TECHNICAL MEMORANDUM

To:	Coachella Valley Salt and Nutrient Management Plan Technical Group	**Date:**	August 29, 2014
From:	MWH	**Reference:**	10505158

Subject DRAFT - Technical Memorandum No.1 Preliminary Data Review and Documentation of Technical Methods

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1 Introduction

The Coachella Valley Water District (CVWD), Coachella Water Authority (CWA), Desert Water Authority (DWA), and Indio Water Authority (IWA) have initiated the preparation of a Salt and Nutrient Management Plan (SNMP) for the Whitewater (Indio), Mission Creek, Garnet Hill, and Desert Hot Springs Groundwater Subbasins in response to the requirements of the California Recycled Water Policy (Policy). This technical memorandum (TM-1) is the first in a series to document the development of the SNMP. TM-1 summarizes the purpose of the SNMP, reviews the areas for which the plan will cover, summarizes a preliminary data review conducted to assess technical methods, and proposes technical methods to develop the SNMP. Technical Memorandum No. 2 (TM-2) will document the calculated ambient water quality (AWQ), salt and nutrient sources and sinks, and the tool used to evaluate future projects. Following these technical memorandums, the SNMP will be prepared that includes summaries from these technical memorandums, salt and nutrient source identification, assimilative capacity and loading estimates; anti-degradation analysis, water recycling and stormwater recharge/use goals and objectives, and monitoring plans.

1.1 BACKGROUND

The State Water Resources Control Board (SWRCB) adopted Resolution No. 2009 011 in February 2009 that established the Recycled Water Policy (Policy). It requires the SWRCB and the nine Regional Water Quality Control Boards (RWQCBs) to exercise the authority granted to them by the Legislature to encourage the use of recycled water, consistent with state and federal water quality laws. To achieve this goal, the Policy provides direction to California's nine RWQCBs on appropriate criteria to be used in regulating recycled water projects (SWRCB, 2009). One objective of the Policy is that salts and nutrients from all sources be managed on a basin-wide or watershed-wide basis that ensures meeting water quality objectives and protection of beneficial uses. The Policy states that the SWRCB finds the most appropriate way to address salt and nutrient issues is through the development of regional salt and nutrient management plans, as opposed to establishing requirements solely on individual recycled water projects.

1.2 PURPOSE OF PLAN

The Policy identifies the requirements of a SNMP, along with requirements for recycled water projects. Tabulated in **Table 1-1** below is each requirement in the Policy related to SNMPs, and a brief description. Declining imported water supply conditions in California has led to the need to increase local water supplies. The Coachella Valley (Valley) is dependent upon the Coachella Valley groundwater system as a reservoir for reliable municipal and irrigation water supply, and therefore the protection of this resource is important. Recycled water projects provide an alternative to augment and secure groundwater resources. This SNMP presents an opportunity to evaluate recycled water projects for the protection of long-term water supplies and to ensure reliability.

Table 1-1
Salt and Nutrient Management Plan Requirements

Policy Section	Component
6(b)(3)(a)	Basin/subbasin wide monitoring plan including an appropriate network of monitoring locations
6(b)(3)(a)(i)	Plan must focus on water quality near supply wells and areas near large water recycling projects (e.g., groundwater recharge); monitoring locations should target areas of groundwater/surface water connectivity, where appropriate
6(b)(3)(a)(iii)	Identify stakeholders responsible for conducting, compiling, and reporting monitoring data
6(b)(3)(b)	Provision for annual monitoring of Constituents of Emerging Concern (CECs)[1]
6(b)(3)(c)	Water recycling and stormwater recharge/use goals and objectives
6(b)(3)(d)	Salt and nutrient source identification; basin/sub-basin assimilative capacity and loading estimates; and fate and transport of salts and nutrients
6(b)(3)(e)	Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis
6(b)(3)(f)	Anti-degradation analysis demonstrating that projects within the plan will, collectively, satisfy the requirements of Resolution No. 68-16[2]

1. Includes human health-based CECs (e.g., NDMA, 17β-estradiol), performance indicator CECs (e.g., DEET, sucralose), and surrogates (e.g., ammonia, TOC, electrical conductivity).
2. Resolution No. 68-16 concerned with maintenance of high-quality waters consistent with maximum benefit to the people of the state.

