Seaside Groundwater Basin
Salt & Nutrient Management Plan

Prepared for:
Monterey Peninsula Water Management District

Prepared by:

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ABBREVIATIONS

AFY	acre-feet per year
ASR	aquifer, storage and recovery
BMP	best management practices
CCR	California Code of Regulations
CDPH	California Department of Public Health
CEC	chemical of emerging concern
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
DWR	California Department of Water Resources
ET	evapotranspiration
GWRP	Groundwater Replenishment Project
IRWMP	Integrated Regional Water Management Plan
MCL	maximum contaminant levels
MCWD	Marina Coast Water District
mg/L	milligrams per liter
MMP	monitoring and management program
MPWMD	Monterey Peninsula Water Management District
MRSWMP	Monterey Regional Storm Water Management Program
MRWPCA	Monterey Regional Water Pollution Control Agency
NPDES	National Pollutant Discharge Elimination System
POTW	publically owned treatment works
RUWAP	Regional Urban Water Augmentation Project
RWQCB	Regional Water Quality Control Board
SNMP	Salt and Nutrient Management Plan
SVRP	Salinas Valley Reclamation Plant
SWRCB	State Water Resources Control Board
TAC	Watermaster's Technical Advisory Committee
TDS	total dissolved solids
USGS	United States Geological Survey
WDR	waste discharge requirements
WQO	water quality objectives

SECTION 1
INTRODUCTION

1.1 Background

As part of State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy, salt and nutrient management plans (SNMP) for each groundwater basin in California are required by 2014. The SNMP are called for to facilitate management of salts and nutrients in a manner that optimizes recycled water use while ensuring protection of groundwater supply and beneficial uses, agricultural beneficial uses, and human health. The SNMP identifies sources, transport and fate of salts and nutrients in surface water and groundwater within the Seaside Basin.

The Seaside Basin SNMP has been prepared in response to the Recycled Water Policy requirement to complete a SNMP by the end of 2014. Its development dovetails with an update to the Monterey Peninsula, Carmel Bay, and South Monterey Bay Integrated Regional Water Management Plan (IRWMP). Funding for the SNMP and IRWMP update is provided by the California State Department of Water Resources (DWR) as part of a Proposition 84 IRWM Planning Grant.

1.2 Goals

The goals of the SNMP are the same as those identified in the IRWMP in 2007:

> *Protect and improve water quality for beneficial uses consistent with regional community interests and the RWQCB basin plan through planning and implementation in cooperation with local and state agencies and regional stakeholders*.

1.3 Objectives

Meet or exceed all applicable water quality regulatory standards.
The primary objective of the SNMP is to protect groundwater in the Seaside Basin. To achieve this, programs need to be in place to ensure that water quality regulations are either met or exceeded. This includes activities that can mitigate current problems and evade possible future water quality degradation, e.g., seawater intrusion.

Meet or exceed urban water quality targets established by stakeholders.
Targets set by municipal and industrial stakeholders that are beyond regulatory requirements should be met or exceeded.

Meet or exceed recycled water quality targets established by stakeholders.
In order to promote public and private recycled water demand, it is important that water quality targets set by stakeholders not only meet regulatory requirements but also meet the requirements or expectations of the eventual end-users.

Protect surface waters from contamination
All surface waters in the planning region should be protected from contamination and the threat of contamination. Protecting surface waters that drain to Monterey Bay will protect the Monterey Bay National Marine Sanctuary. The Monterey Regional Storm Water Management Program is currently being implemented to assist in meeting this objective.

Protect the Seaside Basin from contamination and threat of contamination.
The Seaside Basin should be protected from contamination and the threat of contamination. This includes protecting from point-source and non-point-source pollutants and preventing sea-water intrusion.

Minimize impacts from storm water (or urban) runoff through implementation of Best Management Practices or other alternatives.
The discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The planning Region is subject to Phase II NPDES requirements which are intended to address potentially adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation.

1.4 REGULATORY REQUIREMENTS

1.4.1 BASIN PLAN AND BENEFICIAL USES

The Central Coast Regional Water Quality Control Board (RWQCB) relies on its adopted "Water Quality Control Plan for the Central Coast Basin Plan" (Basin Plan) to manage surface and groundwater in order to provide the highest water quality reasonably possible. The Basin Plan lists beneficial uses and describes water quality objectives to maintain water quality, describes programs, projects, and other actions to achieve the plan's standards, summarizes plans and policies to protect water quality, and describes statewide and regional monitoring programs.

The RWQCB implements the Basin Plan by issuing and enforcing waste discharge requirements (WDR, non-water body discharges) and National Pollutant Discharge Elimination System (NPDES) permits (surface water body discharges) for point discharges, establishment of water-quality based effluent limitations, prohibitions of discharge, and the review and establishment of Total Maximum Daily Loads.

Each water body under the Basin Plan is designated one or more beneficial uses such as domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources. Section 3.9 identifies all beneficial uses in the Seaside Basin.

Monitoring activities to determine compliance with water quality objectives include discharger self-monitoring required under WDRs and NPDES permits, and monitoring undertaken by the RWQCB through its Central Coast Ambient Monitoring Program.

1.4.2 STORM WATER REGULATIONS

The 1987 amendments to the Clean Water Act added Section 402(p) provides a framework for regulating certain storm water discharges under the NPDES program. Separate permits are required for municipal, industrial, and construction activities.

Since March 10, 2003, municipal storm water permits for urbanized areas in the Seaside Basin have been covered under EPA's Storm Water Phase II Final Rule (December 1999), which established application requirements for storm water permits for additional operators of MS4s in urbanized areas. In 2000, the cities in the Southern Monterey Bay area (including all those in the Seaside Basin), Monterey County, and the Pebble Beach Company formed a Working Group to develop a storm water management program and secure a Phase II NPDES permit from the RWQCB. The Working Group developed the Monterey Regional Storm Water Management Program (MRSWMP) and permit coverage was issued by the RWQCB in September 2006. The MRSWMP is currently being implemented by the participating entities. Under the permit, there are six types of pollution control activity: public education, pollution source identification and abatement, water quality monitoring, land use regulations, construction site regulation and control of municipal operations.

The MRSWMP contains a series of management practices, referred to as "Best Management Practices" (BMPs). These BMPs are designed to reduce the discharge of pollutants from the municipal separate storm sewer systems to the "maximum extent practicable," to protect water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act.

Storm water associated with industrial activities that discharge either directly to surface waters or indirectly through separate municipal storm sewers must be regulated by an NPDES permit (Water Quality Order No. 97-03-DWQ, General Permit No. CAS000001).

Currently, the SWRCB has adopted a separate statewide general permit for construction activities disturbing an area greater than one acre (Order No. 2012-0006-DWQ, NPDES No. CAS000002). The intentions of this permit are to eliminate or reduce non-storm water discharges to storm sewer systems and other waters, and to implement and perform inspections of Best Management Practices (BMPs). State agencies such as Caltrans, municipal agencies and private construction activities are subject to this permit.

1.4.3 RECYCLED WATER POLICY

In an effort to increase availability and reliability of existing supplies, the use of recycled water has been increasing in California. In 2009, the SWRCB adopted the Recycled Water Policy (February 2009) to address long-term water quality issues raised by water reuse. As part of the policy, salt and nutrient management plans (SNMP) for each groundwater basin in California are required by 2014 to facilitate management of salts and nutrients in a manner that optimizes recycled water use while ensuring protection of groundwater supply and beneficial uses, agricultural beneficial uses, and human health. The policy was revised in January 2013 to include Chemicals of Emerging Concern (CECs) monitoring requirements for planned and future intentional recycled water recharge projects.

The Recycled Water Policy states that Salt and Nutrient Management Plans need to be completed by 2014 to facilitate basin-wide management of salt and nutrient from all sources in a manner that optimizes recycled water use while ensuring protection of groundwater supply and beneficial uses, agricultural beneficial uses, and human health.

The RWQCB through its regulation of waste discharges, requires operators of publically owned treatment works (POTW) to develop implementation plans to meet the objectives of the Recycled Water Policy.

1.4.4 GROUNDWATER BASIN ADJUDICATION

In 2006, the Monterey County Superior Court (*California American Water v. City of Seaside et al., Case No. M66343*) concluded that groundwater production within the Seaside Basin exceeds the Natural Safe Yield and therefore a physical solution that reduces production to the Natural Safe Yield was established to prevent seawater intrusion and its deleterious effects on the Basin. The adjudication process led to the issuance of the Court Decision (amended in 2007) that created the Seaside Groundwater Basin Watermaster (Watermaster). The Watermaster's role is to administer and enforce the provisions of the Amended Decision (California American Water v. City of Seaside et al., 2007). The Watermaster consists of nine representatives (number of representative in parentheses) from Cal-Am (1), City of Seaside (1), City of Sand City (1), City of Monterey (1), City of Del Rey Oaks (1), Landowner Group (2), Monterey Peninsula Water Management District (1), and Monterey County/Monterey County Water Resources Agency (1).

The threat of seawater intrusion is managed by the Court Decision in part by triennial pumping reductions which end in 2021 at the Natural Safe Yield of 3,000 acre-feet per year (AFY). The Decision required that a monitoring and management plan (MMP) be implemented that was consistent with criteria outlined in the Decision. This MMP was completed in September 2006 and approved by the Court in February 2007 to ensure that the Seaside Groundwater Basin is protected and managed as a perpetual source for beneficial users. The MMP includes groundwater production, groundwater level, and groundwater quality monitoring. Details of the MMP monitoring plan are provided in Section 5.

It should be noted that the adjudicated basin boundary is slightly different than the basin boundary that is used for this SNMP. A discussion of the different boundaries is presented in Section 3.1.

SECTION 2
STAKEHOLDER PROCESS

Stakeholder involvement is key to the success of developing and implementing a SNMP. The stakeholders are those responsible for ensuring the plan is carried out and updated as needed to reflect changing land use and activities within the basin.

2.1 STAKEHOLDER IDENTIFICATION

The Watermaster has a Board that comprises the City of Seaside, Laguna Seca subarea landowners, Monterey Peninsula Water Management District, City of Sand City, California American Water, City of Del Rey Oaks, Monterey County/Monterey County Water Resources Agency, Coastal subarea landowners, and the City of Monterey. These Board members account for most of the stakeholders in the basin. Others that are not as directly represented on the Board include the following golf courses: Nicklaus Club-Monterey (formerly Pasadera Country Club), Laguna Seca Golf Ranch, and Black Horse and Bayonet, which are owned by the City of Seaside.

2.2 STAKEHOLDER INVOLVEMENT

During the course of the SNMP development, the Watermaster's Technical Advisory Committee (TAC) was kept updated on development and asked to provide direction on key issues.

- May 9, 2012 – presentation to TAC on content of SNMP, and information request that will be issued to golf courses and other stakeholders with potential salt and nutrient loading activities.

- February 13, 2013 – TAC input on which basin boundary to use for the SNMP. The topic was referred to the Board who deferred it to the RWQCB's decision.

- January 8, 2014 – presentation to the TAC on SNMP findings and way forward.

- April 2014 – presentation to the Seaside Basin Watermaster TAC and Board to present findings of the SNMP.

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SECTION 3
BASIN CHARACTERISTICS

3.1 Basin Boundary

The Seaside basin as a subbasin of the Salinas Valley Basin is delineated by the DWR in Bulletin 118 as shown on Figure 1. This delineation of the basin has not been used historically or currently for management purposes. There are more relevant basin boundaries which are discussed below that are used in place of the DWR boundary. The Seaside Basin boundary that is included as Exhibit B of the original adjudication decision (Decision) filed March 27, 2006, is from Figure 2-1 of the CH2MHill 2004 report titled *Hydrogeologic Assessment of the Seaside Groundwater Basin*. Although not stated in that report, the overall basin boundaries, subbasin and subarea boundaries are taken from Plate 1 of the Fugro West, Inc. 1997 (Fugro 1997) report titled *Hydrogeologic Assessment, Seaside Coastal Groundwater subareas, Phase III Update*. The overall basin boundary used in the Fugro 1997 report was in turn based on Figure 3 of the U.S. Geological Survey 1982 report titled *Ground Water in the Seaside Area, Monterey County, California* (Muir, 1982). The northern and eastern boundaries delineated in this report were based on very limited geologic control and groundwater levels. Figure 1 shows the basin boundary used for the adjudication decision.

The overall basin boundaries of the adjudication decision are therefore based on reconnaissance-level analyses published by the USGS in 1982. The basin boundary was revised as part of an updated investigation of the Seaside Basin as described by Yates et al. (2005). Due to this more recent and detailed analysis of boundary conditions by Yates et al. (2005), this boundary is considered as the most current and accurate documented depiction of the basin boundaries and has been used in the Monterey Peninsula IRWMP. Figure 1 shows the difference between the adjudicated and updated boundaries.

Per the Decision, the basin is divided into four subareas. The coastal area west of the former Fort Ord boundary is divided into a Northern Coastal subarea and a Southern Coastal subarea by the extension of the Laguna Seca anticline (Figure 1). Similarly the area east of the former Fort Ord boundary is divided by the Laguna Seca anticline into the Northern Inland subarea and the Laguna Seca subarea.

3.2 BASIN PHYSIOGRAPHY

The Seaside basin is located adjacent to Monterey Bay in Monterey County. It underlies the Cities of Seaside, Sand City, Del Rey Oaks, Monterey, and portions of unincorporated county areas, including portions of former Fort Ord, and the Laguna Seca area. The basin is bounded by the Pacific Ocean to the west, the Salinas Valley to the north, the Toro Park area to the east, and Highways 68 and 218 to the south (Figure 1). An active dune system along the coast dominates the coastal topography, with older less active dunes found inland, mostly within the former Ford Ord open space. This hilly coastal plain, slopes both northwards to the Salinas River Valley and westwards towards the Monterey Bay. Elevations in the basin range from sea level at the coast to 950 feet above mean sea level inland.

3.3 WATERSHEDS AND HYDROLOGY

The groundwater basin contains a number of watersheds defined by the DWR that are part of the Salinas Hydrologic Unit (Figure 2). Pilarcitos Canyon and Corral de Tierra Valley watersheds drain northeast to the Salinas Valley, while the Laguna Seca and Monterey watersheds drain northwest to the Pacific Ocean.

There are few flowing creeks in the basin because of the permeable nature of the soils. The only creek with a defined channel is the Arroyo del Rey which flows intermittently in Canyon del Rey to the south of the basin, roughly alongside Highway 68 and 218 (Canyon del Rey Blvd), and into Laguna Grande Lake, through Roberts Lake and eventually into Monterey Bay through a series of flow control structures. Flow in the creek responds rapidly to rainfall, and is usually dry in the summer months. Creeks in the area have a "flashy" nature and readily lose water to streambed seepage. There are no natural surface water bodies within the basin boundary. Just south of the basin boundary, the coastal man-made lakes: Laguna Grande / Roberts Lake are found (Figure 2). Although these lakes do not fall directly within the basin boundaries, their catchments do include part of the Seaside basin.

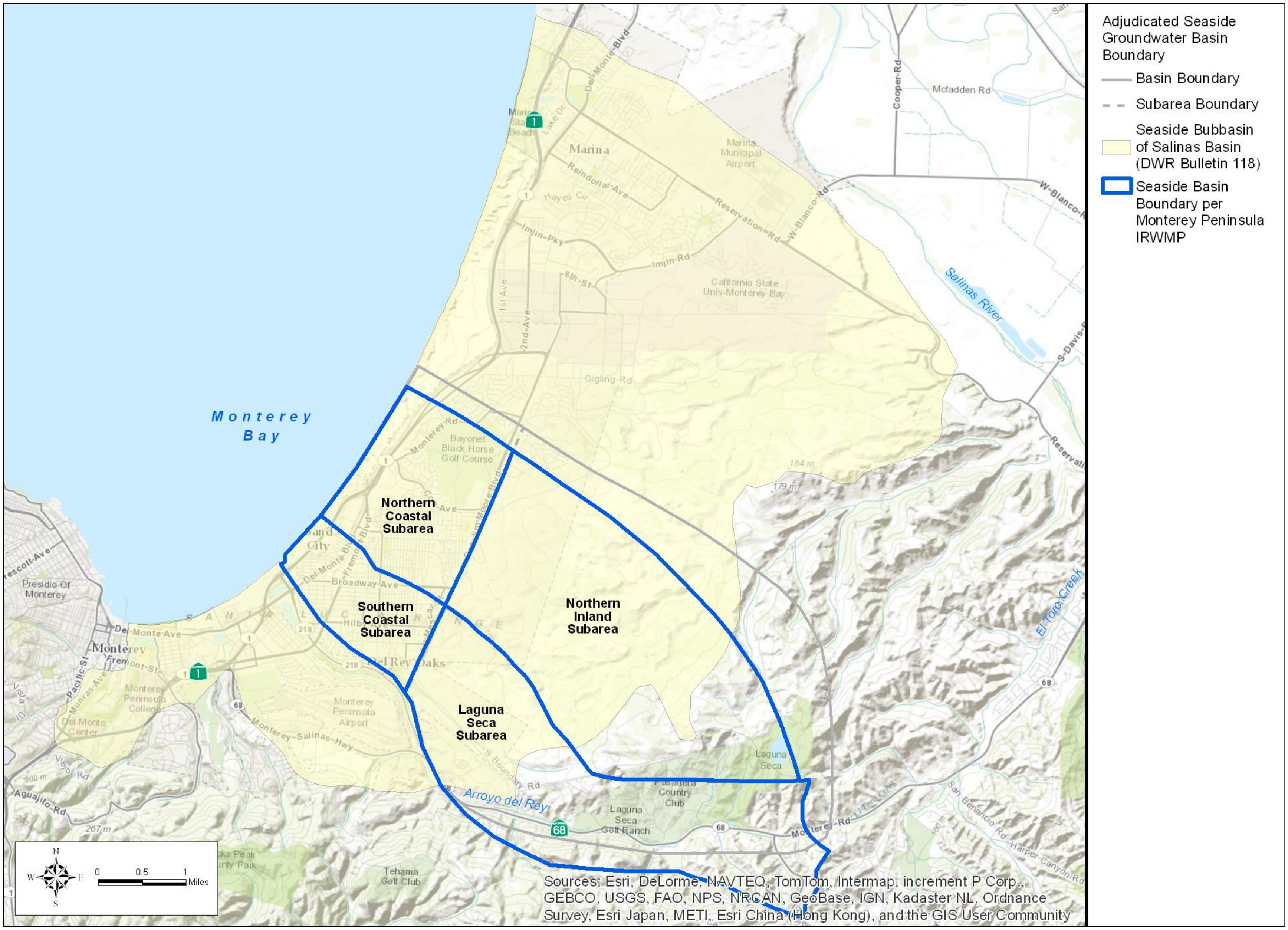


Figure 1: Seaside Groundwater Basin Boundary

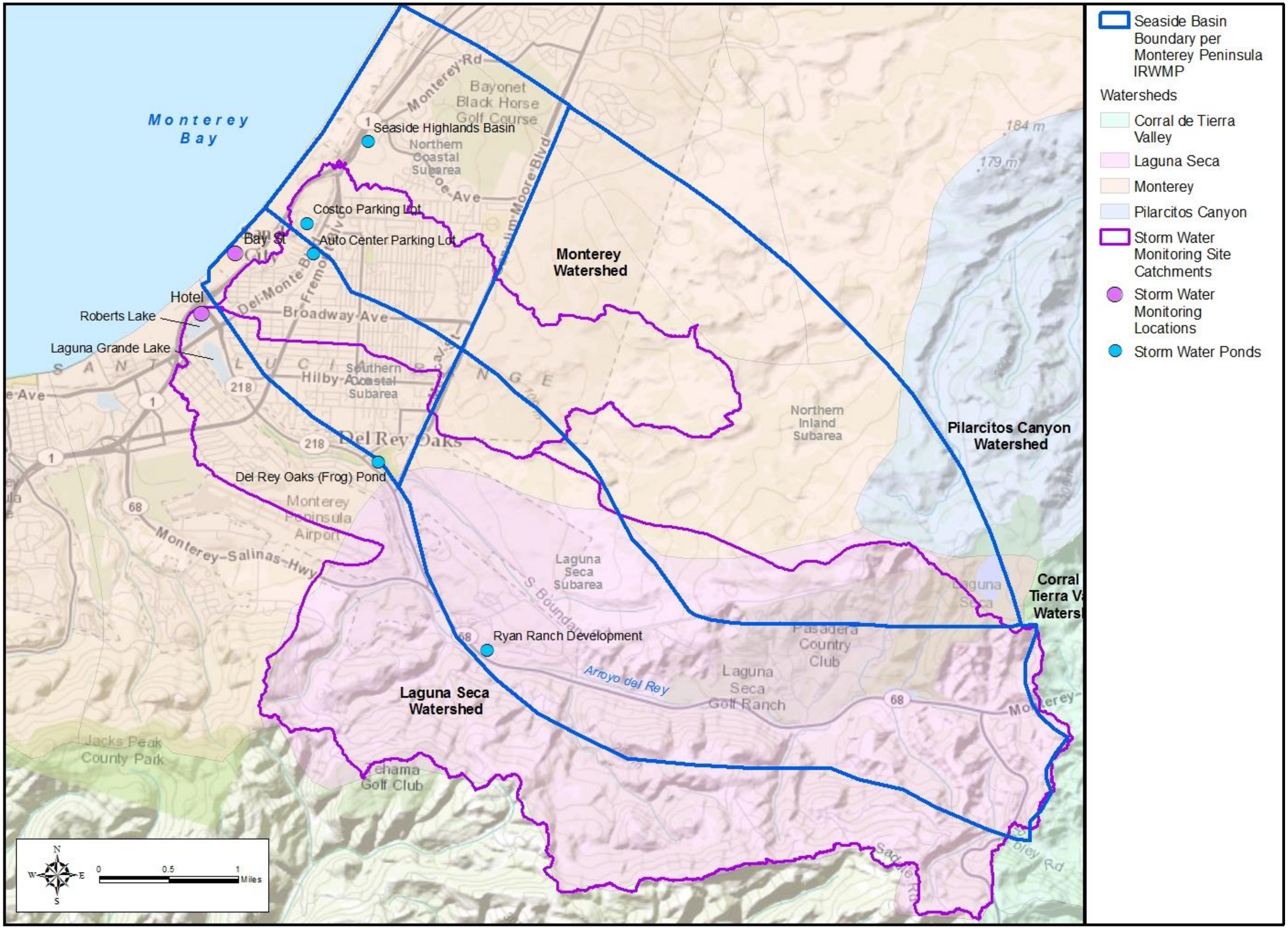


Figure 2: Seaside Groundwater Basin Watersheds and Hydrology

3.4 CLIMATE

The area experiences a Mediterranean-type, semi-arid climate, with warm dry summers and mild winters. Ninety percent of its annual rainfall falls in the months between November and April. There is no long-term weather station in the Seaside basin. The closest long-term climate stations are Monterey Station (045795) and Salinas#2 (047668). The Monterey Station is approximately 3.5 miles to the west of the Seaside Basin, and the Salinas Station approximately seven miles to the northeast (Figure 3). As shown by the isohyetal map on Figure 3, the rainfall across the Seaside basin varies from 14 inches near the Salinas Valley to 20 inches at the southern boundary. An average of the two stations is therefore a good measure of the average rainfall experienced by the basin. Averaging the rainfall from both stations for Water Year 1959 through 2011 gives an average of 16.5 inches per year. The rainfall over this period has ranged from 8 to 41 inches per year. Most years have below average rainfall but the years that are over the average are often at least 10 inches over the average. Figure 3 includes a plot of the annual rainfall from Water Year 1959 to 2011 for each station, and includes a cumulative departure from mean annual rainfall plot for the Monterey Station to show rainfall trends over time. The plot shows there were dry periods between 1959 and 1966, 1984 and 1992, and 1999 and 2004.

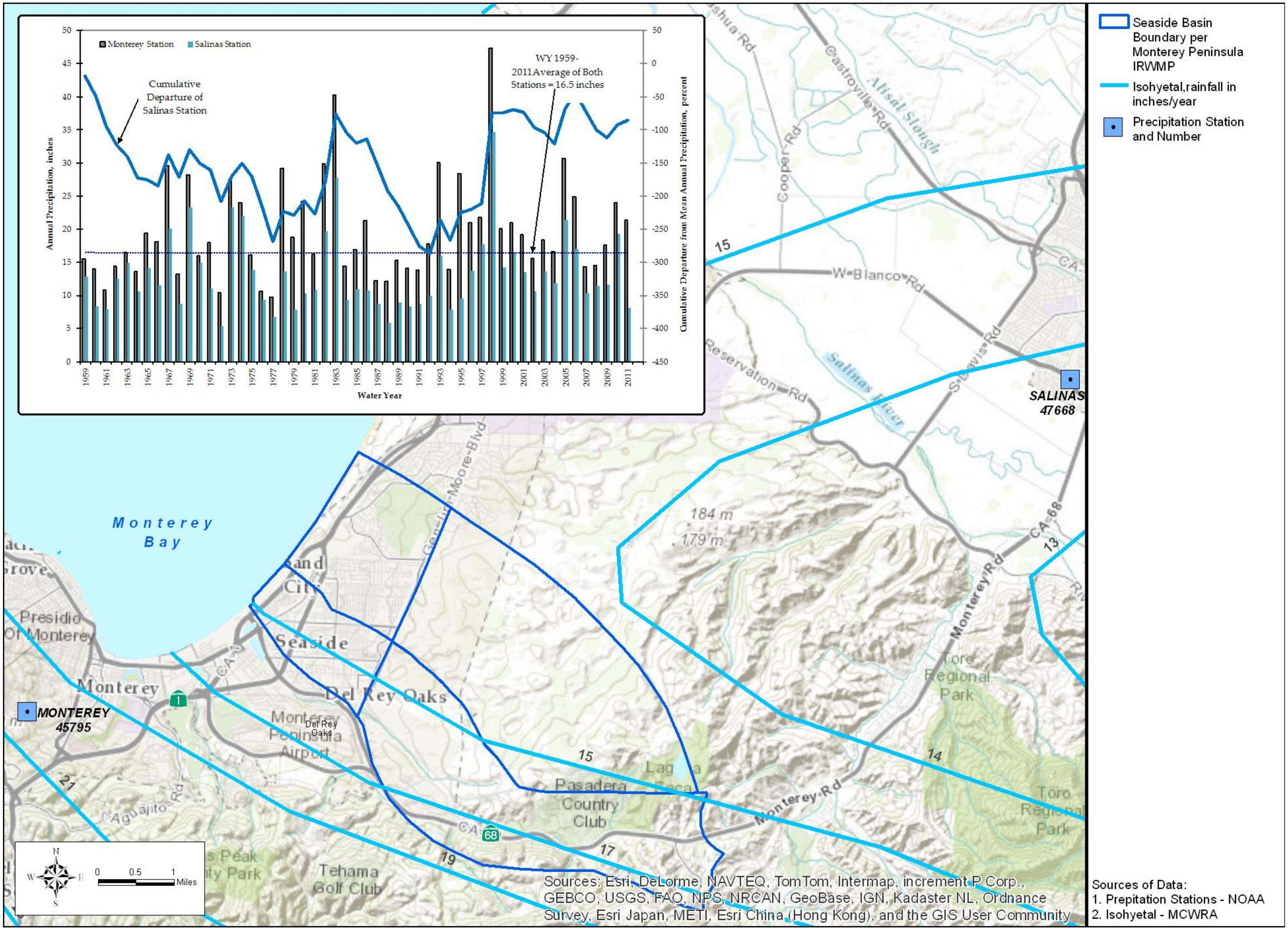


Figure 3: Distribution of Rainfall

3.5 Geologic/Hydrogeologic Framework

3.5.1 Stratigraphy and Hydrostratigraphy

The Seaside basin consists of a sequence of unconsolidated marine, fluvial and aeolian sediments that overlie relatively impermeable Monterey Formation of Miocene age and older crystalline rocks. The geologic map on Figure 4 shows the surface geology as mapped by Rosenberg (2001).

