Langley Area Subbasin. To the south, the subbasin shares a boundary with Quaternary Alluvium and Terrace deposits of the Salinas Valley – Lower Forebay Aquifer Subbasin. The western subbasin boundary generally coincides with the northeastern limit of confining conditions in the adjacent 180/400-Foot Aquifer subbasin (DWR 1946a) and with the location of State Highway 101. The eastern boundary is the contact of Quaternary Terrace deposits with granitic rocks of the Gabilan Range. The subbasin boundaries are generally correlative with those of the East Side subarea of the Monterey County Water Resources Agency (MCWRA). Intermittent streams such as Natividad, Alisal, Quail, Parsons, Muddy and Johnson Creeks drain the western slopes of the Gabilan Range and flow across the Subbasin toward the Salinas River on the west side of the Valley. Average annual precipitation is 13 inches.

Hydrogeologic Information

The Salinas Valley is surrounded by the Gabilan Range on the east, by the Sierra de Salinas and Santa Lucia Range on the west, and is drained by the Salinas River, which empties into Monterey Bay on the north. The King City (Rinconda-Reliz) Fault (Durbin 1978) generally follows the western margin of the Valley from King City in the south to Monterey Bay in the north. Valley-side down, normal movement along the fault allowed the deposition of an asymmetric, westward thickening alluvial wedge. The Salinas Valley has been filled with 10,000 to 15,000 feet of Tertiary and Quaternary marine and terrestrial sediments that include up to 2,000 feet of saturated alluvium (Showalter 1984). Above the generally non-water bearing and consolidated granitic basement, Miocene age Monterey and Pliocene age Purisima Formations are water bearing strata within the Plio-Pleistocene age Paso Robles Formation and within Pleistocene to Holocene alluvium.

Water Bearing Formations

The primary water-bearing units of this subbasin are the same units that produce water in the adjacent 180/400-Foot Aquifer subbasin – namely, the 180-Foot Aquifer and the 400-Foot Aquifer. However, the near-surface confining unit (Salinas Aquitard) does not extend into the Eastside or other subbasins. Groundwater in the Eastside Aquifer subbasin is semi-confined to unconfined and occurs in lenses of sand and gravel that are interbedded with massive units of finer grained material (Durbin 1970).

The thickness of the 180-foot aquifer varies from 50 to 150 feet in the Salinas Valley, with an average 100 feet (MW 1994; DWR 1970). Because of the westward thickening of alluvial units in the Salinas Valley (Showalter 1984), the average thickness in the Eastside subbasin is probably less than that stated above. The 180-Foot Aquifer may be in part correlative to older portions of Quaternary terrace deposits or the upper Aromas Red Sands. The 180-Foot Aquifer is separated from the 400-Foot Aquifer by a zone of discontinuous sands and blue clays called the 180/400-foot Aquiclude (MW 1998) which ranges in thickness from 10 to 70 feet.

More recent studies suggest the 400-Foot Aquifer exist not only in the 180/400-Foot Aquifer subbasin, but also in the Eastside Aquifer and Lower Forebay Aquifer subbasins (MW 1994). The 400-foot aquifer has an average thickness of 200 feet and consists of sands, gravels, and clay lenses (LHI 1985). The upper portion of the aquifer may be correlative with the Aromas Red Sands and the lower portion with the upper part of the Paso Robles Formation (MW 1994).

Later reports term the 180-Foot Aquifer and the 400-Foot Aquifer the "shallow zone" and "deep zone", respectively, in the Eastside and in the Upper and Lower Forebay subbasins (MW 1998).

An additional a deeper aquifer (also referred to as the 900-Foot Aquifer or the Deep Aquifer) is present in the lower Salinas Valley. A blue marine clay aquitard also separates this aquifer from the overlying 400-Foot Aquifer. This deeper aquifer consists of alternating layers of sand-gravel mixtures and clays (up to 900 feet thick), rather than a distinct aquifer and aquitard (MW 1994). The Deep Aquifer has experienced little development except near the coast where it is used to replace groundwater from the 180- and 400-Foot Aquifers rendered unusable by seawater intrusion; water quality and yield data are scarce.

MW (1994) estimated specific yields for the three main aquifers in the Salinas Valley for their Integrated Ground and Surface Water Model (IGSM). The estimated values for the 180-Foot, 400-Foot, and Deep Aquifers were 8-16 percent, 6 percent, and 6 percent, respectively. An average weighted specific yield of 8.8 percent was derived for three depth zones within the interval 20 to 200 feet below grade by the SWRB (1955). Yates (1988) estimated a storage coefficient of 0.0285 in the northern subbasin and 0.030 in the southern subbasin.