Numerous areas within the Valley, such as Desert Hot Springs, Sky Valley, Indio Hills, Oasis, Salton City, and areas adjacent to the San Andreas fault system have naturally-occurring high salinity groundwater as a result of local geologic conditions. If water resources in the Valley are not managed, long-term water quality degradation of the groundwater basin underlying the Valley could occur, potentially impacting the beneficial use of groundwater. The Coachella Valley SNMP seeks to achieve the following objectives:

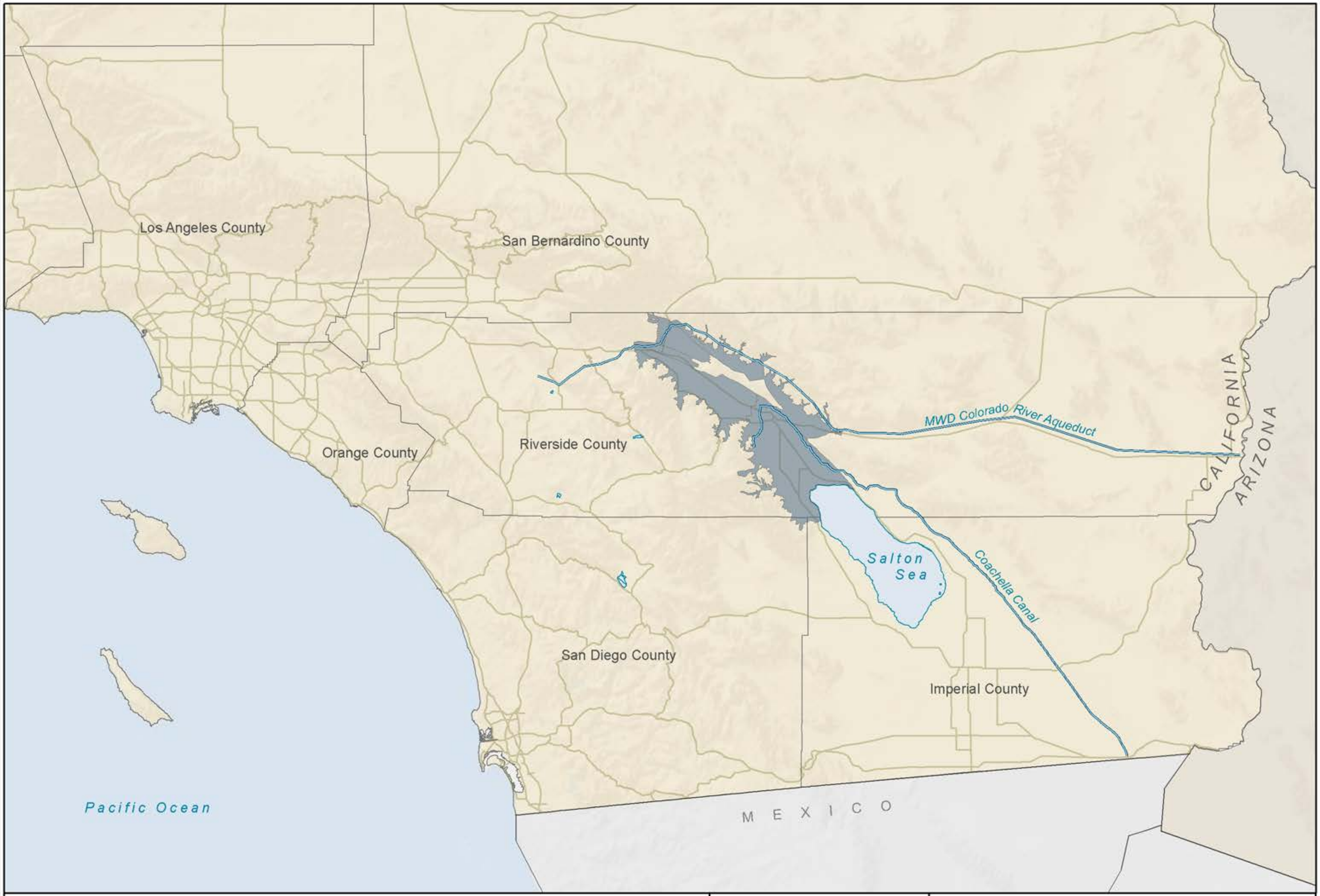
- Fulfill the requirements of the Recycled Water Policy;
- Identify and evaluate potential projects, policies, and opportunities to protect groundwater quality in the Valley;
- Help to promote a sustainable water supply;
- Develop a comprehensive monitoring strategy to better understand the Coachella Valley Groundwater Basin (Basin) and ensure protection of the beneficial uses of groundwater; and
- Recommend beneficial use designation corrections for Coachella Valley groundwaters.