Conformably overlying the Monterey Formation is Santa Margarita Sandstone, which is also referred to as the Santa Margarita aquifer or deep aquifer. The Santa Margarita Sandstone consists primarily of marine-derived, sedimentary sandstone. Exploratory drilling associated with the Watermaster's sentinel wells suggests that parts of the deep aquifer previously assigned to the Santa Margarita Sandstone in and near the Northern Coastal and Northern Inland subareas consist of generally finer-grained sediments that should be assigned to the Purisima Formation. The only outcrops of Santa Margarita Sandstone (Tsm) within the basin occur along the eastern portion of the Laguna Seca Anticline and at the intersection of the Chupines and Ord Terrace Faults.

The Purisima Formation interfingers with the Santa Margarita Sandstone in the northern portion of the basin. The location of the transition is poorly understood due to a paucity of wells in the area where this transition occurs. The Purisima Formation is similar to the Santa Margarita Sandstone in that it is a marine deposit consisting of poorly indurated, gravels, sands, silts, and silty clay. Where the Purisima Formation is known to occur in the Marina area, it is deeper than 1,500 feet below MSL. There is no Purisima Formation outcrop in the basin.

The geologic unit unconformably overlying the Santa Margarita Sandstone and Purisima Formation is a Tertiary and Quaternary continental deposit locally called the Paso Robles or shallow aquifer. This unit consists of a mixture of continentally-derived gravel, sand, silt and clay sedimentary deposits. The unit is exposed in the foothills of the Laguna Seca subarea. It is an unconfined aquifer that is overlain by the surficial Aromas Sand. The Aromas Red Sands and Older Dune deposits are Quaternary surficial deposits representing the uppermost geologic units in the basin. These deposits are a variety of continental deposits, including: fluvial and coastal terrace, flood-plain, stream alluvium, colluviums and basin deposits (Yates, et al., 2002).

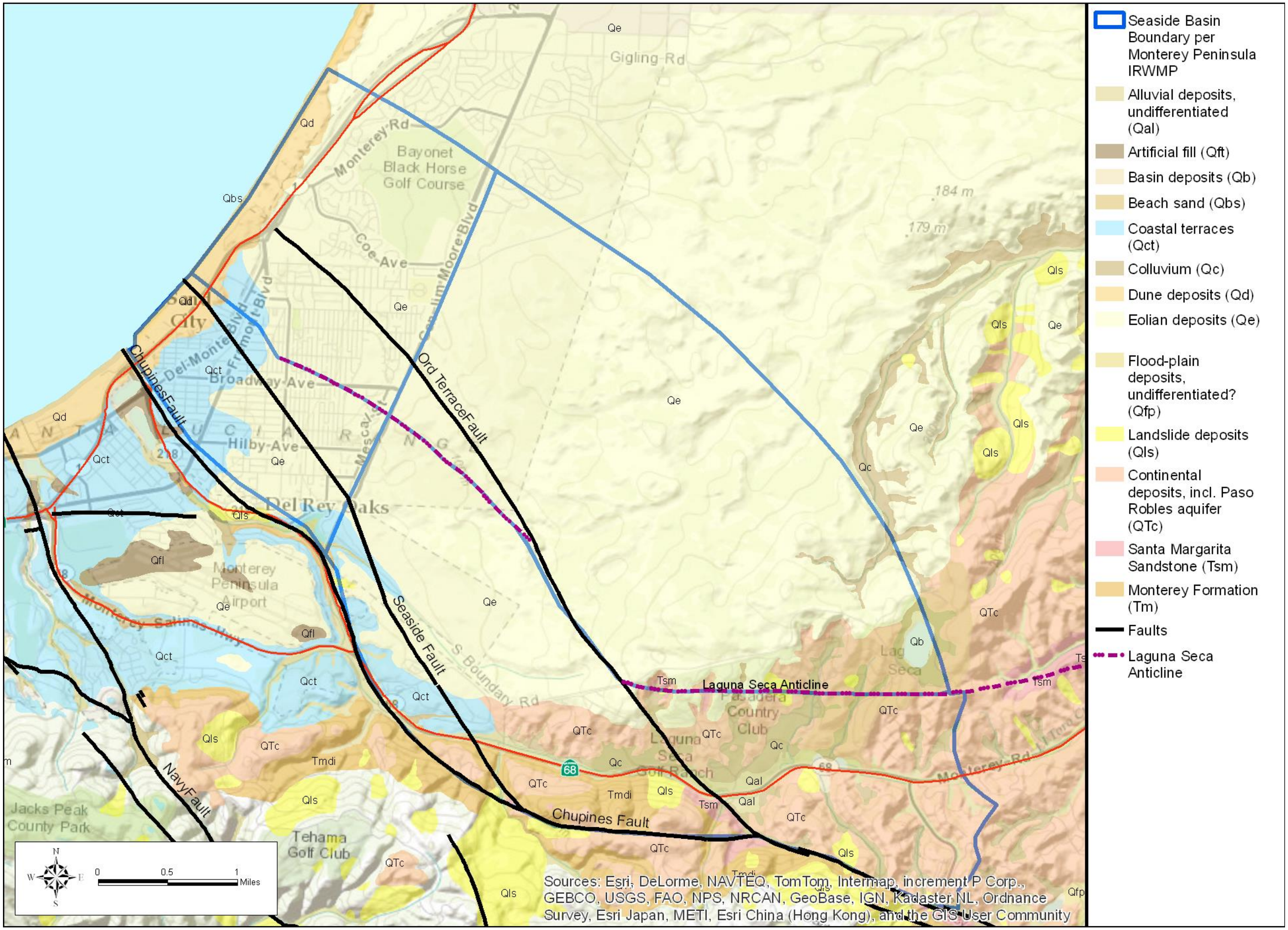


Figure 4: Geology and Faults

3.5.2 STRUCTURAL GEOLOGY

The Chupines Fault zone roughly bounds the southern edge of the basin (Figure 4). The Seaside and Ord Terrace Faults are found running through the basin, north of the Chupines Fault. The northeast side of the each of the faults is typically downthrown. This has resulted in a loss of Santa Margarita Sandstone south of the Seaside Fault, and as a result there is also very little Paso Robles aquifer or alluvial sediments in the area between the Chupines and Seaside Faults. For the conceptual model the faults are considered partial groundwater flow barriers although the offset in geology likely causes more of an impedance to groundwater flow than any fault gouge.

The Laguna Seca Anticline separates the northern and southern subareas of the Seaside Groundwater Basin (Figure 4). This feature—including the segment of the Ord Terrace Fault that offsets the anticline—forms a subsurface hydraulic partial barrier to groundwater flow.

The top of the Monterey Formation is considered non-water bearing due to low yields and poor water quality, and is therefore regarded as the base of the groundwater basin. There is no outcrop of Monterey Formation within the basin. A contour map showing its elevation and topography in basin found in Figure 5. Major features to note are the undulations in the Laguna Seca area due to the Laguna Seca anticline; and the depth of the basin in the north, where it reaches an elevation of 1,200 feet below MSL. Its highest elevation is approximately 500 feet above MSL, which is found at the Laguna Seca Anticline's intersection with the Ord Terrace Fault.

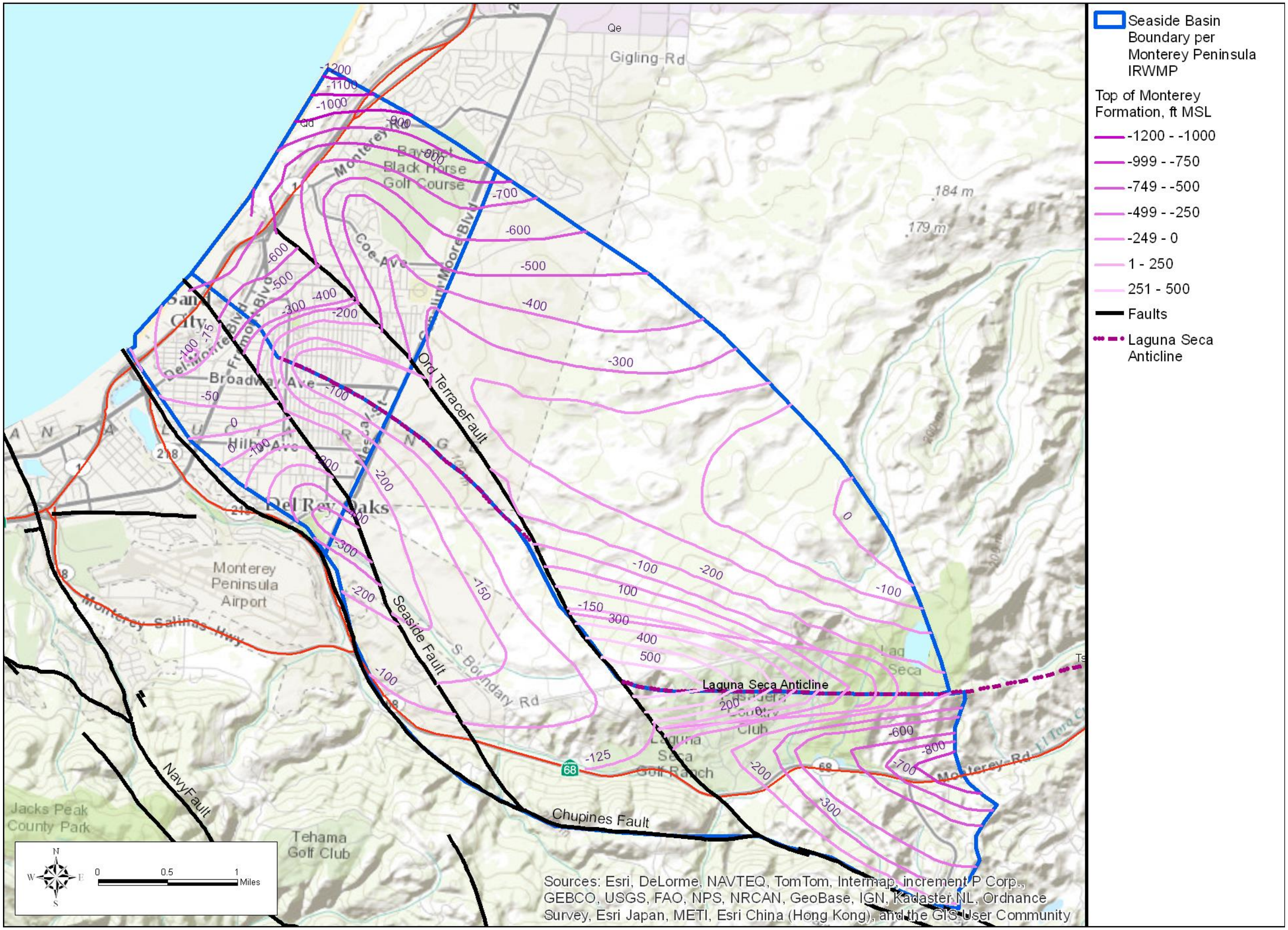


Figure 5: Top of the Monterey Formation (Base of Basin)

3.6 Groundwater Occurrence

3.6.1 Groundwater in the Aromas Sands

The Aromas Sands and other surficial deposits are unsaturated in many parts of the Seaside basin, and are not extensively pumped for municipal use. Only near the coast are they partly saturated. These sediments are not significant sources of groundwater supply (Yates, et al., 2002).

3.6.2 Groundwater in Paso Robles Aquifer

The Paso Robles aquifer is an unconfined aquifer that is tapped by production wells. Many of the wells that are screened in the Paso Robles aquifer are also screened in the underlying Santa Margarita aquifer.

The water-bearing characteristics of the Paso Robles aquifer are variable due to the flood plain depositional environment, which formed coarse-grained channel deposits cutting into fine-grained overbank deposits (Yates, et al., 2002). The Paso Robles aquifer is hydraulically linked to the ocean, which increases its susceptibility to seawater intrusion.

3.6.3 Groundwater in Santa Margarita/ Purisima Aquifers

The majority of production wells in the basin produce groundwater from the deep or Santa Margarita/Purisima aquifer. Groundwater levels in this aquifer have shown a decline since production started in earnest in the 1990s. This in part has been attributable to pumping restrictions imposed on CAW's Carmel River pumping by the State Water Resources Control Board's Order 95-10.

Due to overlying low conductivity sediments, the Santa Margarita/Purisima aquifer is confined. Based on observed groundwater level behavior in the Santa Margarita aquifer, there appears to be limited leakage from the overlying shallow aquifer and limited connection to the ocean.

The Purisima Formation is less permeable than the Santa Margarita aquifer. However, it is much thicker than the Santa Margarita aquifer, which translates to similar transmissivity values (Feeney, 2007).

3.7 GROUNDWATER FLOW

3.7.1 HORIZONTAL FLOW DIRECTIONS

Figure 6 and Figure 7 show groundwater elevation contours for the shallow (Paso Robles) and deep (Santa Margarita/Purisima) aquifers, respectively. These contours were produced as part of the Water Year 2012 Seawater Intrusion Analysis report for the Watermaster (HydroMetrics WRI, 2012). Both aquifers have pumping depressions: in the Northern Coastal subarea and in the Laguna Seca subarea. In general, groundwater flows from the higher inland areas to the lower coastal areas.

3.7.2 VERTICAL FLOW GRADIENTS

Head differences between shallow and deep monitoring wells can be used to determine vertical hydraulic gradients. The data from paired wells showed that in the 1980's and early 1990's vertical gradients were upwards, or from the deep aquifer to the shallow aquifer; but as groundwater pumping in the Seaside basin increased, the gradients reversed to downwards, or from the shallow aquifer to the deep aquifer.

In the area of Roberts Lake and Laguna Grande in the Southern Coastal subarea, there is a probability that an upwards vertical gradient persists due to the area being a groundwater discharge point. This assumption, however, cannot be confirmed with groundwater elevation data as there are no paired monitoring wells in this area.

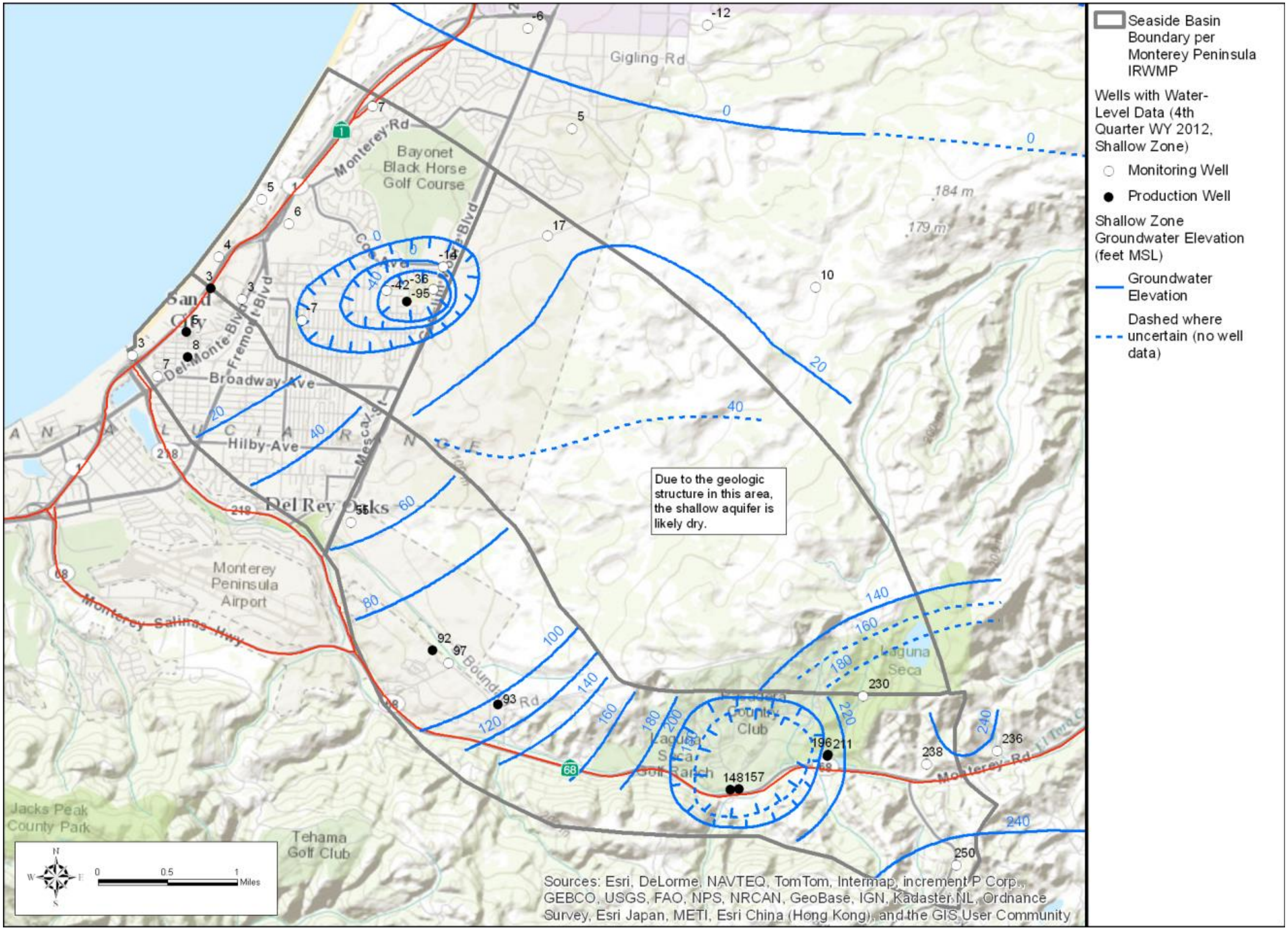


Figure 6: Shallow Groundwater Elevation Map – July/August 2012

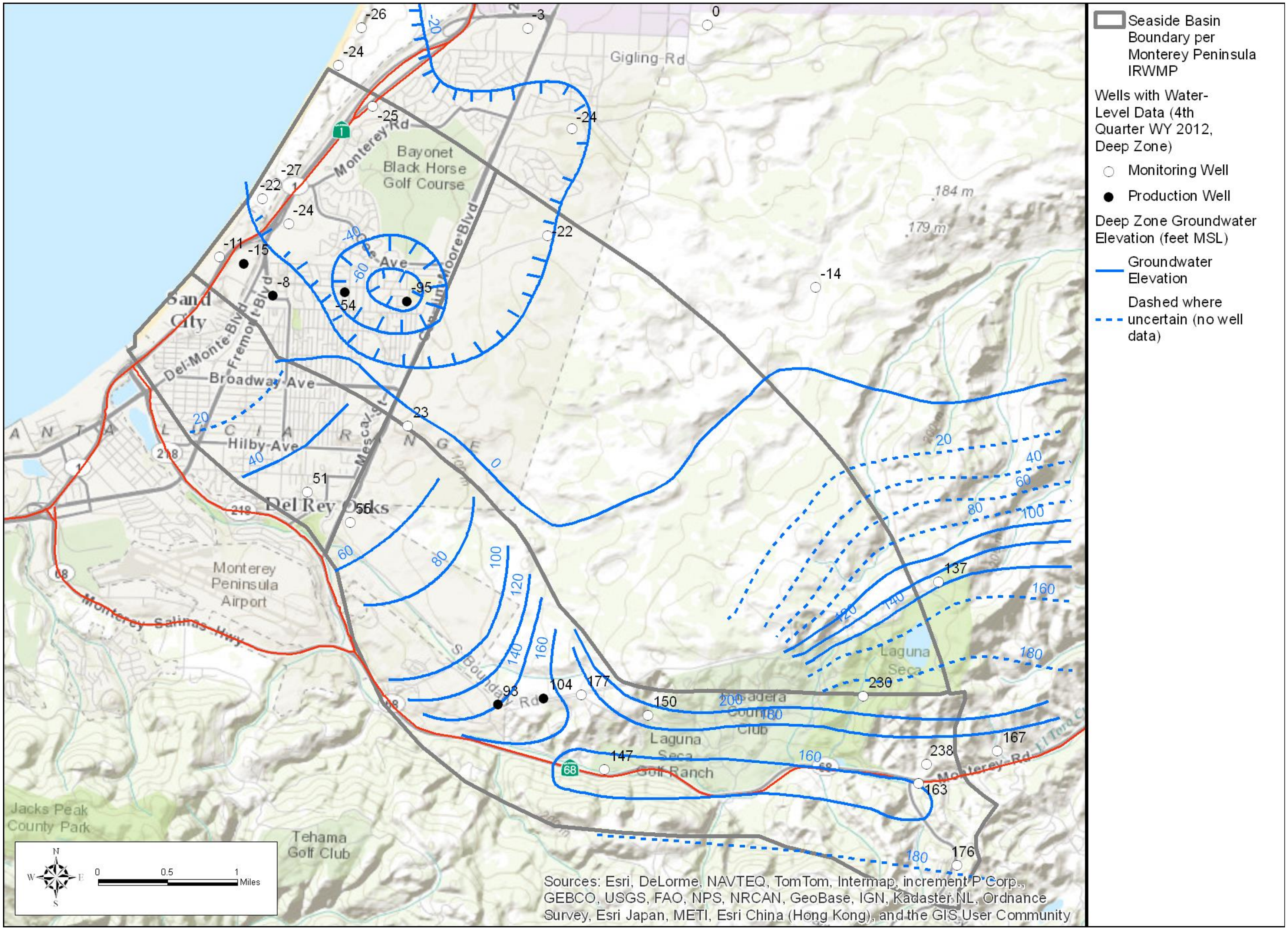


Figure 7: Deep Groundwater Elevation Map – July/August 2012

3.8 LAND USES AND LAND COVER

Land use along the coastal area east of Highway 1 comprises an approximately 1.5 mile wide strip of residential, light industrial, commercial and institutional facilities (Figure 8). The Bayonet and Black Horse Golf Courses are also found within this developed strip.

The other main developed artery is alongside Highway 68 (Monterey Salinas Highway) in the Laguna Sea area. Residential land use predominates, but there is also some industrial and commercial land use. Two golf courses, the Laguna Seca Golf Ranch and the Nicklaus Club-Monterey are found in this area. The Laguna Seca Recreation Area and Raceway is located north of Highway 68.

The Toro area is an additional developed hub in the southeast corner of the basin which extends beyond the basin's eastern boundary and along Highway 68. The main developed land use is residential housing.

The central part of the basin comprises open space that was formerly part of the Fort Ord military facility. Although there are plans to develop a small amount of former Fort Ord land near the already developed area east of Seaside, the remainder of the open space will stay undeveloped.

Figure 8 shows land use and land cover compiled from the 2010 adopted General Plan for Monterey County and City of Seaside's General Plan. Longer-term plans indicate some development along Fort Ord's western boundary. These areas are indicated with a cross-hatch pattern.

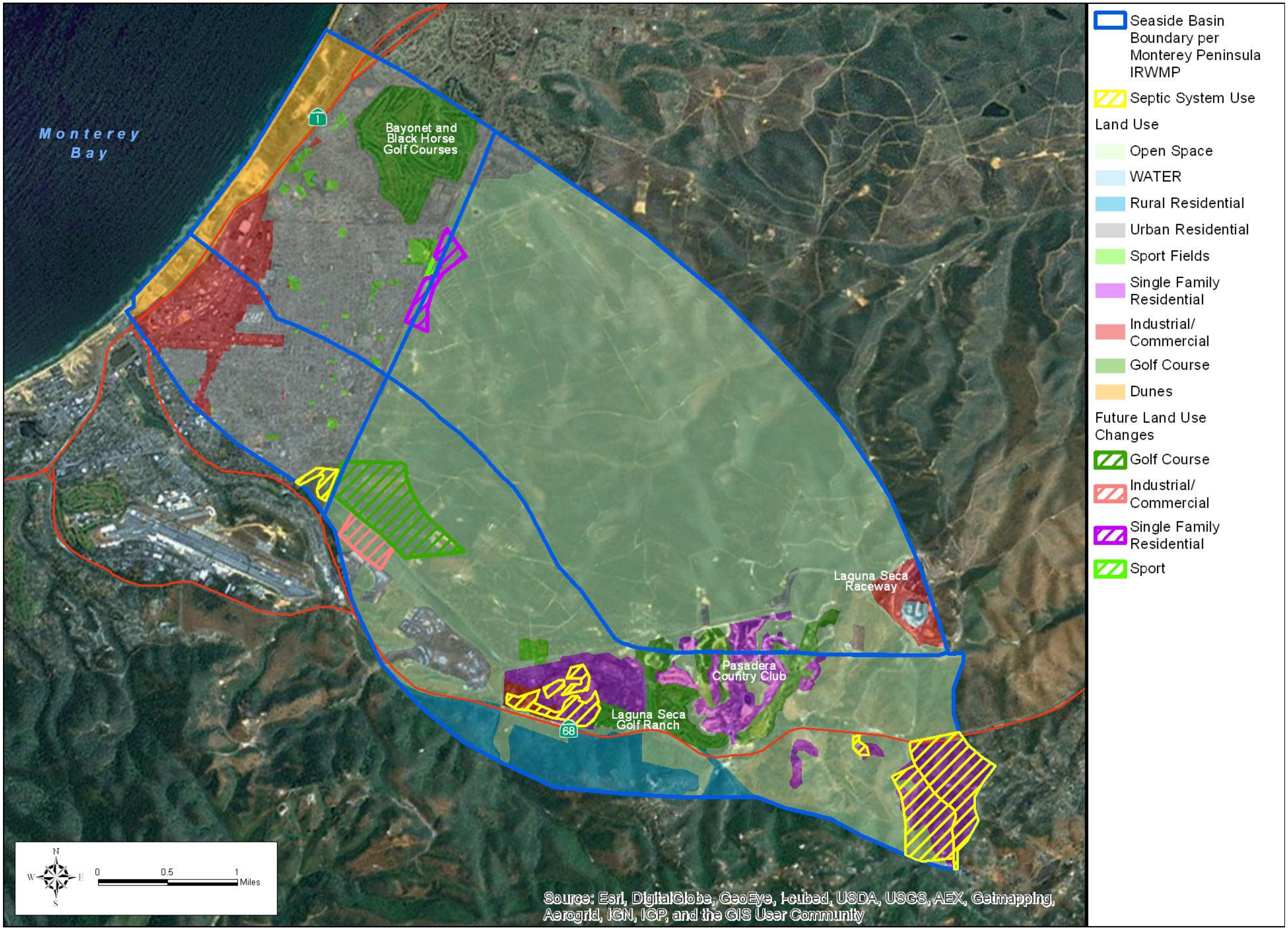


Figure 8: Land Use

3.9 BENEFICIAL WATER USES

Per the Central Coast RWQCB's Basin Plan (2011a), beneficial uses for surface water in the Seaside basin are identified in Table 1. Note that Laguna Grande and Roberts Lakes do not fall directly within the basin boundary, however their watersheds do include part of the Seaside basin.