Groundwater quality issues primarily stem from long-term agricultural production in the Salinas Valley that has contributed to an extensive non-point source nitrate problem. Nitrate concentrations in many wells in the Valley exceed drinking water standards (DWR 1970), including in wells throughout the Eastside Aquifer subbasin (MCWRA 1997).

Restrictive Structures

Groundwater flow is generally in a down-valley direction but extensive pumping has created a long-lasting groundwater table depression near the Valley margin in the northern subbasin northeast of Salinas. Flow is now from the north, west and south into the depression. Average groundwater depths at the depression were up to 50 feet below sea level from 1970 to 1981 (Yates 1988). During Fall 1995, the deepest portion of the depression was over 80 feet below sea level (MCWRA 1997). The linear depression may result from the restriction of groundwater flow caused by the presence of a northwest trending buried fault. Groundwater elevations decrease from the east to the west by over 130 feet within a distance of one mile as this buried structure is crossed (Showalter 1984).

Recharge Areas

Historically, subbasin recharge was from percolation from stream channels that head on the west slopes of the Gabilan Range (DWR 1946a) and from subsurface inflow from rainfall percolated through the Aromas Red Sands deposits in the adjacent Langley Area subbasin to the north (Yates 1988). With the advent of large-scale groundwater pumping over the past 50 years, recharge now is primarily from subsurface flow from the subbasins to the south and west.

Groundwater Level Trends

Between 1964 and 1974, the amount of groundwater in storage increased 86,500 af. This increase slowed to 15,100 af between 1974 and 1984. From 1984 to 1994, the increasing trend reversed, and the amount of water in storage dropped by 155,000 af (MW 1998).

Groundwater Storage

Calculations made by DWR (2000) give an estimated total storage capacity of 3,690,000 af for the subbasin. As of 1994, there is approximately 2,560,000 af of groundwater in storage in this subbasin (MW 1998).

Groundwater Budget (Type A)

A detailed groundwater budget was available for this subbasin for 1994 (MW 1998). Natural recharge (including applied water recharge) is estimated to be 41,000 af. There is no artificial recharge. Subsurface inflow is approximately 17,000 af. Annual urban and agricultural extractions total 86,000 af. There are no other extractions or subsurface outflow.

Groundwater Quality

Characterization. The water in this subbasin is of a sodium-calcium chloride type, with the salts derived from marine formations in the subbasin watershed (JSA 1990). Based on 129 analyses, TDS values range from 168 to 977 mg/L, with an average value of 450 (DHS 2000). The Department of Health Services monitors Title 22 water quality standards, and in 25 public supply wells they report TDS values ranging from 240 to 788 mg/L, with an average value of 413 mg/L (DHS 2000). DHS also report 128 analyses that give EC values ranging from 52 to 1,600 µmhos/cm, with an average value of 693 µmhos/cm (DHS 2000).

Impairments. Of 68 wells sampled for nitrates in 1995, 32 exceeded the drinking water standard of 45 mg/L. The average concentration was 69 mg/L (MCWRA 1997).

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	28	0
Radiological	30	0
Nitrates	28	2
Pesticides	30	0
VOCs and SOCs	30	0
Inorganics – Secondary	28	4

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Production characteristics

	Well yields (gal/min)	
Municipal/Irrigation		
	Total depths (ft)	
Domestic		
Municipal/Irrigation	Range: 299 - 1,100	Average: 610 (12 Well Completion Reports)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
MCWRA	Groundwater levels	74 Varies (Geomatrix 2001)
MCWRA	Mineral, nutrient, & minor element.	67 Annually (Geomatrix 2001)
Department of Health Services (incl Cooperators)	Title 22 water quality	53 Varies

Basin Management

Groundwater management:	MCWRA requires annual extraction reports form all agricultural and municipal well operators; and has researched, developed and/or constructed projects to reduce seawater intrusion, manage nitrate contamination in the ground water, provide adequate water supplies to meet current and future needs, and to hydrologically balance the ground water basin in the Salinas Valley.
Water agencies	
Public	Monterey County Water Resources Agency
Private	California Water Service Co. (CWS)–Salinas; Alco Water Service; Gabilan Water Co.

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Errata

Changes made to the basin description will be noted here.