1.3 SALT AND NUTRIENT MANAGEMENT PLANNING AREA

The Coachella Valley Groundwater Basin lies in the northwestern portion of the Salton Trough, which extends from the Gulf of California in Mexico northwesterly to the Banning-Beaumont area. The California Department of Water Resources designated the Coachella Valley Groundwater Basin as Basin 7-21 in Bulletin 118 (1975). The Basin is located approximately 100 miles east of Los Angeles in Riverside County and portions of Imperial County. The Basin encompasses the area below much of the Valley floor. Geologic faults and structures divide the basin into five subbasins: San Gorgonio Pass, Whitewater River (Indio), Garnet Hill, Mission Creek, and Desert Hot Springs subbasins. A map of the regional setting of the Coachella valley is shown on **Figure 1-1.**

The planning area for the SNMP includes most of the Coachella Valley Groundwater Basin as shown on **Figure 1-2**. The study area is defined as the Coachella Valley floor and underlying groundwater basins, extending from the Riverside County boundary on the north to the Salton Sea at the southeast. The planning area is bounded on the west by the jurisdictional boundary separating Desert Water Agency and Mission Springs Water District (MSWD) from the San Gorgonio Pass Water Agency. This location also corresponds to the boundary between the Whitewater River and the San Gorgonio Pass subbasins. The planning area is bounded on the northeast by the Little San Bernardino Mountains and on the southwest by the San Jacinto and Santa Rosa mountain ranges. This area is coincident with the planning area of the Coachella Valley Integrated Regional Water Management Plan. **Figure 1-3** shows the subbasins and subareas that comprise the Coachella Valley Groundwater Basin.

Most water users in the Valley receive water service from one of six primary purveyors: CVWD, DWA, IWA, CWA, MSWD, and Myoma Dunes Mutual Water Company (MDMWC). Several isolated communities and commercial developments are supplied by smaller private water companies or by tribal water distribution systems. In addition, private wells supply groundwater to many golf courses, farms, and private water users. Wastewater collection and treatment service is provided by MSWD, CVWD, the City of Palm Springs, Coachella Sanitary District, and Valley Sanitary District (portions of Indio). Areas that are not served by one of these agencies rely on individual on-site waste disposal systems for wastewater treatment and disposal. City boundaries, service area boundaries of Valley water purveyors, wastewater service area boundaries, and locations of wastewater treatment plants (WWTPs) and wastewater reclamation plants (WRPs) are presented in **Figure 1-4**.