Table 1: Seaside Basin Beneficial Uses

	Municipal and domestic	Agricultural	Industrial	Contact water recreation	Non-contact water recreation	Wildlife habitat	Cold fresh water habitat	Warm fresh water habitat	Commercial and sport fishing
Laguna Grande/Roberts Lake	X			X	X	X	X	X	X
Any Other Surface Water	X			X	X	X			
Groundwater	X	X	X						

The Basin Plan does not specifically identify beneficial uses for groundwater in the Seaside Basin. It does however state that groundwater throughout the Central Coast Basin, with one exception in another groundwater basin, is suitable for agricultural, municipal and domestic, and industrial uses.

3.10 SURFACE / STORM WATER QUALITY

As described previously, there is little surface water in the Seaside basin. This section describes the quality of water contained in Roberts Lake and storm water. Although there are several storm water percolation locations in the basin, there are no water quality data available for them. These ponds collect storm water from: the Seaside Highlands development, Monterey Peninsula Regional Park (Frog Pond Wetland Preserve), and the Ryan Ranch development off Highway 68 (Figure 2). Within the City of Seaside there are two percolation systems beneath parking lots: at Edgewater shopping center (Costco) and the other at Auto Center (Figure 2).

The only storm water quality data are collected by the Monterey Bay Sanctuary Citizen Watershed Monitoring Network. The network includes two sites in the Seaside basin (Figure 2). One site is near the Best Western hotel at Roberts Lake

(Hotel) and the second is from a storm water outfall near Bay Street (Bay St). Samples are collected at different times of the year. Dry run samples are storm water samples collected after a dry weather rainfall event, and first flush is collected from water flowing into the ocean during the first major storm of the season. Samples are also collected during dry weather in spring and summer.

The catchment for the Hotel monitoring site is much larger than the Bay St catchment; it encompasses almost the entire Laguna Seca subarea, and extends beyond the basin boundary (Figure 9). The land use within the catchment of the Hotel monitoring site includes former Fort Ord open space, urban and rural residential, the Nicklaus Club-Monterey and Laguna Seca golf courses, and a minor amount of industrial and commercial. It also contains the southern portion of the groundwater basin which has the basin's highest native groundwater TDS. Outside of the basin, the Hotel site catchment includes a portion of the Monterey Peninsula Airport, the Tehama Golf Course, urban and rural residential, open space, and industrial and commercial land uses.

The catchment for the Bay St. monitoring site includes almost all the basin's industrial and commercial land, and over half the basin's urban residential area.

Typical ranges in water quality from the two monitored sites are summarized in Table 2. Generally, the spring and summer water quality falls within the ranges for dry run and first flush data, and therefore were not included in Table 2.

The water quality observed at each of the sites is typical of quality expected from each of their respective land uses. The Bay St. site collects more storm water from developed areas than the Hotel site. Because of the permeable nature of the sediments in the basin, areas that are not developed with impervious surfaces have less storm water runoff and more percolation into the basin. As a result, urea, nitrate-nitrogen, metals, TSS, and bacteriological concentrations at Bay St. are greater than those measured at the Hotel site. The Hotel monitoring site has higher conductivity than Bay St., which is probably due to its catchment containing the Laguna Seca subarea where the occurrence of shallow Monterey Shale produces groundwater with higher conductivity and TDS, as described in Section 3.11.

Although the storm water monitored at the two sites is discharged to the ocean and does not have an opportunity to percolate into the basin, the water quality is representative of other storm water generated in similar environments throughout the basin.

Table 2: 2009 - 2012 Range in Storm Water Quality Collected by Monterey Bay Sanctuary Citizen Watershed Monitoring Network

Constituent	Water Quality Criterion	Dry Run 2009-2012 Range		First Flush 2009-2012 Range	
		Bay St	Hotel	Bay St	Hotel
Conductivity, µS/cm	-	NF	NA	70 - 240	36 – 1,480
Urea, µg/L	-	NF	26	62 - 284	37
Nitrate-Nitrogen (NO_3-N), mg/L	≤ 2.25[2]	NF	0.025	0.22 – 0.74	0.025
o-Phosphate as P, mg/L	≤ 0.12[2]	NF	0.14 – 0.51	0.17 – 0.34	0.22 – 0.53
Total Copper, µg/L	≤ 30[1]	NF	6 - 12	52 - 126	7 – 21
Total Zinc, µg/L	≤ 200[1]	NF	2.5	28.0 – 32.5	ND
Total Lead, µg/L	≤ 30[1]	NF	6 - 11	219 - 345	10 – 21
Total Suspended Solids, mg/L	≤ 500[2]	NF	9 - 23	59 - 173	12 – 25
***E. Coli*, MPN/100 ml**	≤ 235[3]	NF	20 - 100	34,162 – 64,900	273 – 2,393
Enterococcus, MPN/100 ml	≤ 104[3]	NF	20 - 100	47,396 – 90,327	344 – 1,465

[1] Basin Plan Objective, [2] Central Coast RWQCB, [3] EPA Ambient Water Quality Criteria
ND = non-detect, NF = not flowing, NA = not available
Source of data: Monterey Bay Sanctuary Citizen Watershed Monitoring Network (2012).

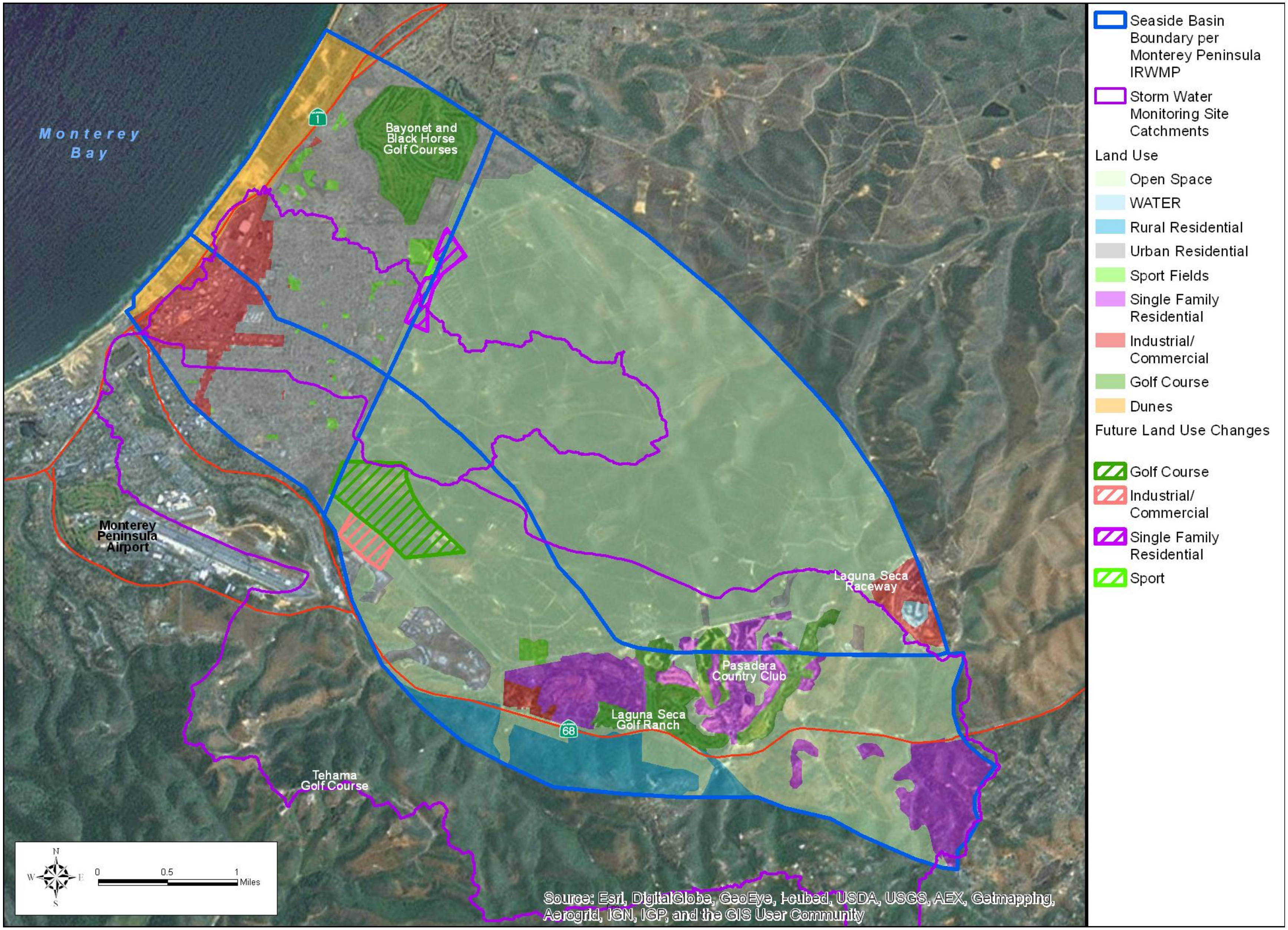


Figure 9: Storm Water Monitoring Site Catchments with Land Use

3.11 GROUNDWATER QUALITY

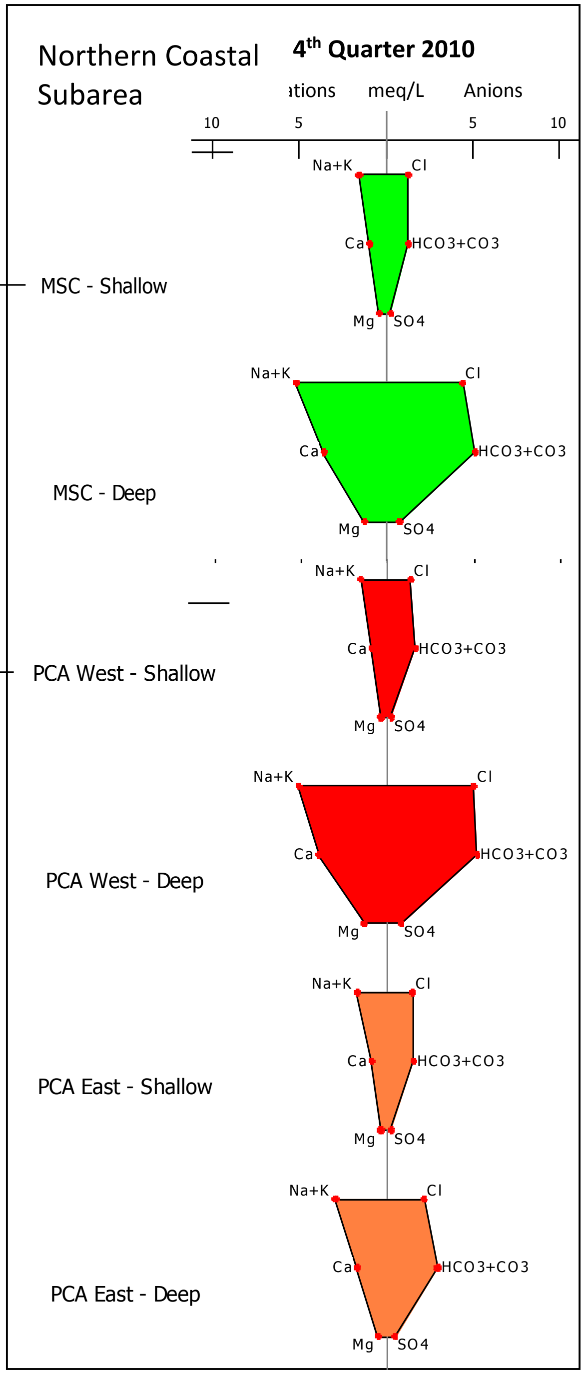
3.11.1 GROUNDWATER QUALITY DESCRIPTION

Groundwater in the basin is divided into two distinct types. The Northern Coastal subarea has sodium-bicarbonate type water, and the Southern Coastal and Laguna Seca subareas have sodium-chloride type waters (Muir, 1982). The shallow and deep aquifers also have differing groundwater qualities. Data used to describe the current groundwater quality in this section is from the Watermaster's database that is described in Section 6.

Data used to show concentration ranges starts in 1990. To characterize groundwater quality for each subarea, median well concentrations for TDS, chloride, and nitrate-N over the past five years (2008 through 2012) were contoured and area-weighted to arrive at an average groundwater quality for each subarea that is representative of current land use practices (Figure 14 through Figure 16). The maps include the wells and their median concentrations used in the analyses. Table 5 summarizes the existing water quality estimated for both the shallow and deep aquifers within each subarea, and also includes an average volume weighted concentration of the shallow and deep aquifers combined.

NORTHERN COASTAL SUBAREA

Stiff diagrams for monitoring wells in the Northern Coastal subarea show that, the shallow or Paso Robles aquifer has a lower anion/cation concentration than the deep or Purisima/Santa Margarita aquifer (Figure 10). As a result, total dissolved solids (TDS) for the Paso Robles aquifer (shallow) in the Northern Coastal subarea typically ranges from 200 to 600 mg/L, while in the Purisima/Santa Margarita (deep) aquifer in the Northern Coastal subarea has a TDS that typically ranges from 250 to 650 mg/L (Figure 11). The TDS of the deep aquifer at the aquifer storage and recovery (ASR) wells located on the eastern boundary of the Northern Coastal subarea has decreased substantially since the start of injection into the deep aquifer by MPWMD in 2010. Figure 12 shows the decrease from 600 to 320 mg/L in monitoring well ASR-MW1 which is located in close proximity to the two existing ASR wells. This conditioning trend is expected to continue and expand in area as Phase II of the program consisting of an additional two wells will be commissioned in 2014. More information on this project can be found in Section 3.12.2.



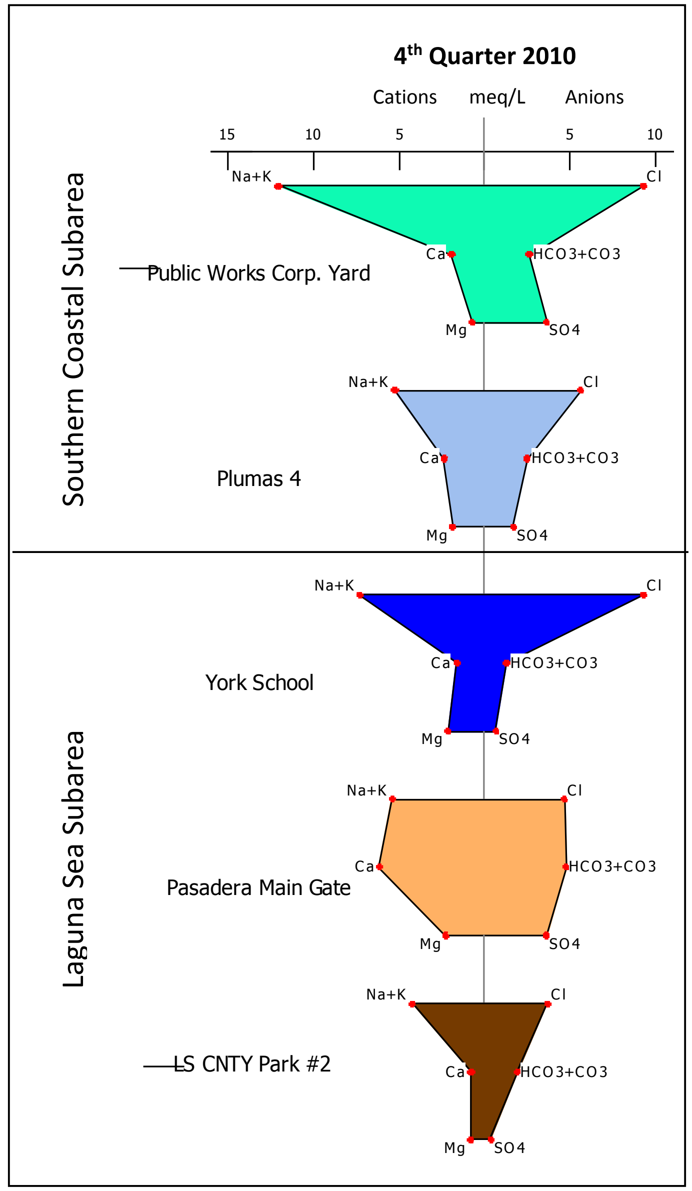


Figure 10: Stiff Diagrams of Monitoring Wells in the Northern Coastal, Southern Coastal, and Laguna Seca subareas

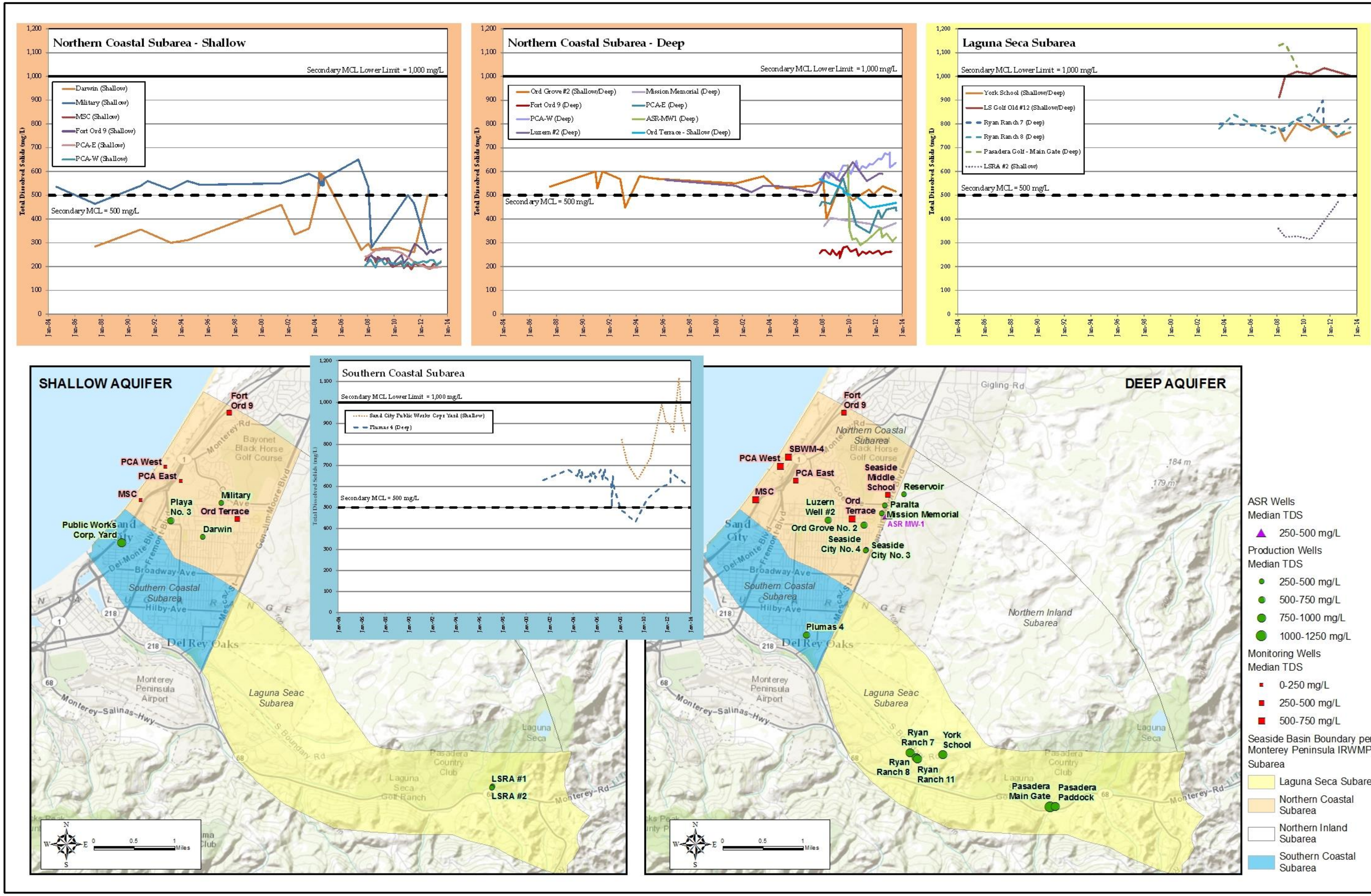


Figure 11: Wells with TDS Data and Selected Graphs of TDS Concentrations over Time

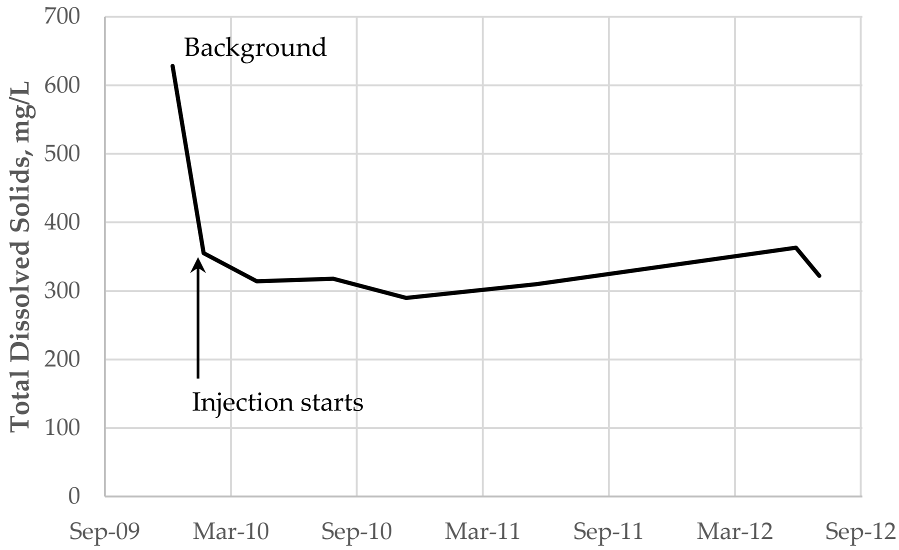


Figure 12: ASR MW-1 Historical TDS Concentrations

Deep aquifer chloride concentrations are slightly higher than the shallow aquifer, and can reach 420 mg/L. Nitrates in a portion the shallow aquifer in the Northern Coastal subarea are relatively high compared to other subareas in the basin (Figure 16), although concentrations have always remained below 10 mg/L nitrate –N (Figure 13). The deep aquifer nitrate-N concentrations are usually non-detect to very low (Figure 13). Wells with the highest nitrates in the subarea are located in an area that was historically used for truck farming before it became urbanized. Furthermore, the dune nature of the soils readily allows nutrients to infiltrate and percolate into the shallow groundwater system.

Hardness is high in the Northern Coastal subarea, although not as high as in the Laguna Seca subarea. Table 3 provides a hardness classification for reference.

Table 4 summarizes the ranges in water quality for each subarea.

Table 3: Hardness Classification

Hardness	mg/L as $CaCO_3$
Soft	0 – 60
Moderate	61 – 120
Hard	121 – 180
Very Hard	> 180

Source: http://water.usgs.gov/owq/hardness-alkalinity.html

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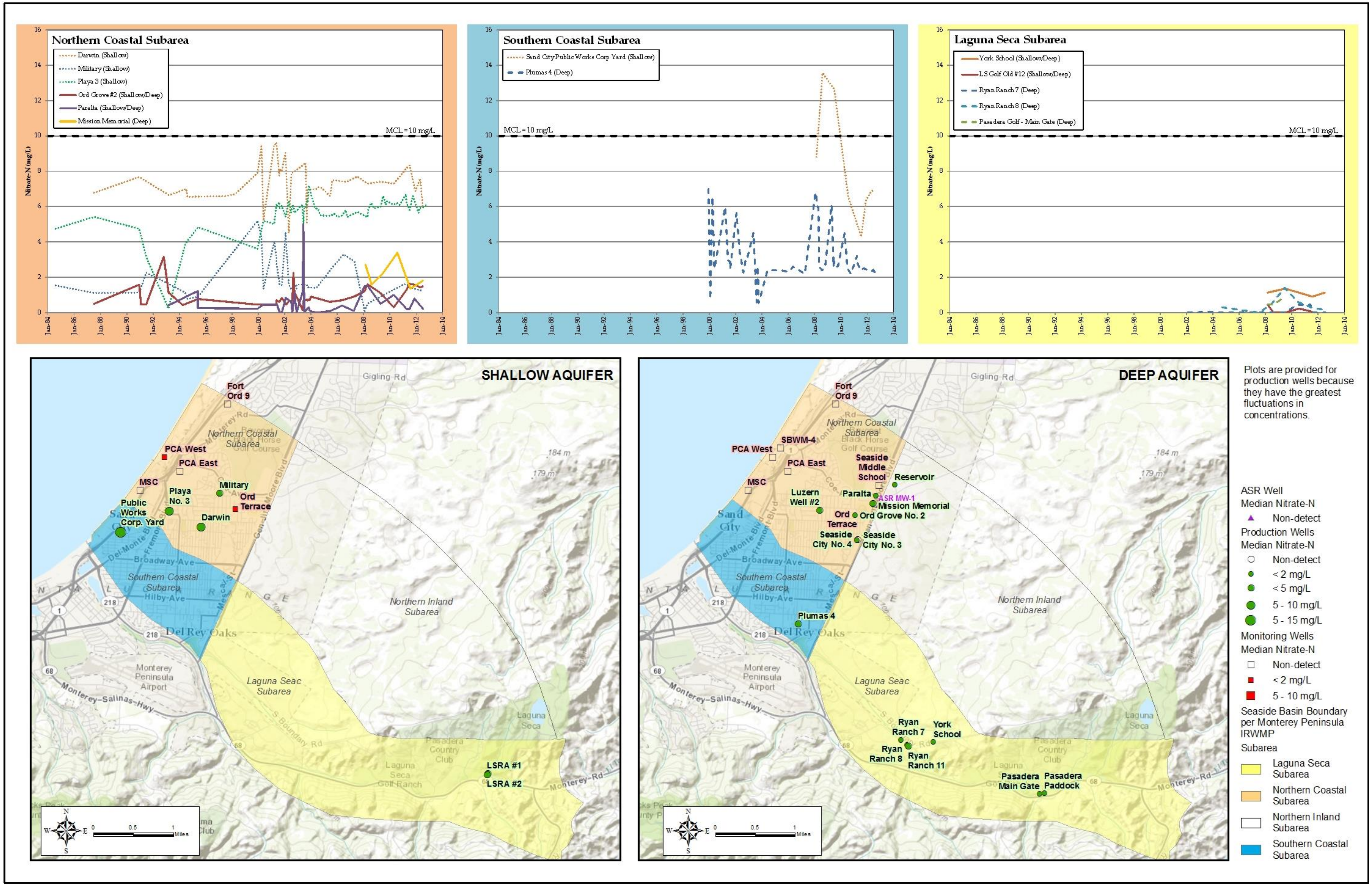

Figure 13: Wells with Nitrate Data and Graphs of Nitrate-N Concentrations over Time

Table 4: Seaside Basin Groundwater Quality Ranges

Constituent	Maximum Contaminant Level (MCL)	Northern Coastal Subarea		Northern Inland Subarea	Southern Coastal Subarea	Laguna Seca Subarea	
		Shallow	Deep			Shallow	Deep
TDS, mg/L	500-1,000*	200-600	250-650	150-630	450-990	300-800	750-1,100
Sulfate, mg/L	250-500*	10-270	10-370	10-100	40-180	10-110	30-250
Chloride, mg/L	250-500*	30-230	30-420	50-180	70-330	80-290	190-350
Sodium, mg/L	-	30-140	30-260	35-105	60-310	80-160	120-170
Magnesium, mg/L	-	2-60	1-80	5-25	5-25	10-30	25-40
Calcium, mg/L	-	10-90	10-180	15-80	30-50	10-65	30-160
Potassium, mg/L	-	ND - 10	ND - 50	2.2-5.5	ND - 5	ND - 20	ND - 6
Hardness as $CaCO_3$, mg/L	-	40-250	25-350	50-280	110-210	60-200	190-530
Nitrate as NO_3, mg/L	45	ND - 40	ND - 20	ND - 3	5 - 60	ND - 4	ND - 6
Nitrate-N (NO_3-N), mg/L	10	ND - 6	ND - 6	ND – 0.2	ND – 13	ND – 1.2	ND – 1.2
Ammonia-N, mg/L	-	ND - 1.9	ND - 1.6	ND	ND – 1.3	ND – 0.4	ND – 0.18
o-Phosphate as PO_4, mg/L	-	ND	ND	NS	ND	NS	ND – 1.69
o-Phosphate as P, mg/L	-	ND – 1.63	ND – 1.63	ND – 0.1	ND – 0.4	ND – 1.16	ND – 1.35
Arsenic, mg/L	0.010	NS	0.006-0.079	ND	NS	NS	NS
Iron, µg/L	0.3	ND - 5	ND - 25	ND – 2.3	ND – 0.1	0.1-4.0	ND – 4.0
Manganese, µg/L	0.05	ND – 1.0	ND – 2.0	ND – 0.1	ND – 0.03	ND – 0.2	ND – 0.6

* lower end of range is recommended
ND = non-detect, NS = no samples

SOUTHERN COASTAL AND LAGUNA SECA SUBAREAS

The southern subareas, i.e., Southern Coastal and Laguna Seca, have higher TDS than the rest of the basin. The Sand City's Public Works Corporation well, in the Southern Coastal subarea, has anomalous TDS, chloride and nitrate concentrations which are not consistent with nearby wells. In 2013, the Watermaster attempted to study the likely source of these anomalous concentrations but were unsuccessful sourcing historical groundwater quality data for the well or nearby wells. The well's sodium/chloride ratio suggests seawater is not the source of chloride. Historically, this area was used for truck farming which could account for the elevated nitrates. It should be noted, however, that this well is not screened in either the deep or shallow aquifers but in a water-bearing zone above these aquifers that is treated separately in the adjudicated Decision. Limited data for the only other well in the Southern Coastal subarea (Plumas 4) shows TDS is higher than the Northern Coastal subarea with chlorides just above 300 mg/L and nitrates being non-detect to very low (Figure 11 and Figure 13, respectively).