Key to Features

—	Highway
▭	Water Bodies
▆	Coachella Valley Groundwater Basin
▭	Counties
—	Canal / Aqueduct

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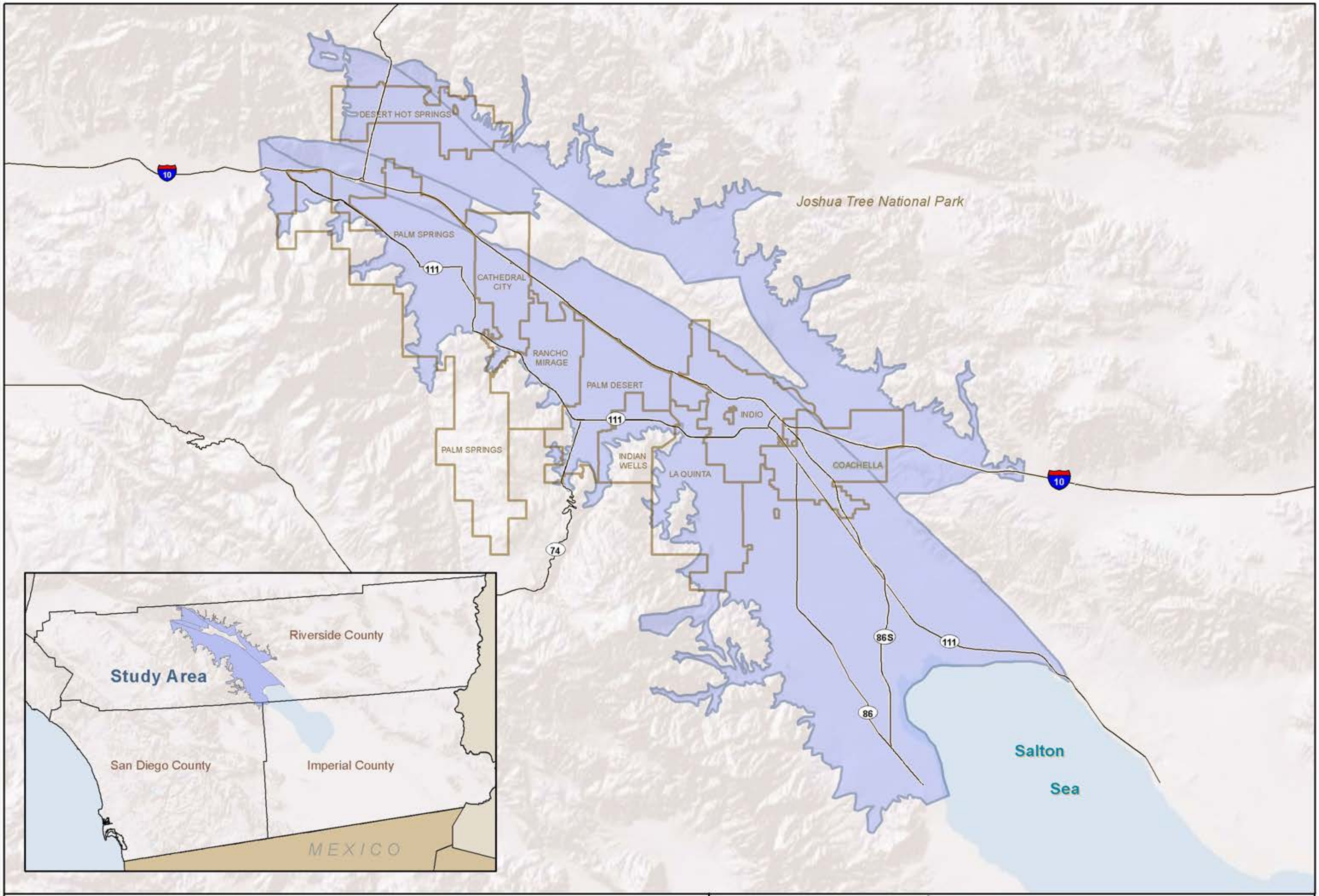
Regional Map

Figure 1-1



Key to Features

— Highway

🟦 Groundwater Basin

▭ City Boundary

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Coachella Valley Cities and Highways