The inland Laguna Seca subarea has naturally occurring poorer groundwater quality than the rest of the basin. TDS typically ranges between 750 and 1,100 mg/L and chloride ranges between 190 – 350 mg/L in deeper wells, i.e., Cal-Am's Ryan Ranch wells (Figure 11). The cause of the higher TDS is likely connate water from the underlying Monterey shale formation mixing with the groundwater (Muir, 1982). Shallow wells in the Laguna Seca subarea have slightly lower TDS (300 – 800 mg/L) and chloride (80 – 290 mg/L) than deep wells (Table 4). Nitrate-N is non-detect to very low in both shallow and deep wells (Figure 13). Hardness is very high throughout the subarea, but particularly in deeper wells.

Hard to very hard water occurs throughout the basin and has compounding impacts on the basin. To improve hardness, residential water softeners use an ion exchange process which requires the addition of salts. These salts are disposed of to the sanitary sewer thereby increasing the salt load to wastewater treatment plants. This is the case with the Pasadera Wastewater Facility, which is located within the Laguna Seca subarea, as described in Section 4.1.8.

NORTHERN INLAND SUBAREA

Limited groundwater quality data exist for the Northern Inland subarea, which contains the former Fort Ord. From the few wells for which there are data, it appears that the groundwater quality is similar to the aquifers of the Northern Coastal subarea (Table 4).

3.11.2 EXISTING GROUNDWATER QUALITY

To characterize existing groundwater quality for each subarea of the Seaside basin, median well concentrations for TDS, chloride, and nitrate-N over the past five years (2008 through 2012) were delineated into zones and area-weighted to arrive at an average groundwater quality for each subarea that is representative of current land use practices (Figure 14 through Figure 16). The maps include the wells and their median concentrations used in the analyses. Table 5 summarizes the existing water quality estimated for both the shallow and deep aquifers within each subarea, and also includes an average of both aquifers based on the relative saturated thickness of each aquifer. The saturated thicknesses were collected from average groundwater levels over the last five years (2005-2009) of the calibrated Seaside Basin groundwater model (HydroMetrics LLC, 2009b).

Table 5: Seaside Basin Existing Groundwater Quality

Constituent		TDS mg/L	Chloride mg/L	Nitrate –N mg/L
Northern Coastal Subarea	**Shallow**	302	72	0.83
	Deep	437	102	0.30
	All	362	85	0.59
Southern Coastal Subarea	**Shallow**	839	260	6.9
	Deep	628	199	0.05
	All	702	221	2.4
Northern Inland Subarea	**Shallow**	344	63	0.43
	Deep	327	61	0.53
	All	336	62	0.48
Laguna Seca Subarea	**Shallow**	781	237	0.85
	Deep	855	241	0.48
	All	824	239	0.63

Concentration for "All" category is a volumetric-weighted average of shallow and deep aquifer concentrations.

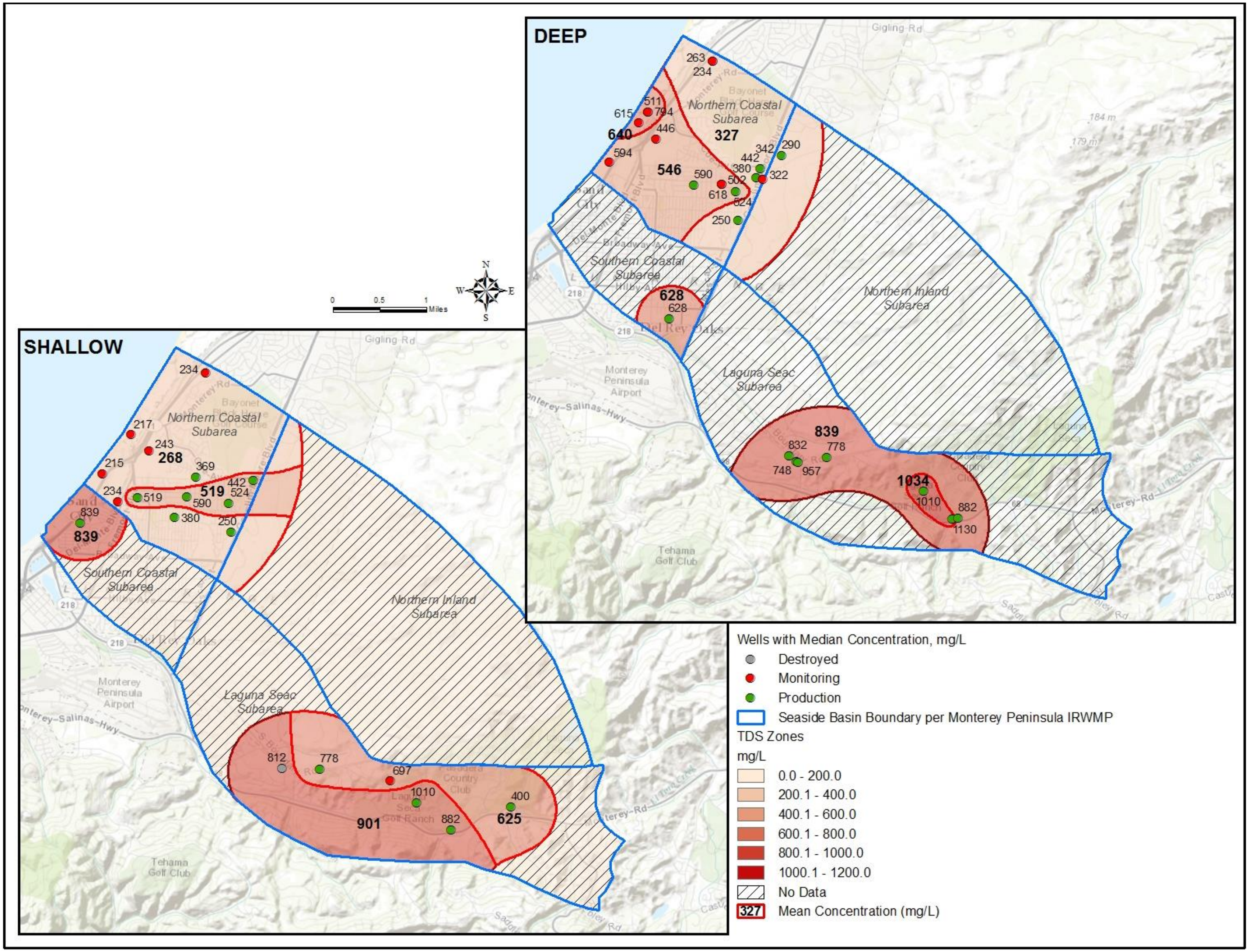

Figure 14: Water Quality Zones for Total Dissolved Solids

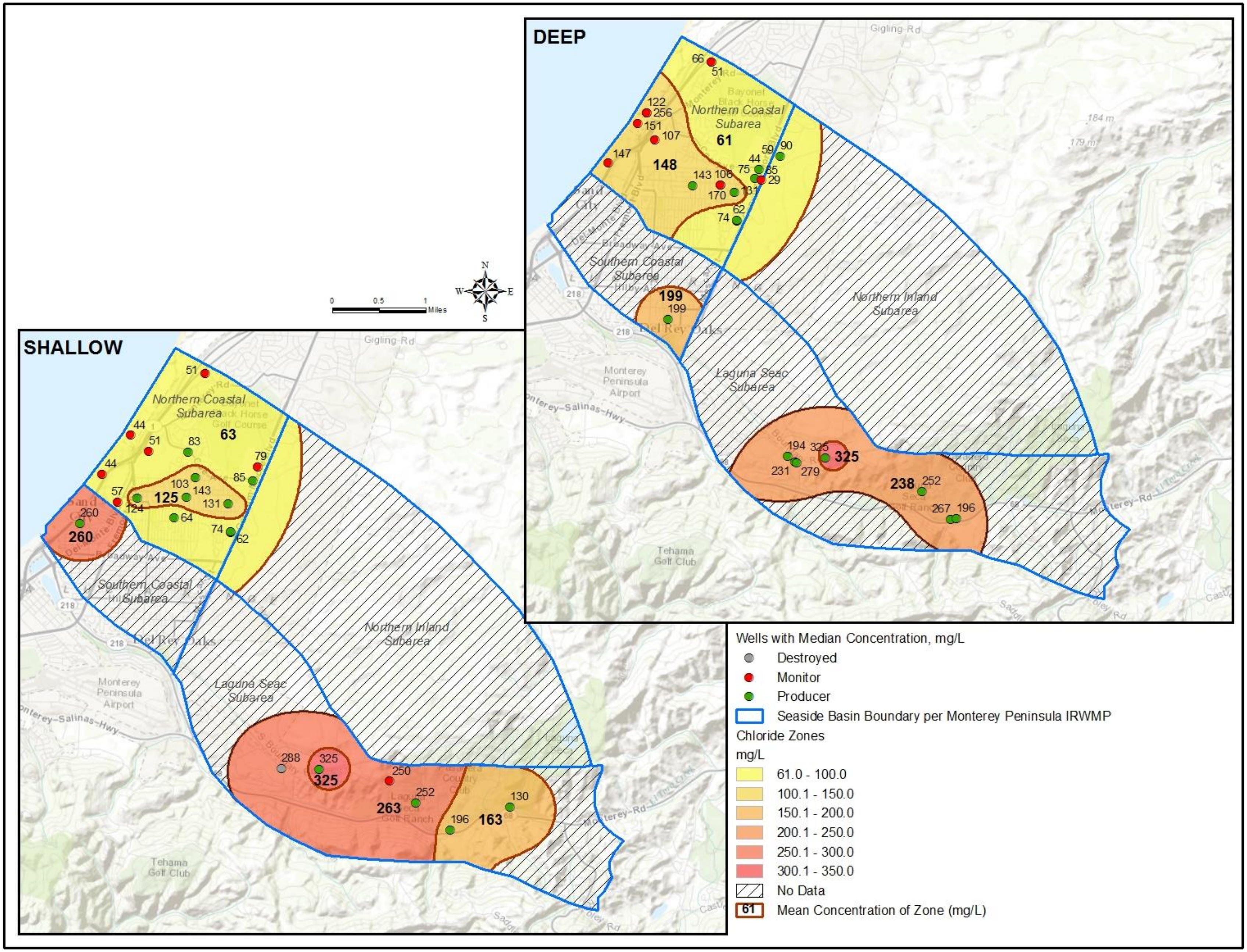

Figure 15: Water Quality Zones for Chloride

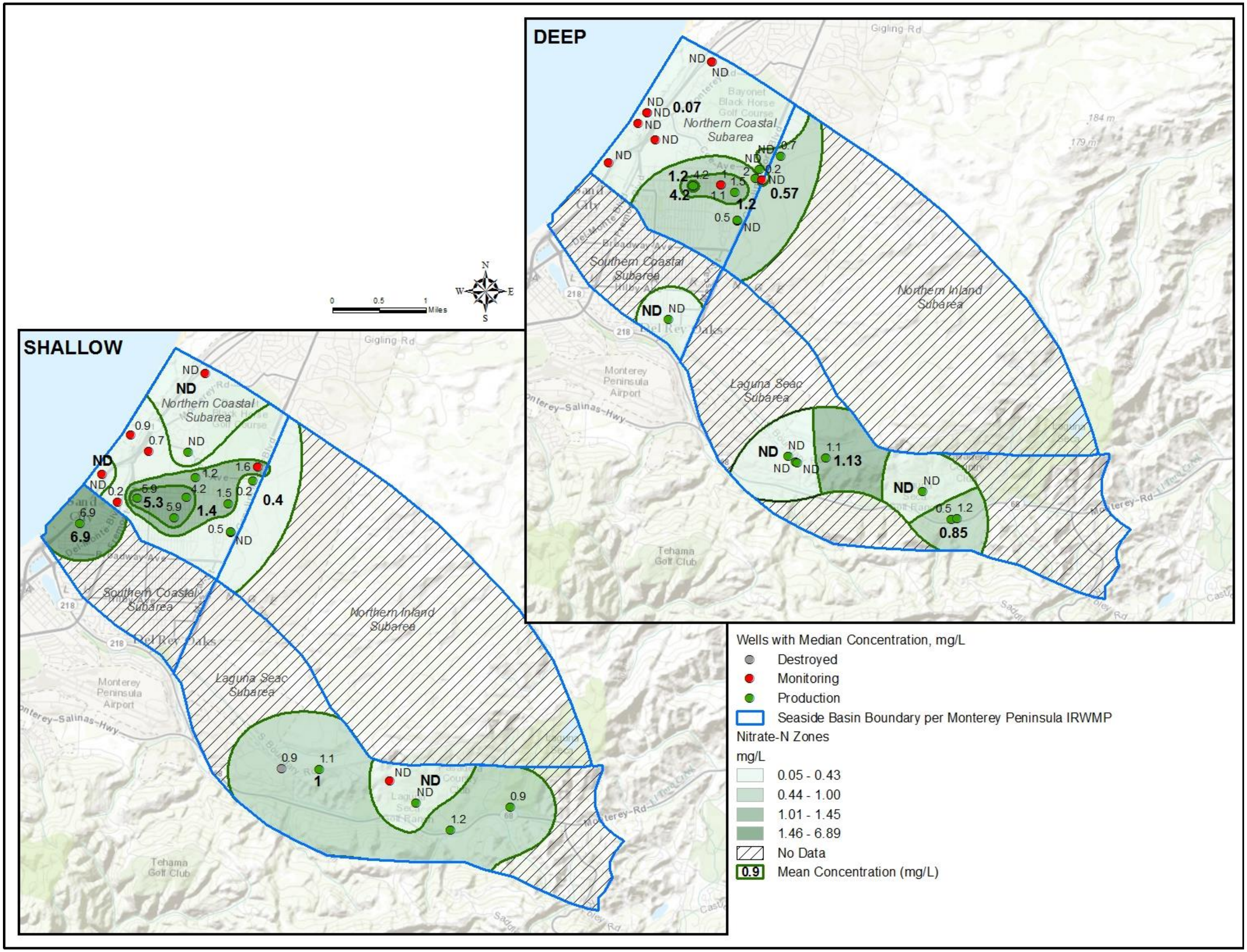

Figure 16: Water Quality Zones for Nitrate-N

3.11.3 HISTORICAL GROUNDWATER QUALITY

The earliest published groundwater quality data for the Seaside basin only dates back to 1982. This is the United States Geological Survey (USGS) report by Muir (1982), which includes groundwater quality for a number of wells in the Northern Coastal subarea. Based on state well numbers, most of these wells have since been destroyed. However, it was possible to substitute active wells completed within corresponding aquifers and within the same section to compare water quality. This comparison indicates that historical groundwater quality is similar to the existing groundwater quality in the Northern Coastal subarea (Table 6), with the exception of nitrate-N which appears to have increased, although it is still below the MCL. Figure 13 shows the concentrations of nitrate-N over time for each subarea. The data shown for the Northern Coastal subarea indicate the only well to exhibit a slight increase in nitrate-N from 1984 to 2012 is Cal-Am's Playa 3 well.

Historical data were not available for the other three subareas.

Table 6: Comparison of 1979/1980 Water Quality with Current Water Quality

Constituent	Playa 3		PCA Production		Luzern		Target		Ord Grove	
	22B3 Feb 1979	Playa 3 Jul 2012	PCA 15K1 Sep 1980	PCA-W Shallow Sep 2012	23D1 Feb 1979	Luzern New Jul 2011	22C2 Sep 1980	MSC Shallow/ Deep Sep 2012	Ord Grove 23B1 Feb 1979	Ord Grove 2 Jul 2012
TDS, mg/L	584	540	-	-	588	532	-	-	640	538
Specific Conductivity, µS/cm	920	878	380	325	920	905	651	300/1,018	1,000	904
Sulfate, mg/L	93	94.6	-	-	61	81.2	-	-	84	61.4
Chloride, mg/L	134	124.4	56	42	139	133.3	130	41/143	133	129.4
Sodium, mg/L	98	90.1	-	-	97	94.6	-	-	97	85.9
Magnesium, mg/L	22	17	-	-	19	18	-	-	21	19
Calcium, mg/L	63	56	-	-	75	66	-	-	87	68
Hardness as $CaCO_3$, mg/L	248	212	-	-	265	239	-	-	304	223
Nitrate as NO_3, mg/L	12.4	26.2	-	-	5.6	20.2	-	-	1.6	6.6
Nitrate-N (NO_3-N), mg/L **converted from nitrate as NO_3**	2.8	5.9	-	-	1.3	4.5	-	-	0.4	1.5
Iron, mg/L	0.03	< 0.1	-	-	0.09	< 0.1	-	-	0.06	< 0.1

S/D = shallow/deep

3.11.4 Groundwater Water Quality Objectives

The Seaside basin is not specifically included in the table of median groundwater quality objectives in the Central Coast RWQCB's Basin Plan (Chapter 3). For basins not specifically listed, quality objectives must meet the water's beneficial use. For the Seaside basin, beneficial uses are municipal, industrial, and agricultural. For the constituents of concern in this SNMP (TDS, chloride, and nitrate as N), the standards for municipal water contained in the California Code of Regulation (CCR) Title 22, Chapter 15 are the most stringent of the beneficial uses. Table 7 lists the water quality objectives (WQOs) used in this report.

Table 7: Seaside Basin Groundwater Quality Objectives

Constituent	Source	Seaside Basin Groundwater Quality Objective mg/L
TDS	Recommended Limit of Secondary MCL	500
Chloride	Recommended Limit of Secondary MCL	250
Nitrate-N	Primary MCL	10

3.12 Imported Water Quality

There are two sources of imported water to the Seaside basin: Salinas Valley groundwater and Carmel River system water.

3.12.1 Salinas Valley Groundwater

Water imported by the City of Seaside for irrigation of the Bayonet and Black Horse golf courses is supplied by Marina Coast Water District (MCWD) from groundwater pumped from the deep aquifer in the Salinas Valley groundwater basin. This use is per an in-lieu replenishment agreement that will expire tentatively in May 2018 (personal communications, Rick Riedl). Additionally, MCWD's service area includes a portion of the Seaside basin around the Bayonet and Black Horse golf courses.

MCWD's 2012 water quality is summarized in Table 8. None of the constituents exceed the basin's WQO.

Table 8: Imported Salinas Valley Water Quality for Bayonet and Black Horse Golf Course Irrigation and Municipal Supply by Marina Coast Water District

Constituent	Seaside Basin WQO mg/L	MCWD Water Quality Range for 2012 mg/L	MCWD Water Quality Averages for 2012 mg/L
TDS, mg/L	500	300 – 600	419
Chloride, mg/L	250	46 – 200	101
Nitrate-N (NO_3-N), mg/L **converted from nitrate as NO_3**	10	ND – 4.4	1.3

ND = non-detect

Source of data: Marina Coast Water District Consumer Confidence Report (2012)

3.12.2 Carmel River System Water

During winter months, Cal-Am imports water from the Carmel Alluvial River Aquifer to: 1) inject into Santa Margarita aquifer ASR wells, and 2) supply to customers in the Seaside basin once flows at the Robles del Rio gage on the Carmel River are greater than 40 cubic feet per second (cfs). Table 9 summarizes the range in selected concentrations from 2009 through 2012 together with the basin's WQOs.

Table 9: Imported Water Quality from the Carmel River System by Cal-Am

Constituent	Seaside Basin WQO mg/L	Carmel River System Water Quality Range mg/L	Carmel River System Water Quality Average mg/L
TDS, mg/L	500	280 – 385	317
Chloride, mg/L	250	23 – 28	26
Nitrate-N (NO_3-N), mg/L	10	ND – 0.3	0.1

ND = non-detect,

Source of data: MPWMD water quality database

Water from the Carmel River system is of higher quality than the native groundwater into which it is injected in the deep Santa Margarita aquifer. In particular, TDS and associated anions and cations, and hardness are substantially lower.

3.13 RECYCLED WATER QUALITY

The only source of recycled water currently used in the Seaside basin is from the Pasadera Wastewater and Recycling Facility that supplies irrigation water to the Nicklaus Club-Monterey (formerly Pasadera Country Club). Recycled water is blended with groundwater produced from two golf course wells (Main Gate and Paddock) at a ratio of approximately ten parts groundwater to one part recycled water before being irrigated. Average effluent water quality delivered in 2012 for irrigation is summarized in Table 10.

Table 10: Nicklaus Club-Monterey Recycled Water Quality for Golf Course Irrigation

Constituent	Seaside Basin WQO mg/L	Pasadera Well Quality* for 2012 mg/L	Recycled Water Quality** Averages for 2012 mg/L	Calculated 10:1 Blended Quality mg/L
TDS, mg/L	500	868	1,241	902
Chloride, mg/L	250	191	375	208
Nitrate-N (NO_3-N), mg/L **converted from nitrate as NO_3**	10	non-detect	2.3	non-detect

Source of Data: Watermaster* and Cal-Am**

3.14 SAND CITY DESALINATION BRINE QUALITY

The City of Sand City has a 300 acre-foot per year capacity desalination plant located in the dunes off Bay Street. The source water for the desalination plant is shallow brackish groundwater from the Southern Coastal subarea extracted by shallow beach wells. Sand City was granted rights to pumping this brackish water in the Amended Decision. Byproduct or reject water from the plant is disposed through a horizontal well beneath the beach in Sand City. The plant has been operating since April 2010 for municipal supply.

The reject water has a TDS similar to seawater and non-detect nitrate. The injected reject water is designed to flow into the ocean beneath the beach, and therefore is designed to have little impact on the basin's groundwater.

3.15 RAINFALL WATER QUALITY

The water quality of rainfall is generally low in salts and nutrients (Table 11). During infiltration into the ground, infiltrating rainwater picks up salts and nutrients that have been deposited on the ground. Atmospheric deposition of nitrogen is one source that has the potential to mobilize nutrients by infiltrating rain. As rainwater percolates through the vadose zone, it can further mobilize salts and nutrients, which increases concentrations.

Table 11: Water Quality of Rain Water

Constituent	Seaside Basin WQO mg/L	Rain Water Average mg/L
TDS, mg/L **converted from conductivity (x0.59)**	500	2.8
Chloride, mg/L	250	0.5
Nitrate-N (NO_3-N), mg/L **converted from nitrate as NO_3**	10	0.05

Source of data: National Atmospheric Deposition Program/NTN, Pinnacles National Monument-Bear Valley, San Benito County (CA66).

SECTION 4
SALT AND NUTRIENT SOURCES

4.1 EXISTING SOURCES

Table 12 summarizes the existing salt and nutrient sources that are/could be introduced into Seaside basin groundwater. Each of the sources are discussed in some detail in the subsections below.

Table 12: Summary of Existing Salt and Nutrient Sources

Potential Salt and/or Nutrient Source	How Introduced to the Basin
Rainfall	Infiltration and percolation in permeable areas
Atmospheric deposition	Deposition, infiltration and percolation
Mineral dissolution	Dissolution of Monterey shale formation
Storm water	Infiltration and percolation
Landscape fertilizer	Fertilization, infiltration and percolation
Golf course fertilizer	Nicklaus Club-Monterey (formerly Pasadera Country Club)
	Bayonet and Black Horse Golf Courses
	Laguna Seca Golf Ranch
Carmel River system water	Injection into Santa Margarita aquifer
	Landscape and sports field irrigation
Salinas Valley groundwater	Return flow of irrigation water from Bayonet/Black Horse Golf Courses
	Landscape and sports field irrigation
City of Sand City desalination plant	Brine disposal into coastal groundwater
Irrigation with recycled water from Pasadera Wastewater/Recycling Facility	Return flow of irrigation water from Nicklaus Club-Monterey
Seaside Basin groundwater	Return flow of water from landscape, golf course, and sports field irrigation
Septic tanks	Leaching and percolation
System losses (water and sewer)	Percolation

4.1.1 DEEP PERCOLATION OF RAINFALL

Rainfall falling on impervious surface has an opportunity to infiltrate into the basin. A large portion of the basin is undeveloped and is underlain by permeable sands, which enhances deep percolation of rainfall. The salts and nutrients contained in rainfall are very low and not a significant loading source in themselves. Percolating rainwater mobilizing salts and nutrients in the vadose zone and atmospheric deposition of salts and nutrients on the ground surface are other potential contributors to loading in the basin.

The amount of deep percolation of rainfall was obtained from the Seaside Basin groundwater model (HydroMetrics LLC, 2009b). Average annual deep percolation occurring over the last five years of the calibrated model (2005 – 2009) was outputted from the model for each of the four subareas.

VADOSE ZONE MOBILIZATION

The processes that mobilize salts and nutrients in the vadose zone are assumed to be stable and occurring under steady-state conditions. This source was therefore not included in the salt and nutrient balance.

ATMOSPHERIC DEPOSITION

The type of surface dictates the transport behavior of salts and nutrients from atmospheric deposition. The UC Davis study on addressing nitrate in California's drinking water (2012) assumed atmospheric deposition of nitrogen in natural areas is retained in the ecosystem and leaching into the groundwater basin is negligible. In urban areas, atmospheric deposition on impervious surfaces is removed by storm water or is sequestered by turf grass. Salts deposited by atmospheric processes are assumed to be insignificant.

4.1.2 MINERAL DISSOLUTION

Section 3.11.1 described groundwater in the Laguna Seca and Southern Coastal subareas as having elevated salts because of the shallow occurrence of Monterey shale formation in these areas of the basin. However, groundwater concentrations in the Laguna Seca and Southern Coastal subareas have remained relatively stable over time, which indicates that this process is in equilibrium and should not be included as a continual salt source.

4.1.3 STORM WATER

Collected storm water in the Seaside basin is either percolated into ponds or subsurface galleries, or flows out to the ocean by means of ocean outfalls and Roberts Lake. Only storm water that percolates down into the aquifers is a source of salts and nutrients to the basin. The water quality and hence the salt and nutrient load from storm water varies depending on the land use within the drainage area.

The volume of runoff generated is not as great as would be expected for a basin of the size of the Seaside basin. A large percentage of the land use is undeveloped, with sandy soils that have high permeability that allows for greater infiltration and less runoff.

The catchments for the various storm water outlets are delineated in Figure 2. The Canyon del Rey catchment that drains into Laguna Grande and Roberts Lake, and ultimately the Monterey Bay, only generates runoff from larger, less frequent storms. This is because the watershed during those storms is considered saturated which causes a larger percentage of runoff to occur as streamflow (Monterey County Flood Control and Water Conservation District, 1977). Rainfall and storm water generated in smaller more frequent storms mostly percolates directly into the basin. Within the Canyon Del Rey catchment there are a couple of percolation ponds that collect storm water that is recharged into the basin (Figure 2).

Available storm water quality data are summarized in Table 2.

4.1.4 LANDSCAPE AND GOLF COURSE FERTILIZATION

Fertilizer applied to residential, commercial, recreational, and public landscapes has the potential to infiltrate the ground surface and percolate into the groundwater basin. Nitrogen losses arise from potential losses to the atmosphere, immobilization, and denitrification of applied fertilizer. However, application rates often exceed actual plant uptake and excess water excess irrigation water in a sufficiently permeable soil root zone will cause nitrogen to leach through the soil profile and into the underlying aquifer.

Although some data suggest nitrate does not leach from highly managed turfs because of nitrogen sequestering, isotope studies have shown that there can be less than 1% leaching (UC Davis, 2012). Golf course fertilization rates are typically higher than other applications and according to Wu et al. (2007) can apply in excess of 2,180 pounds of nitrogen per acre per year. The UC Davis study (2012) derived a net leaching rate of 8.9 pounds of nitrogen per acre per year for urban landscapes and golf courses.

Based on the land use map (Figure 8), there are approximately 109 acres of sports fields in the Seaside basin. Given nitrogen leaching rate of 8.9 pounds per acre per year, the estimated annual nitrogen leached in to the groundwater from sports fields in the Seaside Basin is 970 pounds.

The leaching of nitrogen from fertilizers in residential and commercial properties was estimating by determining the number of parcels within the urban and rural residential land uses, and assuming an average landscape area of 770 acres to be irrigated (approximately a quarter of the urban, residential, and commercial acreage).

There are four golf courses in the Seaside basin. Table 13 summarizes the sizes and estimated fertilizer use based on the fertilized acreage determined from aerial photographs.

Table 13: Summary of Estimated Seaside Basin Golf Course Fertilizer Application

Golf Course	Operating Since	Approx. Fertilized Area (acres)	Leached Nitrogen * (pounds)
Nicklaus Club-Monterey (formerly Pasadera Country Club)	2000	100	890
Laguna Seca Golf Ranch	1970	99	881
Bayonet	1954	160	1,424
Black Horse	1964	112	997

* Assuming net leaching rate of 8.9 pounds nitrogen per acre per year (UC Davis, 2012)

4.1.5 CARMEL RIVER SYSTEM WATER

MPWMD/CAL-AM AQUIFER STORAGE PROJECT

Due to stresses on the Carmel River system and the State Water Control Board's order for Cal-Am to reduce diversions from the Carmel River, Cal-Am diverts excess winter and spring Carmel River flows for recharge and storage in the Seaside basin. The water is recovered from the basin by the ASR and other Cal-Am wells in the dry summer months and delivered to Cal-Am customers. The project has two phases. Phase I, includes two ASR wells that inject a combined 920 AFY, under a water rights permit which has a maximum instantaneous diversion rate of 6.7 cfs, and is owned and operated by MPWMD. This first phase was commissioned in 2008.

Phase II of the ASR project has not yet been completely implemented. It consists of an additional two ASR wells that will inject an estimated 1,080 AFY, under a water rights permit which has a maximum instantaneous diversion rate of 8.0 cfs, and is owned by Cal-Am.

Quality of the water being injected is summarized in Table 9. This water is of higher quality than the native water into which is being injected.

RETURN FLOW FROM IRRIGATION

Water imported into the basin by Cal-Am for delivery to customers is from the Carmel River system. It is used for municipal purposes and mostly exported back out of the basin as wastewater. The portion used for domestic and municipal landscape irrigation within the basin has an opportunity to percolate into the aquifers as return flow.

It is assumed that 23% of Carmel River system water supplied to the Seaside basin is used for irrigation. The loading of salts and nutrients from return flow is estimated from the average concentrations provided for each subarea in Table 5 and the assumed volume of applied water.

4.1.6 SALINAS VALLEY GROUNDWATER WATER

BAYONET AND BLACK HORSE GOLF COURSES IRRIGATION

The Black Horse and Bayonet golf courses are adjacent courses that are owned by the City of Seaside and managed by BSL Golf Corporation. Historically, the City of Seaside has pumped two wells near the golf courses for turf irrigation. Because of their historic over-pumping, the City is currently paying back replenishment water to the Seaside Watermaster by purchasing water from Marina Coast Water District (MCWD) in-lieu of pumping their own wells. The source of water supplied by MCWD is Salinas Valley groundwater. This program started in 2011 and is expected to end in 2018.

RETURN FLOW FROM IRRIGATION

Water imported into the basin by MCWD is from Salinas Valley groundwater. It is used for municipal purposes and is mostly exported back out of the basin as wastewater. The portion used for domestic and municipal landscape irrigation within the basin has an opportunity to percolate into the aquifers as return flow.

It is assumed that 23% of Salinas Valley groundwater supplied is used for irrigation. The loading of salts and nutrients from return flow is estimated from the average concentrations provided for each subarea in Table 5 and the assumed volume of applied water.

4.1.7 CITY OF SAND CITY DESALINATION PLANT

The City of Sand City has a 300 acre-foot per year capacity desalination plant located in the dunes off Bay Street. The source water for the desalination plant is shallow brackish water from the Southern Coastal subarea. Sand City was granted rights to pumping this brackish water in the Amended Decision. Byproduct or reject water from the plant is disposed through a horizontal well beneath the beach in Sand City. The plant has been operating since April 2010 for municipal supply.

The reject water has a TDS and chloride concentration similar to seawater and very low nitrate. It is designed to flow into the ocean after being injected beneath the beach, and therefore is designed to have little impact on the basin's groundwater. Because of this, it is not considered in the loading analysis.

4.1.8 IRRIGATION WITH RECYCLED WATER

The only existing use of recycled water in the basin is for irrigation of the Nicklaus Club-Monterey golf course. The recycled water is provided by the Pasadera wastewater treatment and recycling facility. The wastewater is passed through a tertiary treatment process and disinfected with sodium hypochlorite. All recycled wastewater from the facility is reused on the golf course. The recycled water is stored in a lined storage reservoir where it is blended with well water at a ratio of approximately ten parts well water to one part recycled water before application on the golf course (RWQCB, Central Coast, 2011b). The facility is permitted under Waste Discharge and Recycled Water Producer Requirements Order No. 98-58 and application of the recycled water is permitted under Recycled Water User Requirements Order No. 98-59.

According to the RWQCB (2011b), the facility has had trouble with salt violations of its permit due to:

1. Poor water supply quality. The water supply is local groundwater which has elevated hardness and alkalinity,
2. Widespread use of residential self-regenerating water softeners to combat the hard water which increase the salt load to the wastewater collection system,
3. Spa and pool water discharges to the wastewater collection system,
4. Use of sodium hypochlorite to meet disinfection requirements at the treatment facility, and
5. Effluent concentration limits set in the permit.

Effluent concentration limits for recycled water discharged to the lined storage reservoir are: 600 mg/L for TDS, and 125 mg/L for both sodium and chloride. Table 14 shows how the local groundwater quality regularly exceeds these limits.

Table 14: Comparison of Groundwater Supply, Influent, and Effluent from 2006 - 2010

mg/L	Groundwater Supply			Facility Influent			Facility Effluent		
	TDS	Sodium	Chloride	TDS	Sodium	Chloride	TDS	Sodium	Chloride
Min	639	105	132	853	97	146	1,260	257	428
Max	655	149	179	1,970	264	748	1,890	423	702
Ave	647	130	157	1,249	200	352	1,557	314	562

Data is based on 2006 – 2010 coincident semi-annual monitoring data
Source of data: Central Coast RWQCB, 2011b

The 2012 effluent volumes generated are listed in Table 15.

It is noted that the Court assigned Alternative Producer Allocation for the Nicklaus Club Monterey golf course is less than the amount of groundwater required to meet the 10:1 dilution requirement of Recycled Water User Requirements Order No. 98-59.

Table 15: Pasadera Wastewater Treatment and Recycling Facility Effluent Volumes for 2012

Month	Effluent Volume	
	gallons	Acre-feet
January	1,397,965	4.3
February	1,209,034	3.7
March	1,323,776	4.1
April	1,273,185	3.9
May	1,350,383	4.1
June	1,243,437	3.8
July	1,305,065	4.0
August	1,361,143	4.2
September	1,423,123	4.4
October	1,284,403	3.9
November	1,209,140	3.7
December	1,302,107	4.0
Total	15,682,761	48.1

4.1.9 Seaside Basin Groundwater Return Flow

A portion of the native groundwater used for landscape, golf course, and sports field irrigation will infiltrate the ground surface and percolate into the aquifer. In this report, this water is called return flow. It is assumed that 23% of groundwater pumped in each subarea is used for irrigation. The loading of salts and nutrients from return flow is estimated from the average concentrations provided for each subarea in Table 5 and the assumed volume of applied water.

4.1.10 Septic Systems

Only approximately 10-20% nitrogen removal is achievable in conventional septic systems (Siegrist et. al., 2000). Septic systems are designed to overflow to a leach field buried in approximately three feet of soil. Due to anaerobic conditions in the septic tank, nitrogen is predominantly ammonium, with the remainder in organic form (UC Davis, 2000). A number of other nitrogen transformations can occur beneath the leach field. The UC David study assumed that all nitrogen leaching from properly functioning septic systems reaches groundwater as nitrate.

4.1.11 SYSTEM LOSSES

Within the water purveyor service areas, there are water and sewer distribution system losses that contribute a small amount to groundwater recharge. Water from system losses is assumed to directly recharge the groundwater basin, and is not involved in evapotranspiration (ET).

4.2 PROPOSED SOURCES

Three proposed projects with potential impacts to the Seaside basin are currently in their planning stages. Table 16 summarizes the three projects, which all import water from various sources of better quality than the native groundwater into the Seaside basin.

Table 16: Summary of Foreseeable Salt and Nutrient Sources

Proposed Project	Potential Source of Salt and Nutrients
Regional Urban Water Augmentation Project (RUWAP)	Irrigation of Bayonet/Black Horse Golf Courses with recycled water
Groundwater Replenishment Project by the Monterey Regional Water Pollution Control Agency	Recharge recycled water by injection into both the shallow and deep aquifers
MPWMD/Cal-Am Aquifer Storage Project Phase II	Injection of Carmel River water into the deep aquifer

4.2.1 REGIONAL URBAN WATER AUGMENTATION

The Regional Urban Water Augmentation Project (RUWAP) comprises a recycled water distribution system by MCWD to provide up to 1,727 AFY of recycled water from MRWPCA's existing Salinas Valley Reclamation Plant (SVRP) to urban users within the Ord Community (former Fort Ord) and the Monterey Peninsula. Approximately 300 AFY would be made available to the Monterey Peninsula with the remainder being supplied for redevelopment of Fort Ord. Between 450 and 500 AFY of irrigation water would be provided to the City of Seaside golf courses (Black Horse and Bayonet).

With the exception of a winter storage reservoir, the project design is essentially complete, and most of the right-of-way for the pipelines has been acquired. Some sections of pipeline have already been installed as components of roadway projects constructed under the Fort Ord Reuse Plan. The project is three to five years from completion.

Currently, the Seaside golf courses are being irrigated with Salinas Valley groundwater imported into the Seaside basin by MCWD. The change from Salinas Valley groundwater to recycled water will cause a slight increase in salt and nutrient loading.

4.2.2 Groundwater Replenishment Project

Monterey Regional Water Pollution Control Agency's (MRWPCA) proposed Groundwater Replenishment Project (GWRP) is currently involved in the California Environmental Quality Act (CEQA) process. The GWRP would produce 3,500 AFY of high quality water for injection into both the shallow Paso Robles (four wells) and deeper Santa Margarita (four wells) aquifers in the Seaside basin. To produce this volume of treated water, the GWRP requires a minimum of 4,321 AFY of raw source waters to feed the proposed new GWRP Advanced Water Treatment (AWT) Facility.

The mechanism of recharge is subject to revision during the CEQA process but has initially been planned as 10% into the Paso Robles aquifer through the use of vadose zone wells and 90% injected into the Santa Margarita aquifer. Advanced treatment of wastewater by the AWT plant will include reverse osmosis and microfiltration. The injection water's expected TDS will be less than 200 mg/L, and total nitrogen will be less than 5 mg/L. This water quality is better than the groundwater quality presently occurring in the area where the project is proposed. This means that the project will not cause additional salt and nutrient loading but contribute to improving the groundwater quality.

4.2.3 MPWMD/Cal-Am Aquifer Storage Project Phase II

Phase II of the aquifer storage project described in Section 4.1.5 will be operational in 2014. It is owned by Cal-Am, and consists of an additional two ASR wells capable of injecting an annual average of approximately 1,080 AFY, under a water rights permit which has a maximum instantaneous diversion rate of 8.0 cfs from the Carmel River. The water quality of the injected water is summarized in Table 9. This water quality is better than the groundwater quality presently occurring in the Santa Margarita aquifer where the injection is targeted. This means that the project will not cause additional salt and nutrient loading but will contribute to improving the groundwater quality, as shown in Figure 12.

SECTION 5
EXISTING GROUNDWATER MONITORING PROGRAMS

Historical groundwater monitoring in the Seaside basin started in the mid-1950's when some records of coastal municipal well production and groundwater levels were kept. In 1980, the MPWMD established a coordinated program of collecting and reporting groundwater production in the basin. The program required the reporting of groundwater and surface water production from all water sources. In the early 1990's MPWMD pioneered a program to install dedicated monitoring wells completed within targeted aquifers in the coastal areas of the basin to monitor water quality and levels in an effort to monitor potential seawater intrusion. Since that time the MPWMD's monitoring network has been expanded to 25 wells at 18 locations in the Northern and Southern Coastal subareas, and 25 wells in 17 locations within the Laguna Seca and Northern Inland subareas.

As part of the Adjudicated Decision for the Seaside Groundwater Basin, the Watermaster was required to prepare a comprehensive monitoring and management program (MMP) to assist the Court in the administration and enforcement of the Decision and to ensure the basin is protected and managed as a perpetual source of water for beneficial uses. On February 9, 2007, the Court approved the Seaside Basin MMP which has continued to be implemented since that time.

The purpose of the monitoring portion of the MMP is to monitor current overdraft conditions and threat of potential seawater intrusion into the coastal subarea of the basin. Groundwater production, groundwater quality, and groundwater levels are included in the MMP. The MMP provides for groundwater level monitoring on at least a quarterly basis. Coastal monitoring well groundwater levels are measured monthly manually and have dataloggers set to record at least daily. Inland monitoring well groundwater levels are manually measured quarterly with some of the wells equipped with dataloggers set to record at least daily. Data are entered into the MPWMD/Watermaster database quarterly. Wells that are monitored are listed in Table 17 through Table 19. Figure 17 shows the location of all wells monitored.

Coastal monitoring wells are sampled quarterly using dedicated low-flow bladder pumps and tested for full general mineral and physical parameters. Groundwater quality (full general mineral and physical parameters) is only collected from inland monitoring wells after they are completed and at the request of the Watermaster for special studies.

Producers who are Watermaster members are required to record monthly groundwater levels and production volumes from their production wells and report them to the Watermaster at least quarterly. Water quality samples (full general mineral and physical parameters) from active Watermaster producer coastal production wells are collected in the fourth quarter of each water year. All these data are entered into the MPWMD/Watermaster database quarterly.

The MPWMD/Cal-Am Aquifer Storage Project has a groundwater sampling and analysis plan (SAP) that provides for monitoring of ASR operations. The plan is subject to periodic updates, but essentially requires that MPWMD samples specific wells quarterly during periods the ASR wells are operating (Appendix A). The wells that are monitored as part of the SAP are included in Table 17 through Table 19. Figure 17 shows the location of wells monitored.

Another monitoring program in the area, which overlaps with the monitoring already described, is managed by the California Department of Public Health (CDPH), which requires testing of public water supply wells per the State defined monitoring schedule. See online link below to the CDPH monitoring program. (http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Monitoring.aspx).
The annual data required by the Watermaster from water purveyors for active production wells exceeds the frequency of the CDPH monitoring schedule.

Table 17: Wells in the Laguna Seca Subarea Included in Existing Monitored Programs

					Watermaster MMP					ASR Monitoring by MPWMD	
Watermaster Number	Common Name	Owner	Well Type	Subarea	WL Monitoring Frequency	WL Network	WQ Monitoring Frequency	WQ Network	Monitored By	WL Monitoring Frequency	WQ Monitoring Frequency
135	**Justin Court**	**California American Water**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**	**Quarterly**	**none**
209	Bishop #1 (west)	California American Water	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	CAW		
213	Ryan Ranch #7	California American Water	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	CAW		
215	Ryan Ranch #11	California American Water	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	CAW		
216	Ryan Ranch #8	California American Water	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	CAW		
226	Bay Ridge	California American Water	Production	Laguna Seca	Monthly	Watermaster	none	none	CAW		
242	**CalAm Granite Construction**	**California American Water**	**Monitor**	**Laguna Seca**	**Quarterly**	**Watermaster**	**none**	**none**	**MPWMD**		
262	Bishop #3	CAW	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	CAW		
136	**LS Pistol Range**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
137	**York Rd-West**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
138	**Seca Place**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
139	**Robley Shallow (North)**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
140	**Robley Deep (South)**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
141	**LS Driving Range**	**County of Monterey**	**Monitor**	**Laguna Seca**	**Quarterly**	**Watermaster**	**Annually**	**Watermaster**	**MPWMD**		
142	**LS No. 1 Subdivision**	**Laguna Seca Resorts**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
143	**Blue Larkspur-East End**	**Laguna Seca Resorts**	**Monitor**	**Laguna Seca**	**Quarterly***	**MPWMD**	**none**	**none**	**MPWMD**		
144	LS Golf Old #12	Laguna Seca Resorts	Production	Laguna Seca	Monthly	MPWMD	none	none	LSGR		
196	LSRA #2	Monterey County Parks Department	Production	Laguna Seca	Monthly	Watermaster	none	none	MCPD		
197	LSRA #1	Monterey County Parks Department	Production	Laguna Seca	Monthly	Watermaster	none	none	MCPD		
129	**FO-04-Shallow (E)**	**MPWMD**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
130	**FO-04-Deep (W)**	**MPWMD**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
133	**FO-06-Shallow**	**MPWMD**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
134	**FO-06-Deep**	**MPWMD**	**Monitor**	**Laguna Seca**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
204	Pasadera Golf - Paddock	Pasadera Country Club, LLC	Production	Laguna Seca	Monthly	Watermaster	none	none	Pasadera		
208	Pasadera Golf - Main Gate	Pasadera Country Club, LLC	Production	Laguna Seca	Monthly	Watermaster	none	none	Pasadera		
212	York School 2001	York School	Production	Laguna Seca	Monthly	Watermaster	Annually	Watermaster	MPWMD		

Bold indicates monitoring well

Table 18: Wells in the Northern Coastal Subarea Included in Existing Monitored Programs

					Watermaster MMP					ASR Monitoring by MPWMD	
Watermaster Number	Common Name	Owner	Well Type	Subarea	WL Monitoring Frequency	WL Network	WQ Monitoring Frequency	WQ Network	Monitored By	WL Monitoring Frequency	WQ Monitoring Frequency
107	Ord Grove Test	California American Water	Monitor	Northern Coastal	Monthly	MPWMD	none	none	MPWMD	Daily*	Quarterly
151	Military	California American Water	Production	Northern Coastal	Monthly	Watermaster	none	none	CAW		
153	Ord Grove #2	California American Water	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	CAW		Quarterly
159	Luzern #2	California American Water	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	CAW		
162	Playa #3	California American Water	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	CAW		
163	Playa #4	California American Water	Monitor	Northern Coastal	Monthly	CAW	none	none	CAW		
169	Paralta	California American Water	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	CAW		Quarterly
231	Del Monte Test	California American Water	Monitor	Northern Coastal	Monthly	CAW	Annually	Watermaster	CAW		
243	Luxton	California American Water	Monitor	Northern Coastal	Monthly	CAW	none	none	CAW		
173	Seaside Muni #4	City of Seaside	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	City of Seaside		
174	Seaside Muni #3	City of Seaside	Production	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	City of Seaside		
187	Seaside Golf - Reservoir	City of Seaside	Production	Northern Coastal	Quarterly	Watermaster	Annually	Watermaster	Coty of Seaside		
189	Seaside Golf - Coe	City of Seaside	Production	Northern Coastal	Quarterly	Watermaster	Annually	Watermaster	City of Seaside		
152	Target Well	DBO Development	Production	Northern Coastal	Monthly	MPWMD	none	none	MPWMD		
154	MMP monitor	Mission Memorial Park	Monitor	Northern Coastal	Monthly	Watermaster	none	none	MPWMD		
101	MSC-Shallow	MPWMD	Monitor	Northern Coastal	Monthly	MPWMD	Quarterly	Watermaster	MPWMD		
102	MSC-Deep	MPWMD	Monitor	Northern Coastal	Monthly*	MPWMD	Quarterly*	Watermaster	MPWMD		
103	PCA-W Shallow	MPWMD	Monitor	Northern Coastal	Quarterly	MPWMD	Quarterly*	Watermaster	MPWMD		
104	PCA-W Deep	MPWMD	Monitor	Northern Coastal	Quarterly*	MPWMD	Quarterly*	Watermaster	MPWMD		
105	PCA-E Shallow	MPWMD	Monitor	Northern Coastal	Monthly	MPWMD	Annually	Watermaster	MPWMD	Daily*	Quarterly
106	PCA-E Deep	MPWMD	Monitor	Northern Coastal	Monthly	MPWMD	Annually	Watermaster	MPWMD	Daily*	Quarterly**
108	Paralta Test	MPWMD	Monitor	Northern Coastal	Monthly	MPWMD	none	none	MPWMD	Daily*	Quarterly
109	Ord Terrace-Shallow	MPWMD	Monitor	Northern Coastal	Annually	MPWMD	Annually	Watermaster	MPWMD	Daily*	Quarterly
110	Ord Terrace-Deep	MPWMD	Monitor	Northern Coastal	Monthly	MPWMD	Annually	Watermaster	MPWMD		
111	FO-09-Shallow	MPWMD	Monitor	Northern Coastal	Monthly*	MPWMD	Quarterly*	Watermaster	MPWMD		
112	FO-09-Deep	MPWMD	Monitor	Northern Coastal	Monthly*	MPWMD	Quarterly*	Watermaster	MPWMD		
251	CDM MW-1	MPWMD	Monitor	Northern Coastal	Monthly	Watermaster	none	none	MPWMD		
252	CDM MW-2	MPWMD	Monitor	Northern Coastal	Monthly	Watermaster	none	none	MPWMD		
261	ASR - 3	MPWMD	Monitor	Northern Coastal	Quarterly	MPWMD	Annually	MPWMD	MPWMD	Daily*	Quarterly
283	ASR - 4	MPWMD	Monitor	Northern Coastal	Quarterly	MPWMD	Annually	MPWMD	MPWMD	Daily*	Quarterly
248	Sentinel MW #4	Seaside Watermaster	Monitor	Northern Coastal	Monthly	Watermaster	Annually	Watermaster	MPWMD		
171	PCA Production	Security National Guaranty Inc	Production	Northern Coastal	Monthly	Watermaster	none	none	Craig Evans		
259	Seaside Middle School (S)	MPWMD	Monitor	Northern Coastal						Monthly	Quarterly
260	Seaside Middle School (D)	MPWMD	Monitor	Northern Coastal						Monthly	Quarterly**

Bold indicates monitoring well
* in water level column indicates datalogger is installed
** in water quality column indicates low-flow bladder pump is installed for sampling

Table 19: Wells in the Northern Inland and Southern Coastal Subareas Included in Existing Monitored Programs

					Watermaster MMP					ASR Monitoring by MPWMD	
Watermaster Number	Common Name	Owner	Well Type	Subarea	WL Monitoring Frequency	WL Network	WQ Monitoring Frequency	WQ Network	Monitored By	WL Monitoring Frequency	WQ Monitoring Frequency
115	**FO-01-Shallow**	**MPWMD**	**Monitor**	**Northern Inland**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
116	**FO-01-Deep**	**MPWMD**	**Monitor**	**Northern Inland**	**Quarterly**	**MPWMD**	**none**	**none**	**MPWMD**		
118	**FO-07-Shallow**	**MPWMD**	**Monitor**	**Northern Inland**	**Monthly**	**MPWMD**	**none**	**none**	**MPWMD**	**Daily***	**Quarterly**
119	**FO-07-Deep**	**MPWMD**	**Monitor**	**Northern Inland**	**Monthly**	**MPWMD**	**none**	**none**	**MPWMD**	**Daily***	**Quarterly**
188	**ASR - 1**	**MPWMD**	**Monitor**	**Northern Inland**	**Quarterly**	**MPWMD**	**Annually**	**MPWMD**	**MPWMD**	**Daily***	**Quarterly**
256	**ASR - 2**	**MPWMD**	**Monitor**	**Northern Inland**	**Quarterly**	**Watermaster**	**none**	**none**	**MPWMD**	**Daily***	**Quarterly**
257	**ASR MW-1**	**MPWMD**	**Monitor**	**Northern Inland**	**Quarterly**	**Watermaster**	**none**	**none**	**MPWMD**	**Daily***	**Quarterly**
177	Plumas #4	California American Water	Production	Southern Coastal	Monthly	Watermaster	Annually	Watermaster	CAW		
184	La Salle #2	California American Water	Production	Southern Coastal	Monthly	CAW	Annually	Watermaster	CAW		
244	**Hilby MGT**	**California American Water**	**Monitor**	**Southern Coastal**	**Monthly**	**Watermaster**	**none**	**none**	**CAW**	**Daily***	
165	Sand City Corp Yard	City of Sand City	Production	Southern Coastal	Monthly	Watermaster	Annually	Watermaster	MPWMD		
167	Design Ctr.	City of Sand City	Production	Southern Coastal	Monthly	Watermaster	Annually	Watermaster	MPWMD		
150	Cypress Pacific Production	King Venture	Production	Southern Coastal	Monthly	Watermaster	Annually	Watermaster	MPWMD		
156	Mission Memorial	Mission Memorial Park	Production	Southern Coastal	Quarterly	Watermaster	Annually	MPWMD	MPWMD		
124	**Plumas Test 1990**	**MPWMD**	**Monitor**	**Southern Coastal**	**Monthly**	**MPWMD**	**none**	**none**	**MPWMD**		
125	**K-Mart**	**MPWMD**	**Monitor**	**Southern Coastal**	**Monthly**	**MPWMD**	**none**	**none**	**MPWMD**		
238	**CDM MW-4**	**MPWMD**	**Monitor**	**Southern Coastal**	**Monthly**	**Watermaster**	**none**	**none**	**MPWMD**		
239	**CDM MW-3**	**MPWMD**	**Monitor**	**Southern Coastal**	**Monthly**	**Watermaster**	**none**	**none**	**MPWMD**		
240	**MW-BW-08-A**	**U.S.A. Fort Ord**	**Monitor**	**Southern Coastal**	**Monthly**	**Watermaster**	**none**	**none**	**MPWMD**		
241	**MW-BW-09-180**	**U.S.A. Fort Ord**	**Monitor**	**Southern Coastal**	**Monthly**	**Watermaster**	**none**	**none**	**MPWMD**		

Bold indicates monitoring well
* in water level column indicates datalogger is installed
** in water quality column indicates low-flow bladder pump is installed for sampling

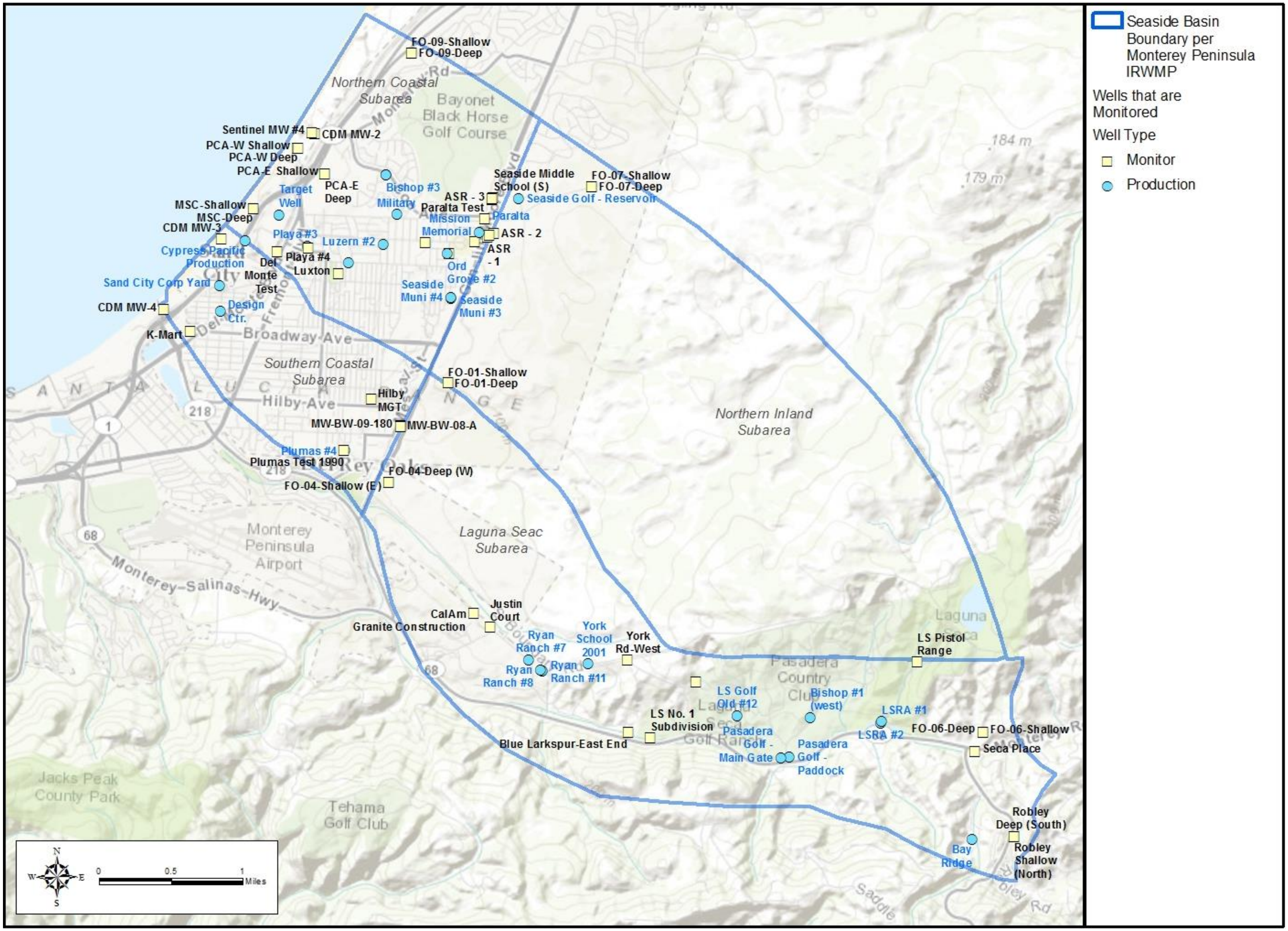

Figure 17: Location of Wells Monitored (Production and Dedicated Monitoring Wells)

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SECTION 6
EXISTING DATABASES

6.1 EXISTING DATABASE IDENTIFICATION AND DESCRIPTION

MPWMD, working with the Watermaster has developed a database that contains groundwater quality and groundwater level data collected within the Seaside Groundwater Basin. The database is in 2010 MS Access format and has been adapted from an earlier database initially developed by Watermaster consultants in 2006. MPWMD maintains the database on a quarterly basis. The database is backed up weekly, with backup tapes rotated, and kept in an off-site lockbox.

Water quality data contained in the MPWMD database includes data collected for Watermaster required monitoring, Carmel River system specific monitoring, ASR specific monitoring, and remaining areas within the MPWMD service area.

Groundwater level data contained in the database includes groundwater levels collected since 2008 for Watermaster-required monitoring and all data MPWMD has historically collected prior to the establishment of the Watermaster and in connection with regulatory requirements for ASR. The database does not contain groundwater level data recorded by dataloggers.

A streamflow database developed and maintained by the MPWMD is separate from the MS Access groundwater database. The streamflow database includes flows and water quality. Of relevance to the Seaside basin is the streamflow record of Arroyo Del Rey at Del Rey Oaks. This streamflow monitoring gage has been maintained by MPWMD since October 2002.

6.2 RECOMMENDED DATABASE

It is recommended that the current MPWMD/Watermaster database be used as the data storage location for any groundwater data collected as part of salt and nutrient monitoring. The database provides a comprehensive, maintained, well-established location for groundwater data collected for the Seaside basin.

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SECTION 7
SALT AND NUTRIENT EVALUATION

7.1 WATER BALANCE

7.1.1 CONCEPTUAL MODEL

The conceptual model used for this salt and nutrient management plan is a simplified representation of the essential features of the basin's physical system, its hydrologic behavior, and man-made components that influence the water balance. These data, interpretations, and simplifications form the basis of the salt and nutrient balance that follows.

The water balance consists of developing quantitative estimates of all of the inflows and outflows for the basin, both natural and man-made. The water balance developed for the Seaside Basin groundwater model (HydroMetrics LLC, 2009b) is used as a primary source with water imports and exports from the basin also included, as these were not part of the original hydrologic water balance prepared for the groundwater flow model. A graphical conceptual depiction of the water balance is provided in Figure 18. The following sections describe each of the water balance components. Table 20 summarizes the annual average water balance components.

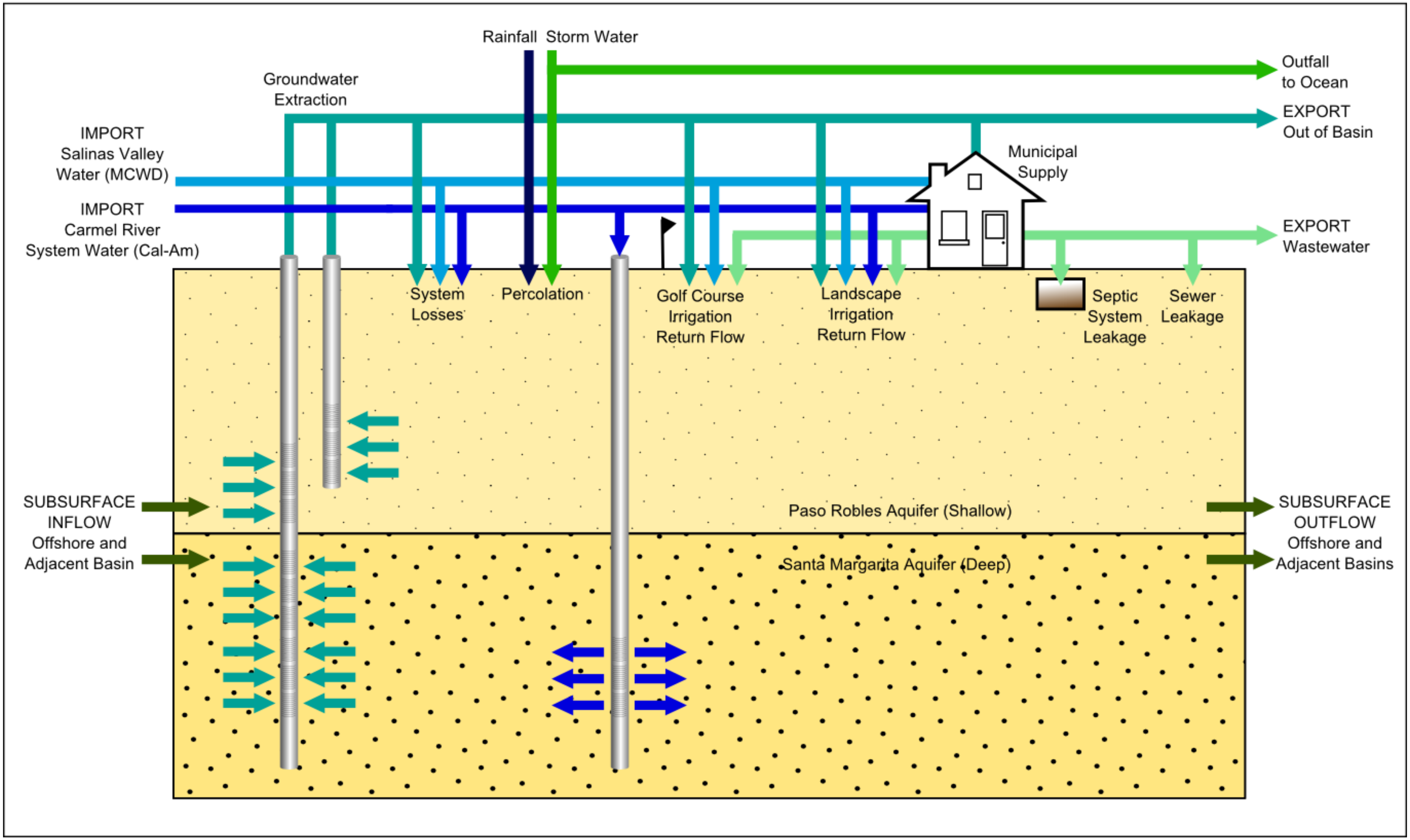

Figure 18: Conceptual Water Balance

7.1.2 INFLOWS

Inflows to the Seaside basin include all water that is naturally and artificially brought into the basin. Natural inflow mechanisms adding water to the groundwater system include:

1. Deep percolation of rainfall, and
2. Underflow from onshore and offshore areas (inflow).

Water introduced into the groundwater basin by artificial or man-made means include:

1. Imported water from outside the basin,
2. Losses from water distribution systems,
3. Losses from sewer system,
4. Septic systems,
5. Return flow from irrigation,
6. Infiltration from storm water ponds.

Although a general discussion of each of the inflow terms have already been included in Section 4, more detail on the quantity and source of flow data is provided in this section.

DEEP PERCOLATION OF RAINFALL

The amount of deep percolation occurring in each subarea of the Seaside basin was extracted from the calibrated Seaside basin groundwater flow model (HydroMetrics LLC, 2009b). The primary source of data for the model was daily rainfall data were obtained from Monterey Co-op Station 45795 and Salinas Co-op Station 47668 (Figure 3). The resultant amount of deep percolation from rainfall was calculated at each model cell using a combination of daily rainfall, monthly evapotranspiration, land use type, and soil classifications. The amount of deep percolation of rainfall in the Seaside basin is approximately 2,258 AFY (Table 20).

Table 20: Seaside Basin Water Balance

Water Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
Inflows (AFY)					
Precipitation	78	1,450	30	700	2,258
Groundwater Underflow					
From Onshore	2,850	0	450	180	180*
From Offshore	100	0	0	0	100
ASR Wells (Injection)	625	0	0	0	625
Water Distribution System Losses	411	0	21	46	478
Sewer Distribution System Losses	77	0	9	19	105
Septic Systems	0	0	5	22	27
Irrigation Infiltration					
Golf Courses	85	0	0	88	173
Landscaping	461	0	52	114	627
Recycled Water Irrigation	0	0	0	9	9
Storm Water	68	0	37	0	105
Total Inflow	***4,754***	***1,450***	***604***	***1,177***	***7,985***
Outflows (AFY)					
Groundwater Pumping	4,278	0	227	869	5,374
Groundwater Underflow					
To Onshore	0	2,060	790	450	0*
To Offshore	70	0	30	0	100
Total Outflow	***4,348***	***2,060***	***1,047***	***1,319***	***8,774***
Storage Change (Inflow - Outflow)	**406**	**-610**	**-443**	**-142**	**-789**

* This value is not equal to the sum of the four subarea columns; it is a summary for the entire basin which is made up of all four subareas combined. The subarea columns are a summary of the water balance for each subarea. The four subarea columns include exchanges of groundwater between subareas, as they are an important source of loading and removal of salts and nutrients for individual subareas. The basin-wide value, however, only considers inputs to or outputs from the entire basin. The net values (total groundwater inflow less total groundwater outflow) derived from each approach are equivalent.

Underflow from Onshore and Offshore Areas

Inflow to the basin from adjacent basins is limited to the northeastern boundary connection to the Salinas Valley. Between subareas there is also groundwater underflow. The estimated underflow into each subarea is shown on Table 20. A total of 180 AFY of water enters the basin as groundwater underflow from inland areas. The southern basin boundary is considered a no-flow boundary because it coincides with the Chupines Fault that marks the southernmost extent of the Seaside basin.

A minor amount of groundwater underflow (100 AFY) occurs from the ocean into the basin. This does not constitute seawater intrusion as the basin's aquifers extend offshore. The source of these data is the water balance included in the Seaside basin groundwater flow model report (HydroMetrics LLC, 2009b).

IMPORTED WATER

Approximately 625 AFY of Carmel River system water is imported by MPWMD/Cal-Am for direct injection into the Santa Margarita aquifer. This amount is dependent on water availability in the Carmel River and therefore changes, sometimes significantly, each year.

Municipal and irrigation water is imported into the basin by both Cal-Am and MCWD. The amounts imported over the past two years average: 186 AFY for Cal-Am (Carmel River system water) and 927 AFY for MCWD (Salinas Valley water). The MCWD water is used in the Northern Coastal subarea by the Bayonet and Black Horse golf courses and the residential areas north of Coe Ave. Cal-Am uses its imported water to supply its customers in all the basin's subareas.

Water imported for use in the basin is not a recharge component to the water balance. Various uses of the water become recharge components, such as distribution system losses and irrigation return flow. These are discussed in the following sub-sections.

LOSSES FROM WATER DISTRIBUTION SYSTEMS

Within the water purveyor service areas, there are system losses that contribute a small amount to groundwater recharge. A loss of 8.5% of water distributed to customers by water purveyors was assumed for the water balance. Volumes were provided by MPWMD (groundwater), MCWD (imported Salinas Valley water), and Cal-Am (groundwater and imported Carmel River system water). Water from system losses is assumed to directly recharge the groundwater basin, and is not involved in evapotranspiration. Losses from water distribution systems account for approximately 478 AFY of recharge to the basin (Table 20).

Losses from Sewer Distribution Systems

The volume of sewer system losses was estimated as 5% of the amount of water remaining from imported water and local groundwater after system losses and irrigation return flow are accounted for. For the Seaside basin this amount is estimated as 105 AFY (Table 20).

Septic Systems

To estimate the amount of groundwater recharge by septic systems, water use of 140 gallons per day per capita was assumed, with 40% of that use being indoor use that gets disposed in the septic system. The number of people residing in each of the septic tank areas was estimated using 2010 census data. The average recharge from septic systems is 27 AFY.

Return Flow from Irrigation

Return flow from irrigation was estimated separately for golf courses and landscape irrigation. For golf courses, it was assumed that irrigation efficiencies are 80% and therefore 20% of applied water becomes return flow and recharges the basin. For urban, residential, industrial, and commercial landscape irrigation, it was assumed that of the amount of imported and local groundwater water distributed by water purveyors and private landowners less system losses, 23% becomes irrigation return flow and recharges the groundwater basin. Of the recycled water that is diluted with local groundwater for irrigation of the Nicklaus Club-Monterey golf course, it was assumed that because the recycled water is stored in an open pond, 10% evaporates, and then of the remaining portion, an 80% irrigation efficiency was applied.

Estimates of irrigation return flow as shown in Table 20 are 173 AFY from golf courses, 627 AFY from landscape irrigation, and 9 AFY of recycled water irrigation.

Infiltration from Storm Water Ponds

Infiltration of storm water into five storm water ponds in the groundwater basin (Figure 2) was extracted from the groundwater flow model (HydroMetrics LLC, 2009b). The ponds are constructed to capture storm runoff and allow for percolation into the groundwater. Each percolation pond has a catchment area defined within the model area. Runoff from the catchment is diverted to its corresponding storm water pond. Water diverted to storm water ponds in the area typically infiltrates within 48 hours. Consequently, losses of recharge to ET are assumed to be negligible, and water recharged through the ponds is applied directly to groundwater recharge.

Based on output from the Seaside basin groundwater flow model, the average groundwater recharge from storm water ponds between 2008 and 2012 was 68 AFY for ponds in the northern area and 37 AFY in the southern area.

7.1.3 **OUTFLOWS**

Outflows from the Seaside basin include all discharge mechanisms that remove water from the groundwater system. Discharge components include:

1. Groundwater pumping by water agencies and private landowners,
2. Underflow to onshore and offshore areas (outflow).
3. Exported wastewater

GROUNDWATER PUMPING BY WATER AGENCIES AND PRIVATE LANDOWNERS

The Seaside basin groundwater producers include Cal-Am, City of Seaside, and a number of private pumpers. Production is reported to the Watermaster annually. For the water balance, it was estimated that based on production data for 2011 and 2012, an average of 5,374 AFY was extracted from the basin. Of note, approximately 60% of groundwater pumped by Cal-Am in the Seaside basin is exported out of the basin.

UNDERFLOW TO ONSHORE AND OFFSHORE AREAS

The same onshore and offshore sources as described in the inflow section above apply to the outflows that occur in the Seaside basin, i.e., across the northeastern boundary and to the ocean. In the water balance, approximately 100 AFY of water flows out of the basin and into onshore and offshore areas (Table 20). The source of these data is the water balance included in the Seaside basin groundwater flow model report (HydroMetrics LLC, 2009b).

Export of Wastewater

Like water imported into the basin, wastewater exported is not part of the groundwater balance but it is used to estimate sewer distribution system losses. Wastewater from the City of Seaside, Del Rey Oaks, Sand City, and Monterey is exported out of the basin to the MRWPCA's wastewater treatment plant to the north of the basin. After system losses, irrigation and consumptive uses are removed from the water imported from outside the basin and pumped from the basin, the remaining amount is assumed to be wastewater that is exported from the Seaside basin (approximately 1,900 AFY).

7.2 SALT AND NUTRIENT BALANCES

The salt and nutrient balance consists of developing quantitative estimates of all of the loadings and removals of salts and nutrients for the Seaside basin, both natural and man-made. The loadings and removals that comprise the salt and nutrient balance follow the components of the water balance. Salts and nutrients are carried into the basin with each of the different sources of water, of which each has a natural quantity of salts and nutrients and possibly an additional man-made source. Salts and nutrients are carried out of the basin with natural outflows and exports of water. A graphical conceptual depiction of the salt and nutrient balance is provided in Figure 19. The following sections describe each of the salt and nutrient balance components.

7.2.1 LOADING

Loadings to the Seaside basin include all salts and nutrients that are naturally and artificially brought into the basin. Natural mechanisms of salt and nutrient loading to the groundwater system include those carried by:

1. Deep percolation of rainfall, and
2. Underflow from onshore and offshore areas (inflow).

Salts and nutrients introduced into the groundwater basin by artificial or man-made means include those carried by:

3. Injection of imported water,
4. Losses from water distribution systems,
5. Losses from sewer systems,
6. Septic systems,
7. Return flow from irrigation,
8. Fertilizer application,
9. Infiltration from storm water ponds.

Although a general discussion of each of the sources has already been included in Section 4, more detail on the data and assumptions used to estimate loading are provided in this section. Table 21 through Table 23 summarize the salt and nutrient balances estimated for the Seaside basin, and Table 24 summarizes the different water source concentrations.

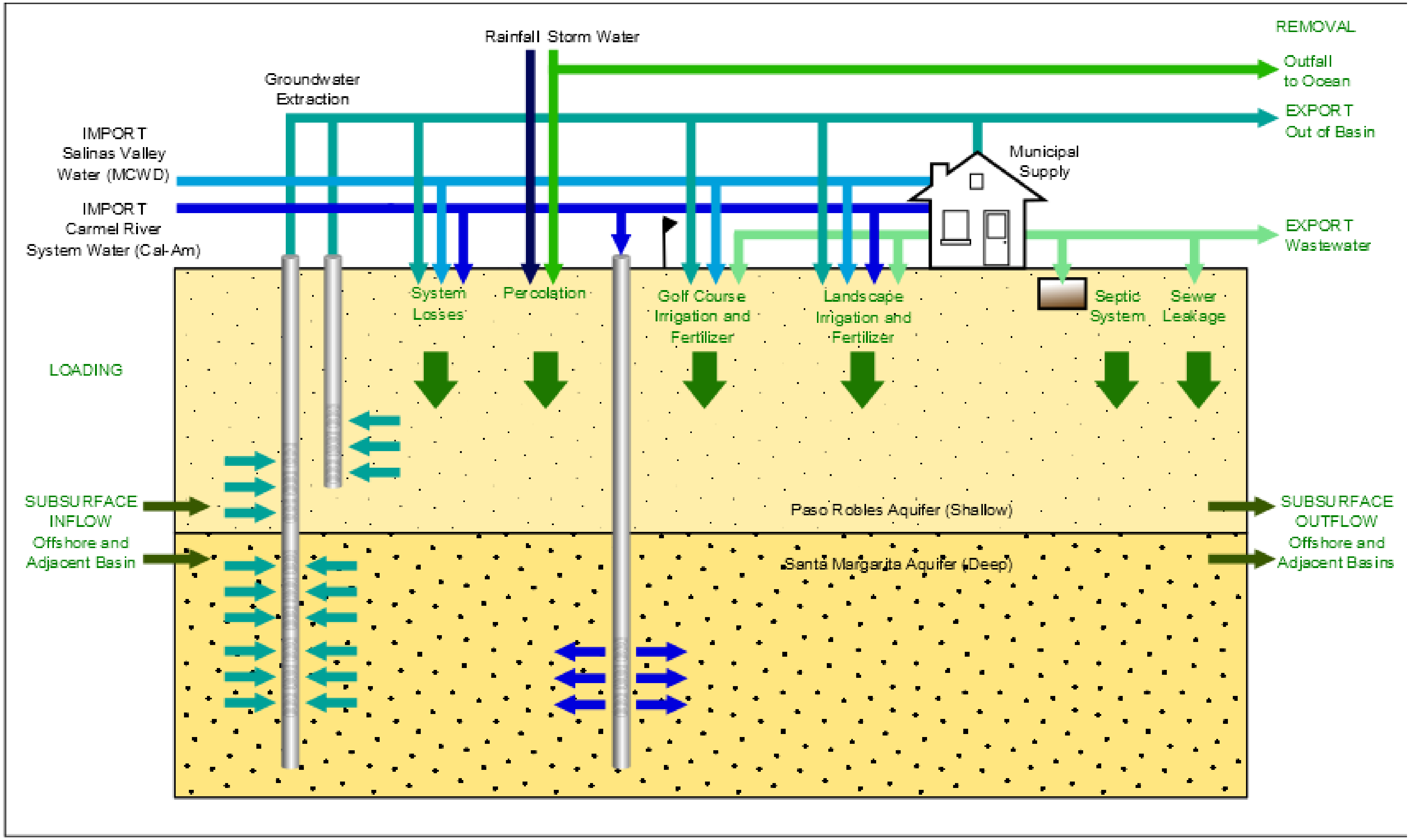

Figure 19: Conceptual Salt and Nutrient Balance

Table 21: Seaside Basin TDS Balance

Salt Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
Inflows (lb/yr)					
Precipitation	593	11,041	230	5,328	17,191
Groundwater Underflow					
From Onshore	3,388,324	0	1,008,928	193,836	292,260*
From Offshore	98,423	0	0	0	98,423
ASR Wells (Injection)	538,343	0	0	0	538,343
Water Distribution System Losses	408,175	0	38,184	89,934	536,293
Sewer Distribution System Losses	218,731	0	24,527	53,988	297,246
Septic Systems	0	0	13,694	62,423	76,116
Irrigation Infiltration					
Golf Courses	435,570	0	0	0	435,570
Landscaping	462,509	0	94,538	222,666	779,713
Recycled Water Irrigation	0	0	0	29,218	29,218
Storm Water	20,034	0	52,670	0	72,704
Total Inflow	***5,570,702***	***11,041***	***1,232,772***	***657,392***	***7,471,907***
Outflows (lb/yr)					
Groundwater Pumping	4,210,062	0	433,187	1,948,353	6,591,602
Groundwater Underflow					
To Onshore	0	1,880,759	1,507,566	1,008,928	0*
To Offshore	68,896	0	57,249	0	126,146
Total Outflow	***4,278,959***	***1,880,759***	***1,998,001***	***2,957,281***	***11,115,000***
Storage Change (Inflow - Outflow)	**1,291,743**	**-1,869,718**	**-765,230**	**-2,299,889**	**-3,643,094**

* This value is not equal to the sum of the four subarea columns; it is a summary for the entire basin which is made up of all four subareas combined. The subarea columns are a summary of the water balance for each subarea. The four subarea columns include exchanges of groundwater between subareas, as they are an important source of loading and removal of salts and nutrients for individual subareas. The basin-wide value, however, only considers inputs to or outputs from the entire basin. The net values (total groundwater inflow less total groundwater outflow) derived from each approach are equivalent.

Table 22: Seaside Basin Chloride Balance

Salt Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
Inflows (lb/yr)					
Precipitation	106	1,972	41	951	3,070
Groundwater Underflow					
From Onshore	821,494	0	293,331	41,117	64,270*
From Offshore	23,156	0	0	0	23,156
ASR Wells (Injection)	44,154	0	0	0	44,154
Water Distribution System Losses	94,286	0	11,682	24,440	130,408
Sewer Distribution System Losses	64,518	0	7,235	15,925	87,677
Septic Systems	0	0	4,039	18,412	22,452
Irrigation Infiltration					
Golf Courses	92,505	0	0	0	92,505
Landscaping	104,495	0	28,924	60,511	193,930
Recycled Water Irrigation	0	0	0	8,829	8,829
Storm Water	5,539	0	14,708	0	20,247
Total Inflow	***1,250,252***	***1,972***	***359,960***	***170,186***	***1,782,369***
Outflows (lb/yr)					
Groundwater Pumping	990,482	0	136,124	566,454	1,693,060
Groundwater Underflow					
To Onshore	0	347,760	473,734	293,331	0*
To Offshore	16,209	0	17,990	0	34,199
Total Outflow	***1,006,691***	***347,760***	***627,847***	***859,785***	***2,842,084***
Storage Change (Inflow - Outflow)	**243,561**	**-345,789**	**-267,888**	**-689,600**	**-1,059,715**

* This value is not equal to the sum of the four subarea columns; it is a summary for the entire basin which is made up of all four subareas combined. The subarea columns are a summary of the water balance for each subarea. The four subarea columns include exchanges of groundwater between subareas, as they are an important source of loading and removal of salts and nutrients for individual subareas. The basin-wide value, however, only considers inputs to or outputs from the entire basin. The net values (total groundwater inflow less total groundwater outflow) derived from each approach are equivalent.

Table 23: Seaside Basin Nitrate-N Balance

Nitrate Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
Inflows (lb/yr)					
Precipitation	11	197	4	95	307
Groundwater Underflow					
From Onshore	7,927	0	776	783	950*
From Offshore	162	0	0	0	162
ASR Wells (Injection)	170	0	0	0	170
Water Distribution System Losses	781	0	128	65	975
Sewer Distribution System Losses	514	0	14,554	603	15,672
Septic Systems	0	0	700	3,193	3,893
Irrigation Infiltration					
Golf Courses	1,748	0	0	0	1,748
Landscaping	1,033	0	318	162	1,513
Fertilizer Application					
Golf Courses	2,421	0	0	1,771	4,192
Sports Fields	587	0	103	280	970
Commercial and Residential Landscaping	2,492	445	2,136	1,780	6,853
Recycled Water Irrigation	0	0	0	54	54
Storm Water	5	0	49	0	53
Total Inflow	***17,850***	***445***	***18,769***	***8,787***	***45,851***
Outflows (lb/yr)					
Groundwater Pumping	6,919	0	1,507	1,499	9,924
Groundwater Underflow					
To Onshore	0	2,683	5,243	776	0*
To Offshore	113	0	199	0	312
Total Outflow	***7,032***	***2,683***	***6,949***	***2,275***	***18,939***
Storage Change (Inflow - Outflow)	**10,818**	**-2,238**	**11,820**	**6,512**	**26,912**

* This value is not equal to the sum of the four subarea columns; it is a summary for the entire basin which is made up of all four subareas combined. The subarea columns are a summary of the water balance for each subarea. The four subarea columns include exchanges of groundwater between subareas, as they are an important source of loading and removal of salts and nutrients for individual subareas. The basin-wide value, however, only considers inputs to or outputs from the entire basin. The net values (total groundwater inflow less total groundwater outflow) derived from each approach are equivalent.

Table 24: Source Concentrations used for Salt and Nutrient Loading Calculations

Constituent	Imported Water		Rain Water	Recycled Water Irrigation	Storm Water		Sewer and Septic Systems
	Salinas Valley	Carmel System			Bay St.	Hotel	
TDS, mg/L	396	317	2.8	1,241	109	519	1,043
Chloride, mg/L	84	26	0.5	375	30	144	308
Nitrate-N, mg/L	1.6	0.1	0.05	2.3	0.025	0.75	2.45

Deep Percolation of Rainfall

Deep percolation of rainfall carries salts and nutrients into the groundwater system at the concentration of natural rainfall. While percolation of rainfall may actually mobilize salts and nutrients introduced to the soil through fertilizers or other means, these loading sources are discussed separately from rainfall.

Loading estimates were made using concentration values of 2.8 mg/L TDS, 0.5 mg/L chloride, and 0.05 mg/L nitrate-N from Table 24 and volumes of percolation of rainfall from the Seaside basin groundwater flow model. Average annual totals of 17,190 pounds/year TDS, 3,070 pounds/year chloride, and 310 pounds/year nitrate-N are estimated to enter the groundwater system by deep percolation of rainfall.

Underflow from Onshore and Offshore Areas

Salts and nutrients are carried into the groundwater basin through groundwater inflow from adjacent onshore and offshore areas. Onshore groundwater inflow takes place only from the Salinas River Valley along the northeastern boundary of the basin. The quality of this groundwater underflow was obtained from wells along the boundary in the Salinas Valley. Underflow from offshore was considered to have the same water quality as the adjacent onshore area. This assumption was made because coastal monitoring shows no evidence of seawater intrusion (HydroMetrics WRI, 2013), and thus the freshwater aquifer extends some distance offshore. The concentrations of TDS, chloride, and nitrate-N in groundwater from Table 5 were used for groundwater for each subarea.

Groundwater underflow from onshore areas has concentrations of 396 mg/L TDS, 84 mg/L chloride, and 1.6 mg/L nitrate-N. Groundwater inflow from offshore to the Northern Coastal subarea has concentrations of 362 mg/L TDS, 85 mg/L chloride, and 0.59 mg/L nitrate-N. Groundwater inflow from offshore to the Southern Coastal subarea has concentrations of 702 mg/L TDS, 221 mg/L chloride, and 2.4 mg/L nitrate-N.

From the concentrations provided above, an average of 292,260 pounds/year TDS, 64,270 pounds/year chloride, and 950 pounds/year nitrate-N are estimated to be loaded into the groundwater system through groundwater underflow from onshore and offshore areas.

INJECTION OF IMPORTED WATER

Some salts and nutrients are introduced into the Seaside basin with Carmel River system water that is imported for direct injection into the Santa Margarita aquifer by MPWMD/Cal-Am. Carmel River system water has concentrations of 317 mg/L TDS, 26 mg/L chloride, and 0.1 mg/L nitrate-N. From these concentrations and volumes described in Section 7.1.2, average annual totals of 538,340 pounds/year TDS, 44,154 pounds/year chloride, and 3,890 pounds/year nitrate-N were estimated to be injected into the groundwater system by the ASR wells.

It should be noted that although the injected water contains salts and nutrients, and is a source of loading to the aquifer, this water is of much better quality than the native groundwater. The injected water has been shown to dilute the salt and nutrient concentrations of the native groundwater and improve its quality (Figure 12).

LOSSES FROM WATER DISTRIBUTION SYSTEMS

The sources of water that are lost by leakage from water distribution systems include local groundwater, Salinas Valley groundwater, and Carmel River System water. The water qualities applied to each of these sources to estimate salt and nutrient loading are shown in Table 5 and Table 24.

From these concentrations and volumes in Table 20, average loadings of 536,290 pounds/year TDS, 130,410 pounds/year chloride, and 980 pounds/year nitrate-N are estimated to occur through delivery system losses.

LOSSES FROM SEWER DISTRIBUTION SYSTEMS

The quality of the water lost from sewer systems is based upon the quality of untreated influent accepted by the Pasadera Wastewater Facility and Regional

Wastewater Treatment Plant. Using a sewer system loss of 105 AFY and concentrations of 1,040 mg/L TDS, 306 mg/L chloride, and 2.5 mg/L nitrate-N, average loadings of 297,250 pounds/year TDS, 87,680 pounds/year chloride, and 15,670 pounds/year nitrate-N are estimated to occur through sewer system losses.

SEPTIC SYSTEMS

The quality of the water leached from septic systems was assumed to be the same as that lost from sewer distribution systems. Using a leached volume of 27 AFY, average loadings of 76,120 pounds/year TDS, 22,450 pounds/year chloride, and 3,890 pounds/year nitrate-N are estimated to occur from septic system leaching.

RETURN FLOW FROM IRRIGATION

All water used for irrigation contains salts and nutrients, regardless of whether or not fertilizer is added. As a result, fertilizer is treated as an independent loading source and irrigation return flow includes only the salts and nutrients that are present in the water before it is applied as irrigation. The amount of salts and nutrients in this water is based upon the quality of the source water. These sources include Salinas Valley groundwater, Carmel River System Water, local groundwater, and recycled water from the Pasadera Wastewater Treatment Plant. The quality of these water sources are listed in Table 5 and Table 24.

Using the volume irrigation return flow from Table 20, an average of 1,244,500 pounds/year TDS, 295,260 pounds/year chloride, and 3,320 pounds/year nitrate-N are estimated to be added to the basin from irrigation return flow.

FERTILIZER APPLICATION

Fertilizer application was considered independently of irrigation water and was assumed to only be a source of nitrate-N loading to the groundwater system. As described in Section 4.1.4, fertilizer loading is assumed to occur in the land use categories of residential, commercial, golf course, and sports fields.

Using a net leaching rate of 8.9 pounds of nitrogen per acre per year for urban landscapes and golf courses (UC Davis, 2012), and land use shown in Figure 8, the nitrogen loading from fertilizer application was estimated.

- From the approximately 109 acres of sports fields in the Seaside basin, the estimated annual nitrogen leached in to the groundwater is 970 pounds.

- Approximately one quarter of urban, residential, and commercial acreage was assumed to be fertilized. From the average landscaped area of 770 acres, 6,850 pounds of nitrogen was estimated to be leached into groundwater.

- There are four golf courses in the Seaside basin. Table 13 summarizes the sizes and estimated fertilizer use based on the fertilized acreage determined from aerial photographs.

Table 25: Summary of Estimated Seaside Basin Golf Course Fertilizer Application

Golf Course	Operating Since	Approx. Fertilized Area (acres)	Leached Nitrogen * (pounds)
Nicklaus Club-Monterey (formerly Pasadera Country Club)	2000	100	890
Laguna Seca Golf Ranch	1970	99	881
Bayonet	1954	160	1,424
Black Horse	1964	112	997

* Assuming net leaching rate of 8.9 pounds nitrogen per acre per year (UC Davis, 2012)

A total average annual total of 12,020 pounds/year nitrate-N was estimated to be introduced into the groundwater system through fertilizer application.

Infiltration from Storm Water Ponds

The quality of infiltrating storm water was derived from the storm water quality data collected by Monterey Bay Sanctuary Citizen Watershed Monitoring Network and listed in Table 2. Water quality data from the Bay St. sampling location was applied to all storm water ponds within the Northern Coastal subarea. Water quality data from the Hotel sampling location was applied to all storm water ponds within the Southern Coastal subarea.

For each of the two sampling locations, the average water quality of infiltrating water was assumed to fall at the center of the ranges listed for the "First Flush 2009-2012." Of the three water quality parameters covered in this SNMP, only nitrate-N was measured directly in the storm water. Therefore, it was required to estimate TDS and chloride concentrations by other means. The average concentration of TDS in the storm water was estimated (in mg/L) by applying a factor of 0.7 to the electrical conductivity (in μS/cm). The average concentration of chloride in the storm water was then estimated by deriving a relationship between chloride and TDS using other available water quality data from the basin. The derived relationship was: chloride = 0.278 x TDS.

The estimated water quality of the Hotel sampling location was 519 mg/L TDS, 144 mg/L chloride, and 0.75 mg/L nitrate-N. The estimated water quality of the Bay St. sampling location was 109 mg/L TDS, 30 mg/L chloride, and 0.025 mg/L nitrate-N. Using a volume of 105 AFY of infiltrating storm water, average loadings of 72,700 pounds/year TDS, 20,250 pounds/year chloride, and 53 pounds/year nitrate-N are estimated.

7.2.2 REMOVAL

Two mechanisms were identified by which salts and nutrients are removed from the basin.

1. Groundwater pumping by water agencies and private landowners,
2. Underflow to onshore and offshore areas (outflow).

GROUNDWATER PUMPING BY WATER AGENCIES AND PRIVATE LANDOWNERS

Salts and nutrients are removed from the groundwater system when groundwater is pumped. Some of this water is exported out of the basin entirely and some of the water is reapplied within the basin. The loading associated with reapplication of pumped groundwater within the basin is covered by the descriptions of the loading sources in the previous section.

Groundwater pumping removes salts and nutrients from the groundwater system according to the concentration of the native groundwater in the subarea of pumping. Groundwater quality for each subarea is listed in Table 5. From the groundwater extracted from the basin each year, an average of 6,591,600 pounds/year TDS, 1,693,060 pounds/year chloride, and 9,920 pounds/year nitrate-N are estimated to be removed from the basin.

UNDERFLOW TO ONSHORE AND OFFSHORE AREAS

Salts and nutrients are removed from the basin as groundwater flows out of the basin and into adjacent areas. Salts and nutrients are removed at the native quality of the groundwater in the subarea from which outflow occurs. Groundwater underflow occurs from the basin through the Northern Coastal and Southern Coastal subareas at the concentrations listed in Table 5.

An average of 100 AFY of groundwater underflow takes place from the basin. Average annual totals of 126,150 pounds/year TDS, 34,200 pounds/year chloride, and 310 pounds/year nitrate-N were estimated to be removed from the groundwater system through groundwater pumping.

7.2.3 DISCUSSION OF OVERALL SALT AND NUTRIENT LOADING

The difference between salt and nutrient loading and removal from the Seaside basin shown at the bottom of Table 21 through Table 23 suggests that there is a net removal of salts (TDS and chloride) from the basin and a net loading of nutrients into the basin.

The net removal of salts is being driven by groundwater pumping. Overall, pumping extracts native groundwater that is relatively high in salts and exports a significant portion of that water away from the basin – to outside customers or to the regional wastewater treatment plant. Groundwater pumping alone, however, will not improve the quality of the basin's groundwater unless a source of imported water is adding higher quality water to the basin's aquifers. Simply removing groundwater will only draw down groundwater levels without improving quality. The ASR project, with its injection of Carmel River water, is a major source of imported high-quality water that complements the extraction of groundwater and leads to a sustainable net removal of salts from the basin. Other future projects, such as the GWRP, provided they import better quality water than the native groundwater will further improve the salt content of groundwater in the Seaside basin.

The nitrate balance suggests a net addition of nitrates to the basin. This is because the groundwater in the basin does not have significantly different nitrate-N concentrations than other imported sources of water, and thus dilution like what occurs with salts does not take place at a noticeable level. Nutrient loading from sewer system losses and fertilization are the largest man-made sources of nutrients to the basin. The estimate of nitrogen loading by fertilization may be overestimated because it is unlikely all residents fertilize their lawns regularly.

7.3 ASSIMILATIVE CAPACITY

Because assimilative capacity is determined for the entire Seaside basin, the existing groundwater quality estimated for the four subareas in Section 3.11.2 are area-weight averaged to estimate the groundwater quality of the entire basin. Table 26 shows that the basin does not have assimilative capacity for TDS, but there is assimilative capacity remaining for chloride and nitrate-N. The poor TDS quality is influenced mostly by the two southern subareas (i.e., Southern Coastal and Laguna Seca subareas).

Table 26: Seaside Basin Assimilative Capacity

Constituent	Existing Water Quality	Water Quality Objective	Assimilative Capacity
TDS, mg/L	540	500	**-40**
Chloride, mg/L	140	250	**110**
Nitrate-N, mg/L	0.7	10	**9.3**

When looking to implement future water projects in the basin, it is important to ensure that imported or recycled water being irrigated or recharged needs to have a water quality that is better (i.e., lower WQO parameter values) than the native groundwater that will be influenced by the project. Current plans to use recycled water in the basin will generally improve groundwater quality by diluting the native groundwater with better quality water (e.g., GWRP advanced tertiary treated, less than 200 mg/L TDS). Storm water quality generated within the basin is also of better quality than the native groundwater and would contribute to improving the basin's general water quality with appropriate pre-treatment. Carmel River system water imported by MPWMD/Cal-Am is generally less than 385 mg/L TDS and has already been proven to improve the groundwater quality in the area around the existing ASR wells into which it is injected.

7.4 Anti-degradation Analysis

This section is not required because native Seaside basin groundwater quality is not a high quality water resource described in the state's Anti-Degradation Policy, Resolution No. 68-16. The three potential projects planned for the Seaside basin will all have positive water quality impacts because they use imported water of better quality than the native groundwater.

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SECTION 8
SALT AND NUTRIENT MANAGEMENT STRATEGIES

8.1 ACTIONS TO MANAGE SALT AND NUTRIENT LOADING

The objective of this section is to develop strategies to manage salt and nutrient loadings on a sustainable basis in order to maintain a long term supply for the basin's beneficial uses. Per the Recycled Water Policy, these strategies should be site specific and have the purpose of:

- Pollution prevention,
- Source load reductions to groundwater basins,
- Treatment and management of areas of impaired water quality,
- Increasing groundwater recharge by storm water, and
- Increasing recycled water use.

In the Seaside basin there is a net export of salts from the basin because over 2,400 AFY of groundwater is used outside of the basin. Additionally, the bulk of wastewater generated in the basin is exported to a regional plant outside of the basin. Together with injection of Carmel River system water into the basin, these activities improve the groundwater quality of the basin. Nutrients do not have a net export because

Based on our source assessment in Section 4, the following activities currently contribute salts and nutrients to the basin above what would naturally occur:

- Fertilization in urban areas and golf courses – loads from fertilizers are transported with water from irrigation or precipitation.
- Septic systems and leaking sewer pipes – loads in septic system outflows or leaky septic tanks infiltrate into the groundwater.
- Irrigation of recycled water at the Nicklaus Club-Monterey golf course – recycled water generated at the Pasadera wastewater treatment and recycling facility is diluted with groundwater. The wastewater treated by this facility has a high salt load partly because of the use of residential water softeners in the area.

There are currently no management measures and activities instituted in the basin for reducing either salt or nutrient loads. Management strategies that could be considered are summarized in Table 27.

8.2 MANAGEMENT TRIGGERS

For seawater intrusion in the basin, the Watermaster has developed a Seawater Intrusion Response Plan (SIRP) as a contingency plan for responding to seawater intrusion in the Seaside Groundwater Basin, if and when it occurs (HydroMetrics LLC, 2009a). The SIRP details both the indicators of seawater intrusion, and a list of recommended actions to be taken if seawater intrusion is observed.

Management triggers for salts and nutrients generated by current land use activities are not necessary because of the net export of salts and nutrients from the basin. Future projects such as the GWRP will be permitted by relevant authorities, which will include setting monitoring requirements, limits, and triggers.

Table 27: Proposed Salt and Nutrient Management Measures

Management Measure	Agency/Action	Description	Effect
Source control of nutrients from residential fertilizer	City of Seaside, Laguna Seca subarea landowners, Monterey Peninsula Water Management District, City of Sand City, California American Water, City of Del Rey Oaks, Monterey County/Monterey County Water Resources Agency, Coastal subarea landowners, and the City of Monterey	Outreach on effective use of fertilizers.	Reduces the load of nitrogen that is transported by runoff to surface waters and by infiltration to groundwater.
Source control of salts and nutrients from septic systems	Toro community, City of Seaside - Prohibit installation of new septic tanks	Prohibit installation of new septic tanks. Require tie-in of a septic tank to the sewer if located within 200 feet of a sewer line. or Consideration of a septic system conversion program to reduce the number of septic systems in the basin.	Reduces the volume of septic system leachate that percolates into shallow groundwater.
Source control of salts in wastewater and recycled water quality from Pasadera WTF	Cal-Am – water softener ban	Outreach, removal and incentive program aimed at reducing the number of self-regenerating water softeners.	Fewer self-regenerating water softeners (or other treatment devices that produce a high mineral waste) will reduce the salt load in residential wastewater.

Management Measure	Agency/Action	Description	Effect
Storm water recharge	City of Seaside, Laguna Seca subarea landowners, Monterey Peninsula Water Management District, City of Sand City, California American Water, City of Del Rey Oaks, Monterey County/Monterey County Water Resources Agency, Coastal subarea landowners, and the City of Monterey	Storm water is infiltrated onsite where it is generated or conveyed to a nearby recharge facility.	Provides dilution of groundwater through recharge of surface water (flood and storm flows) to potentially lower salt and nutrient concentrations.
Irrigation with recycled water	City of Seaside, City of Sand City	Urban irrigation of schools, parks, golf courses and other locations. Recycled water permit establishes concentration limits for irrigation water that should be lower than native groundwater concentrations.	Limits the concentrations of salts and nutrients in irrigation water.

SECTION 9
SALT AND NUTRIENT MONITORING PROGRAM

9.1 GOALS AND OBJECTIVES

The goals of a salt and nutrient monitoring program for the Seaside basin are:

1. Develop a program that provides an adequate spatial network of monitoring locations through the Seaside basin;
2. Develop a cost-effective means of determining whether the concentrations of salts, nutrients, and other constituents of concern as identified in this salt and nutrient plan are consistent with applicable water quality objectives;
3. Focus monitoring near public water supply wells and large recycled water projects; and
4. Per the Recycled Water Policy, use existing monitoring features where possible.

9.2 LOCATION OF MONITORING FEATURES

The current monitoring features in the Seaside basin described in Section 5 are all recommended as monitoring features for this SNMP. These monitoring features have an adequate spatial distribution to determine impacts from current recycled water use in the basin.

In addition to the wells currently sampled under the Watermater's MMP and MPWMD monitoring programs, there are some dedicated monitoring wells in the Laguna Seca subarea that are excluded from those schedules. These are: FO-4 shallow and deep, and FO-6 shallow and deep.

The RWQCB will require additional monitoring features when future recycled water projects are implemented. These should be included as part of salt and nutrient monitoring for the basin.

9.3 CONSTITUENTS TO BE MONITORED

For all wells in the monitoring network, the same constituents that are required under the Watermaster's MMP are recommended for testing. This is general physical and minerals, which includes TDS, chloride, nitrate as NO_3, nitrate as N, and nitrite as N.

Per the SWRCB's Recycled Water Policy (2013), CEC monitoring requirements are not designated for recycled water used for landscape irrigation due to the low risk for ingestion of the water. However, the CEC monitoring requirements prescribed in the Recycled Water Policy pertain to the production and use of recycled water for groundwater recharge by surface and subsurface application methods. Currently there are no active projects in the Seaside basin that fall into this category. The proposed GWRP described in Section 4.2.2 is the only planned project that proposes to use recycled water for groundwater recharge. Prior to the implementation of this project, or any other future proposed groundwater recharge with recycled water project, the appropriate agency (or agencies) will monitor the water for CECs as prescribed in the Recycled Water Policy, as applicable, unless an alternative monitoring plan is proposed and approved by the RWQCB.

9.4 Sampling Frequency

The groundwater sampling frequency will be at least annually.

9.5 Stakeholder Roles and Responsibilities

The Seaside basin stakeholders' current responsibilities for collecting and providing production, groundwater levels, and groundwater quality data to the Watermaster are described in Section 5. Because these roles and responsibilities are already in place and well established, it is recommended that the SNMP adopt them and therefore no changes are required.

9.6 Reporting

The monitoring data collected will be reported to the RWQCB every three years. The SNMP stakeholders will be responsible for preparing the monitoring report. The monitoring report will include relevant monitoring data, comparisons to historical/baseline values, comparisons to applicable water quality objectives, and an update of relevant projects and implementation information.

SECTION 10
IMPLEMENTATION MEASURES

Based on the Seaside basin's native groundwater quality and limited number of recycled water projects, managing salt and nutrient loadings on a sustainable basis is feasible with minimal implementation measures. Best Management Practices (BMPs) and public outreach are recommended implementation measures. If necessary, based on future monitoring results, the implementation measures identified in the following sub-sections will be reevaluated and updated measures recommended for future implementation.

10.1 TOTAL DISSOLVED SOLIDS

Implementation measures to reduce TDS concentrations in groundwater that could be considered include:

- All water imported into the basin should have lower TDS than the native groundwater of the area in which the water is to be used for irrigation or recharge,
- Reducing the amount of salts added to groundwater via source water – wastewater treatments, modified processes such as increased retention time, or blending prior to use for irrigation or basin recharge, and
- Reducing the amount of salts added to water via anthropogenic sources – BMPs, public outreach, and land management guidelines.

10.2 CHLORIDE

Implementation measures to reduce chloride concentrations in groundwater that could be considered include:

- Reducing the amount of chlorides added to water via anthropogenic sources – BMPs, public outreach, and land management guidelines,
- Water softener ordinance or ban, and
- Reducing the amount of chlorides in wastewater - modified processes such as incorporating UV and MF/RO to remove chlorides.

10.3 NITRATE

Implementation measures to reduce nitrate concentrations in groundwater that could be considered include developing BMPs such as limiting excess landscape fertilizing and eliminating over-irrigation to curtail the leaching transport process.

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APPENDIX A:

MONTEREY PENINSULA AQUIFER STORAGE AND RECOVERY PROJECT – SAMPLING AND ANALYSIS PLAN

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MONTEREY PENINSULA AQUIFER STORAGE AND RECOVERY PROJECT

SAMPLING AND ANALYSIS PLAN

Prepared for:

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

December 2012

MONTEREY PENINSULA
AQUIFER STORAGE AND RECOVERY PROJECT

GROUNDWATER SAMPLING AND ANALYSIS PLAN

INTRODUCTION

This Groundwater Sampling and Analysis Plan (SAP) has been developed for the Monterey Peninsula Aquifer Storage and Recovery (ASR) Project. The project is cooperatively implemented by the Monterey Peninsula Water Management District (MPWMD or District) and California American Water (CAW), and generally involves the diversion of excess winter/spring flows from the Carmel River system for recharge, storage and subsequent recovery in the Seaside Groundwater Basin (SGB). Treated (potable) drinking water from the CAW distribution system is injected into the Santa Margarita Sandstone aquifer in the SGB via three existing ASR wells located at two ASR facilities in the SGB. The injected water is stored within the aquifer and subsequently recovered into the CAW distribution system during dry periods. The overall objective of the project is to facilitate the conjunctive use of water supplies in the Carmel River system and SGB that will benefit the resources of both systems.

ASR operations generally consist of three components or phases: (1) injection of drinking-quality water into the aquifer through the ASR wells; (2) storage of the injected water within the aquifer; and, (3) recovery of the stored water by pumping at one or more of the ASR wells. Periodic samples of the injected, stored, and recovered waters are to be collected from the ASR wells and associated monitoring wells and analyzed for a variety of water-quality constituents pursuant to requirements of the Central Coast Regional Water Quality Control Board (RWQCB) for the project. The purpose of this SAP is to identify the locations, sample collection frequency, and parameters to be monitored as part of the project's ongoing water-quality data collection program. The project location and associated wells in the SGB are shown on **Figure 1** – Project Location Map.

GROUNDWATER MONITORING

Groundwater Monitoring Wells

ASR Project On-Site Wells. There are two ASR facilities located in the SGB; the Santa Margarita and Seaside Middle School ASR Facilities. Groundwater monitoring wells for collection of on-site water-quality samples include three ASR wells and two associated monitoring wells that have been constructed at the two ASR facilities. Two of the ASR wells are located at the Santa Margarita (SM) ASR Facility and are designated as SM ASR-1 and SM ASR-2. This facility is also referred to as the Phase 1 ASR Project. The third existing ASR well is located at the Seaside Middle School (SMS) ASR Facility and is designated as SMS ASR-3.

This facility is also referred to as the Phase 2 ASR Project[1]. All three existing ASR wells are completed solely within the Santa Margarita Sandstone (Tsm) aquifer.

In addition to the ASR wells, there are two on-site monitoring wells (one located at each ASR facility) that are also completed solely within the Tsm aquifer. SM MW-1 is located at the SM ASR Facility and is located in between SM ASR-1 and SM ASR-2, at distances of approximately 90 and 190 feet, respectively. SMS Deep MW is located at the SMS ASR Facility at a distance of approximately 20 feet from SMS ASR-3. An additional monitoring well is also located at the SMS ASR Facility that is completed within the overlying Paso Robles aquifer, designated as SMS Shallow MW. This well is instrumented with a submersible water-level transducer/data logger unit to observe the water-level response of this aquifer to ASR operations (it is not designed or equipped for collection of water-quality samples). The locations of the ASR wells and on-site monitoring wells are shown on **Figure 2** – Site Location Map. A summary of the on-site wells is presented in **Table 1** below:

Table 1. On-Site Wells Summary

Well ID	Distance from ASR Well (feet)			Aquifer Completed
	SM ASR-1	SM ASR-2	SMS ASR-3	
SM ASR-1	--	280	1,380	Tsm
SM ASR-2	280	--	1,235	Tsm
SM MW-1	90	190	1,325	Tsm
SMS ASR-3	1,380	1,235	--	Tsm
SMS Deep MW	1,380	1,240	20	Tsm
SMS Shallow MW	1,415	1,265	25	QTp

Table 1 Notes:

Tsm – Santa Margarita Sandstone aquifer
QTp – Paso Robles aquifer

<u>Off-Site SGB Wells</u> In addition to the on-site wells at the two ASR facility sites, submersible water-level transducer/data logger units have been installed at seven off-site District monitoring well sites in the SGB to observe the water-level response of the aquifer system to ASR operations. The locations of the off-site monitoring wells are shown on **Figure 1**. The distances from each of the project sites and aquifers monitored by the off-site wells are summarized in **Table 2** below:

[1] The Phase 2 ASR Project will consist of two ASR wells and associated facilities at the SMS ASR Facility. SMS ASR-4 is currently planned to be installed during summer/fall of 2012 and will be added to the SAP when completed and equipped for operation.

Table 2. Off-site Monitoring Wells Summary

Well ID	Distance from ASR Site (feet)		Aquifer Monitored
	SM	SMS	
Paralta Test	680	740	QTp & Tsm
Ord Grove Test	1,540	2,535	QTp & Tsm
Ord Terrace (Deep)	2,275	2,910	Tsm
FO-7 (Deep)	4,265	3,700	Tsm
FO-7 (Shallow)			QTp
PCA East (Deep)	6,390	6,200	Tsm
PCA East (Shallow)			QTp
FO-9 (Deep)	7,290	6,125	Tsm
FO-8 (Deep)	7,585	6,450	Tsm

Table 2 Notes:

Monitoring well distances are measured to centroid of each ASR site.
Tsm – Santa Margarita Sandstone aquifer
QTp – Paso Robles aquifer

In addition to water-level monitoring at the above off-site monitoring wells, CAW's Paralta well and PCA East Deep have been designated as off-site monitoring wells for periodic water-quality sampling as part of this SAP (refer to **Table 4**).

Groundwater Monitoring Equipment

The equipment required to perform the groundwater monitoring as prescribed in the SAP includes:

- Sampling Pumps
- Pressure Transducers/Data Loggers
- Electric Water Level Sounder
- Field Water Quality Monitoring Devices
- Flow-Thru Cell Device(s)
- Sample Containers
- Coolers and Ice

Each of the on-site wells is equipped with a dedicated pump. The ASR wells are equipped with water-lubricated, vertical line-shaft turbine pumps. SM MW-1, SMS Deep MW, and PCA East Deep are equipped with submersible sampling pumps. The flow rates for each monitored wells are measured using in-line flow meters. Sampling ports on the well-head piping at each well allow for the collection of grab samples during injection and pumping operations.

Field water-quality monitoring is to be performed using various instruments that allow for the field analysis of a variety of constituents, including but not limited to: chlorine residual, conductivity, dissolved oxygen, pH, temperature, redox/ORP, and Silt Density Index (SDI). The field water-quality monitoring devices are to be routinely calibrated as prescribed in the operating procedures manual for each device.

All of the ASR and monitoring wells are instrumented with dedicated pressure/level transducers and dataloggers. Reference-point elevations have been established by surveying on each of the monitored wells. Static water-levels in each of the wells are to be measured with an electric sounder on a quarterly basis (minimum) and the transducers calibrated accordingly. The transducers are to be programmed with the reference static water-level and the data-collection interval, which will measure and record the water level in each of the wells a minimum of four times per day.

Purging and Sampling

During injection periods, samples of the injectate are to be collected directly at one of the ASR wellheads while active injection is occurring. During storage periods, each of the ASR wells that has been utilized for injection during the season will be periodically purged and sampled. During recovery periods, one or more of the ASR well pumps will be operating and purging is continuous and sustained. Groundwater samples are also to be collected routinely during all three ASR periods (i.e., injection, storage and recovery) from both the on-site monitoring wells (SM MW-1 and SMS Deep MW) and periodically from the far-field off-site monitoring wells (Paralta and PCA-E Deep).

The existing pumps will be used to purge a volume equivalent to a minimum of three (3) casing volumes from the well prior to sampling. Purge water from the ASR wells during backflushing and sampling is to be discharged to the backflush pit at the SM ASR Facility and percolated back into the SGB. Water produced by the ASR well(s) during recovery period operations is to be discharged to the CAW potable water supply system (in accordance with Department of Public Health approvals). Purge water from the monitoring wells will be directed to either the SM backflush pit or to the ground away from the wellheads and percolated back into the SGB.

During purging and prior to sampling, field water-quality parameters of temperature, pH and specific conductance are to be monitored. Stabilization of these water-quality parameters will indicate when collection of a representative sample is obtainable.

Chain-of-Custody, Sample Handling, and Transport

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. All sample shipments for analyses will be accompanied by a chain-of-custody record. Forms will be completed and sent with the samples for each shipment. The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Samples will be placed in a cooler for delivery to the laboratory.

Documentation Procedures

Field data will be recorded by field personnel on the attached Field Sampling Log Form and routinely submitted to the Project Manager for review and QA/QC. Field data will include the completed field sampling-log form and chain-of-custody records. At a minimum, documentation of each monitoring and sampling event will include the following information:

- Sample location and description
- Sampler's name(s)
- Date and time of sample collection
- Type of sampling equipment used
- Field instrument calibration procedures and results
- Field instrument readings
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Sample preservation
- Shipping arrangements
- Name(s) of recipient laboratory
- Any deviations from SAP procedures

Project information will be filed by Water Year. The project file will contain project field data, correspondence, survey reports, laboratory reports, charts, tables, permits, and other project-related information. This information will be utilized in the preparation of the annual Summary of Operations Reports for the project.

LABORATORY PROGRAM

A complete list of constituents and constituent "groups" to be monitored as part of the ASR Project for injected, stored, and recovered waters is presented in **Table 3** below. **Table 4** summarizes the planned sample constituent group frequencies for each source for the injection, storage, and recovery periods.

Table 3. Analytic Testing Program Constituent Summary

Constituent	PQL	General Parameters	Disinfection Byproducts	Supple-mental	Field[1]
Group ID		G-1	DBP	S-1	F-1
Major Cations					
Calcium (Ca)	1 mg/L	✓			
Magnesium (Mg)	1 mg/L	✓			
Sodium (Na)	1 mg/L	✓			
Potassium (K)	0.5 mg/L	✓			
Major Anions					
Total Alkalinity (as $CaCO_3$)	10 mg/L	✓			
Sulfate (SO_4)	1 mg/L	✓			
Chloride	1 mg/L	✓	✓		
Nitrate as (NO3)	1 mg/L	✓			
Nitrite as (Nitrogen)	0.1 mg/L	✓			
General Physical					
pH	0.1 units	✓			✓
Temperature	0.5 ^{o}C				✓
Specific Conductance (EC)	10 uS	✓			✓
ORP (redox potential / Eh)[2]	10 mV				✓
Total Dissolved Solids (TDS)	10 mg/L	✓			
Metals					
Arsenic (As)	1 ug/L			✓	
Barium (Ba)	0.5 mg/L			✓	
Iron (Fe) (Total and Dissolved)	50 ug/L	✓			
Lithium (Li)	5 ug/L			✓	
Manganese (Mn) (Total and Dissolved)	10 ug/L	✓			
Molybdenum (Mo)	5 ug/L			✓	
Nickel (Ni)	10 ug/L			✓	
Selenium (Se)	5 ug/L			✓	
Strontium (Sr)	5 ug/L			✓	
Uranium (U)	1 pCi/L			✓	
Vanadium (V)	5 ug/L			✓	
Zinc (Zn)	0.5 ug/L			✓	
Miscellaneous					
Ammonia (as N)	0.05 mg/L	✓			
Boron (B)	0.05 mg/L	✓			
Chlorine residual (free)	0.1 mg/L				✓

Constituent	PQL	General Parameters	Disinfection Byproducts	Supple-mental	Field[1]
Group ID		G-1	DBP	S-1	F-1
Chloramines	50 ug/L		✓		
Dissolved Methane	0.5 ug/L			✓	
Dissolved Oxygen (DO)[2]	0.025 mg/L				✓
Gross Alpha	1 pCi/L			✓	
Hydrogen Sulfide (H_2S)	0.05 mg/L				✓
Total Nitrogen (N)	0.2 mg/L	✓			
Total Phosphorous	0.05 mg/L	✓			
Orthophosphate as P	0.05 mg/L	✓			
Radium 226	1 pCi/L			✓	
Silt Density Index (SDI)	0.1 units				✓
Total Kjehldahl N (TKN)	0.2 mg/L	✓			
Organic Analyses					
Total trihalomethanes	1 ug/L		✓		
Bromodichloromethane	1 ug/L		✓		
Bromoform	1 ug/L		✓		
Chloroform	1 ug/L		✓		
Dibromochloromethane	1 ug/L		✓		
Haloacetic Acids (HAA)	1 ug/L		✓		
Monobromoacetic Acid	1 ug/L		✓		
Monochloroacetic Acid	1 ug/L		✓		
Dibromoacetic Acid	1 ug/L		✓		
Dichloroacetic Acid	1 ug/L		✓		
Trichloroacetic Acid	1 ug/L		✓		
Total organic carbon (TOC)	0.1 mg/L	✓			
Dissolved organic carbon (DOC)	0.1 mg/L	✓			

Table 3 Notes:

1 – Field Parameters (Group F-1) must be taken concurrently with collection of all laboratory samples.
2 – ORP and DO must be analyzed utilizing a flow-thru cell device.

Table 4. Analytic Testing Program Schedule

<table>
<tr><th colspan="8">INJECTION PERIOD (active injection)</th></tr>
<tr><th>Analyte Group</th><th colspan="3">Injectate</th><th>SM MW-1</th><th>SMS Deep MW</th><th colspan="2">PCA East (deep)</th></tr>
<tr><td>F-1</td><td colspan="3">Bi-Weekly</td><td>Bi-Weekly</td><td>Bi-Weekly</td><td colspan="2">Semiannually</td></tr>
<tr><td>DBP</td><td colspan="3">Monthly</td><td>Quarterly</td><td>Quarterly</td><td colspan="2">Semiannually</td></tr>
<tr><td>G-1</td><td colspan="3">Quarterly</td><td>Quarterly</td><td>Quarterly</td><td colspan="2">Semiannually</td></tr>
<tr><td>S-1</td><td colspan="3">Quarterly</td><td>Quarterly</td><td>Quarterly</td><td colspan="2">Semiannually</td></tr>
<tr><th colspan="8">STORAGE PERIOD (one month duration or longer)</th></tr>
<tr><th>Analyte Group</th><th>SM ASR-1</th><th>SM ASR-2</th><th>SMS ASR-3</th><th>SM MW-1</th><th>SMS Deep MW</th><th colspan="2">PCA East (deep)</th></tr>
<tr><td>F-1</td><td>Monthly</td><td>Monthly</td><td>Monthly</td><td>Quarterly</td><td>Quarterly</td><td colspan="2">Semiannually</td></tr>
<tr><td>DBP</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td colspan="2">Semiannually</td></tr>
<tr><td>G-1</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually</td><td>Semiannually</td><td colspan="2">Semiannually</td></tr>
<tr><td>S-1</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually</td><td>Semiannually</td><td colspan="2">Semiannually</td></tr>
<tr><th colspan="8">RECOVERY PERIOD</th></tr>
<tr><th>Analyte Group</th><th>SM ASR-1[1]</th><th>SM ASR-2</th><th>SMS ASR-3</th><th>SM MW-1</th><th>SMS Deep MW</th><th>Paralta</th><th>PCA East (deep)</th></tr>
<tr><td>F-1</td><td>Bi-Weekly</td><td>Monthly</td><td>Monthly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually[2]</td><td>Semiannually</td></tr>
<tr><td>DBP</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually</td><td>Semiannually</td><td>Semiannually[2]</td><td>Semiannually</td></tr>
<tr><td>G-1</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually</td><td>Semiannually</td><td>Semiannually[2]</td><td>Semiannually</td></tr>
<tr><td>S-1</td><td>Quarterly</td><td>Quarterly</td><td>Quarterly</td><td>Semiannually</td><td>Semiannually</td><td>Semiannually[2]</td><td>Semiannually</td></tr>
</table>

Table 4 Notes:

1 – SM ASR-1 is currently the only ASR well authorized by DPH to recover into the CAW distribution system.
2 – Near the beginning and end of the SGB production/recovery season (e.g., in June and November).

December 2012
Project No. 06-0025

PUEBLO water resources

FIGURE 1. PROJECT LOCATION MAP
Monterey Peninsula ASR Project
Sampling and Analysis Plan

PUEBLO water resources

FIGURE 2. SITE LOCATION MAP
Monterey Peninsula ASR Project
Sampling and Analysis Plan

Monterey Peninsula Water Management District

Pueblo water resources

Monterey Peninsula ASR Project
Field Sampling Log Form

Water Year: ______________

Well ID: ____________________

Observer: ____________________

Date: ____________________

Observation Period: Start: Stop:

Weather:

Purging & Water-Level Data

Purging & Water-Level Data		Notes:
ASR Period (injection, storage, recovery)		
Well Status (injecting, idle, pumping)		
Purge Rate (gpm)		
Totalizer Reading Start (gals)		
Totalizer Reading at Sampling (gals)		
Purge Volume (gals)		
Totalizer Reading End (gals)		
Static Water Level (ft btoc)[1]		
Datalogger Water Level (ft btoc)		

Field Water-Quality Parameter Data

Time:						
Elapsed Time:						
Temperature (^{o}C)						
Conductivity (umhos/cm)						
pH						
ORP (mV)[2]						
Free Chlorine Residual (mg/L)						
Dissolved Oxygen (mg/L)[2]						
Silt Density Index						
Gas Volume (mL)						
H2S (mg/L)						
Visual Observations						

Sampling and Laboratory Data

Collection Time	Laboratory	Laboratory Analyses Requested (analyte group or other constituents)

Additional Information and Observations

Notes:

1 - Pump must be off a minimum of 10 minutes prior to measuring.

2 - ORP and Dissolved Oxygen must be analyzed utilizing a flow-thru cell device

APPENDIX B:
WATER BALANCE SPREADSHEET

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Water Type	Subarea	Water Source	Component	Imported AFY	Exported AFY	Volume Back into Groundwater AFY	Groundwater Volume Extracted AFY
Imported Salinas Valley	Northern Coastal	Salinas Valley Groundwater	Bayonet and Black Horse Golf Courses	400	0	80	0
			Municipal Supply	527	0	0	0
			Water System Losses	0	0	45	0
			Irrigation Return Flow	0	0	111	0
		Sewer	Sewer Losses	0	0	19	0
			Regional Waste Water Treatment Plant	0	353	0	0
Imported Carmel River System	Northern Coastal	Carmel River System Alluvial Aquifer	Santa Margarita Injection	625	0	625	0
			Municipal Supply	56	0	0	0
			Water System Losses	0	0	5	0
			Irrigation Return Flow	0	0	12	0
		Sewer	Sewer Losses	0	0	2	0
			Regional Waste Water Treatment Plant	0	37	0	0
	Southern Coastal	Carmel River System Alluvial Aquifer	Municipal Supply	19	0	0	0
			Water System Losses	0	0	2	0
			Irrigation Return Flow	0	0	4	0
		Sewer	Sewer Losses	0	0	1	0
			Regional Waste Water Treatment Plant	0	12	0	0
	Laguna Seca	Carmel River System Alluvial Aquifer	Municipal Supply	112	0	0	0
			Water System Losses	0	0	9	0
			Irrigation Return Flow	0	0	23	0
		Sewer	Sewer Losses	0	0	4	0
			Regional Waste Water Treatment Plant	0	75	0	0

Water Type	Subarea	Water Source	Component	Imported AFY	Exported AFY	Volume Back into Groundwater AFY	Groundwater Volume Extracted AFY
Recycled Water	Laguna Seca	Pasadera WTF Recycled Water	Nicklaus Club-Monterey Golf Course Irrigation	0	0	9	0
Precipitation	Northern Coastal	Precipitation	Deep Percolation of Precipitation	0	0	68	0
	Southern Coastal			0	0	30	0
	Laguna Seca			0	0	607	0
	Northern Inland			0	0	1,450	0
Storm Water	Northern Coastal	Storm Water	Storm Water Infiltration	0	0	68	0
	Southern Coastal			0	0	37	0
	Laguna Seca			0	0	0	0

Water Type	Subarea	Water Source	Component	Imported AFY	Exported AFY	Volume Back into Groundwater AFY	Groundwater Volume Extracted AFY
Seaside Basin Groundwater	Northern Coastal	Groundwater	Municipal Supply from Wells	0	0	0	4,278
			Water System Losses	0	0	364	0
			Irrigation Return Flow	0	0	348	0
			Groundwater Exported out of Basin	0	2,421	0	0
		Underflow	Groundwater Inflow - From Onshore	0	0	2,850	0
			Groundwater Inflow - From Offshore	0	0	100	0
			Groundwater Outflow	0	0	0	70
		Sewer	Sewer Losses	0	0	57	0
			Regional Waste Water Treatment Plant	0	1,076	0	0
	Southern Coastal	Groundwater	Municipal Supply from Wells	0	0	0	227
			Water System Losses	0	0	19	0
			Irrigation Return Flow	0	0	48	0
		Underflow	Groundwater Inflow - From Onshore	0	0	450	0
			Groundwater Inflow - From Offshore	0	0	0	0
			Groundwater Outflow	0	0	0	820
		Sewer	Sewer Losses	0	0	8	0
			Regional Waste Water Treatment Plant	0	147	0	0
			Septic Systems	0	0	5	0

Water Type	Subarea	Water Source	Component	Imported AFY	Exported AFY	Volume Back into Groundwater AFY	Groundwater Volume Extracted AFY
Seaside Basin Groundwater	Laguna Seca	Groundwater	Municipal Supply from Wells	0	0	0	869
			Water System Losses	0	0	74	0
			Irrigation Return Flow	0	0	183	0
			Laguna Seca and Nicklaus Club-Monterey Golf Course Irrigation	0	0	88	0
		Underflow	Groundwater Inflow - From Onshore	0	0	180	0
			Groundwater Outflow	0	0	0	450
		Sewer	Sewer Losses	0	0	31	0
			Regional Waste Water Treatment Plant	0	217	0	0
			Septic Systems	0	0	22	0
	Northern Inland	Underflow	Groundwater Inflow - From Onshore	0	0	0	0
			Groundwater Outflow	0	0	0	2,060

APPENDIX C:
SALT AND NUTRIENT LOADING SPREADSHEETS

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Water Type	Subarea	Salt and/or Nutrient Source	Component	TDS In, lb	TDS Out, lb	Chloride In, lb	Chloride Out, lb	Nitrate-N In, lb	Nitrate-N Out, lb
Imported Salinas Valley	Northern Coastal	Salinas Valley Groundwater	Bayonet and Black Horse Golf Courses	430,747	0	91,371	0	1,740	0
			Municipal Supply	0	0	0	0	0	0
			Water System Losses	48,281	0	10,241	0	195	0
			Irrigation Return Flow	119,539	0	25,357	0	483	0
		Sewer	Sewer Losses	52,677	0	15,538	0	124	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
Imported Carmel River System	Northern Coastal	Carmel River System Alluvial Aquifer	Santa Margarita Injection	538,343	0	44,154	0	170	0
			Municipal Supply	0	0	0	0	0	0
			Water System Losses	4,089	0	335	0	1	0
			Irrigation Return Flow	10,123	0	830	0	3	0
		Sewer	Sewer Losses	5,572	0	1,644	0	13	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
	Southern Coastal	Carmel River System Alluvial Aquifer	Municipal Supply	0	0	0	0	0	0
			Water System Losses	1,363	0	112	0	0	0
			Irrigation Return Flow	3,374	0	277	0	1	0
		Sewer	Sewer Losses	1,857	0	548	0	4	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
	Laguna Seca	Carmel River System Alluvial Aquifer	Municipal Supply	0	0	0	0	0	0
			Water System Losses	8,177	0	671	0	3	0
			Irrigation Return Flow	20,245	0	1,661	0	6	0
		Sewer	Sewer Losses	11,145	0	3,287	0	26	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0

Water Type	Subarea	Salt and/or Nutrient Source	Component	TDS In, lb	TDS Out, lb	Chloride In, lb	Chloride Out, lb	Nitrate-N In, lb	Nitrate-N Out, lb
Recycled Water	Laguna Seca	Pasadera WTF Recycled Water	Nicklaus Club-Monterey Golf Course Irrigation	29,218	0	8,829	0	54	0
Precipitation	Northern Coastal	Precipitation	Deep Percolation of Precipitation	516	0	92	0	9	0
	Southern Coastal			230	0	41	0	4	0
	Laguna Seca			4,623	0	825	0	83	0
	Northern Inland			11,041	0	1,972	0	197	0
Storm Water	Northern Coastal	Storm Water Infiltration	Percolation Pond	20,034	0	5,539	0	5	0
	Southern Coastal			52,670	0	14,708	0	49	0
	Laguna Seca			0	0	0	0	0	0

Water Type	Subarea	Salt and/or Nutrient Source	Component	TDS In, lb	TDS Out, lb	Chloride In, lb	Chloride Out, lb	Nitrate-N In, lb	Nitrate-N Out, lb
Seaside Basin Groundwater	Northern Coastal	Groundwater	Municipal Supply from Wells	0	4,210,062	0	990,482	0	6,919
			Water System Losses	357,855	0	84,191	0	588	0
			Irrigation Return Flow	342,745	0	80,636	0	563	0
		Underflow	Groundwater Inflow - From Onshore	3,388,324	0	821,494	0	7,927	0
			Groundwater Inflow - From Offshore	98,423	0	23,156	0	162	0
			Groundwater Outflow	0	68,896	0	16,209	0	113
		Sewer	Sewer Losses	162,233	0	47,853	0	381	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
	Southern Coastal	Groundwater	Municipal Supply from Wells	0	433,187	0	136,124	0	1,507
			Water System Losses	36,821	0	11,570	0	128	0
			Irrigation Return Flow	91,164	0	28,647	0	317	0
		Underflow	Groundwater Inflow - From Onshore	1,008,928	0	293,331	0	776	0
			Groundwater Inflow - From Offshore	0	0	0	0	0	0
			Groundwater Outflow	0	1,564,815	0	491,724	0	5,443
		Sewer	Sewer Losses	22,670	0	6,687	0	14,550	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
			Septic Systems	13,694	0	4,039	0	700	0

Water Type	Subarea	Salt and/or Nutrient Source	Component	TDS In, lb	TDS Out, lb	Chloride In, lb	Chloride Out, lb	Nitrate-N In, lb	Nitrate-N Out, lb
Seaside Basin Groundwater	Laguna Seca	Groundwater	Municipal Supply from Wells	0	1,948,353	0	566,454	0	1,499
			Water System Losses	165,610	0	48,149	0	127	0
			Irrigation Return Flow	410,031	0	119,210	0	315	0
			Golf Course Irrigation	197,302	0	57,362	0	152	0
		Underflow	Groundwater Inflow - From Onshore	193,836	0	41,117	0	783	0
			Groundwater Outflow	0	1,008,928	0	293,331	0	776
		Sewer	Sewer Losses	86,785	0	25,598	0	577	0
			Regional Waste Water Treatment Plant	0	0	0	0	0	0
			Septic Systems	62,423	0	18,412	0	3,193	0
	Northern Inland	Underflow	Groundwater Inflow - From Onshore	0	0	0	0	0	0
			Groundwater Outflow	0	1,880,759	0	347,760	0	2,683
Fertilizer	Laguna Seca	Fertilization (Nitrate-N only)	Laguna Seca and Nicklaus Golf-Monterey Golf Course Fertilization	0	0	0	0	1,771	0
			Sports Fields Fertilization	0	0	0	0	280	0
			Residential and Commercial Landscaping Fertilization	0	0	0	0	1,780	0
	Northern Coastal		Bayonet and Black Horse Golf Course Fertilization	0	0	0	0	2,421	0
			Sports Fields Fertilization	0	0	0	0	587	0
			Residential and Commercial Landscaping Fertilization	0	0	0	0	2,492	0
	Southern Coastal		Sports Fields Fertilization	0	0	0	0	103	0
			Residential and Commercial Landscaping Fertilization	0	0	0	0	2,136	0
	Northern Inland		Sports Fields Fertilization	0	0	0	0	0	0
			Residential and Commercial Landscaping Fertilization	0	0	0	0	445	0