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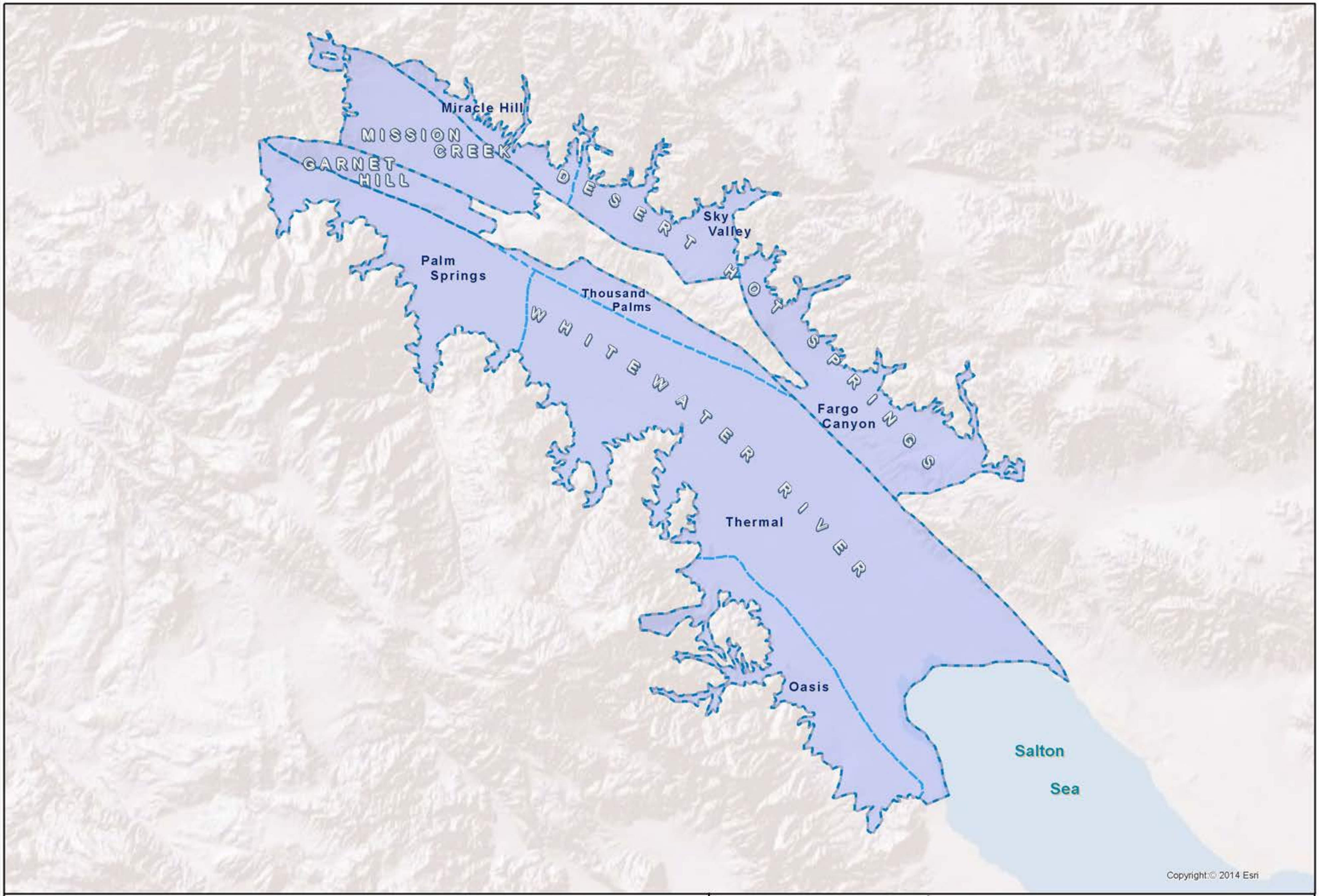
Figure 1-2



Key to Features

▨ Subbasins

┅ Subareas

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Coachella Valley Subbasins and Subareas

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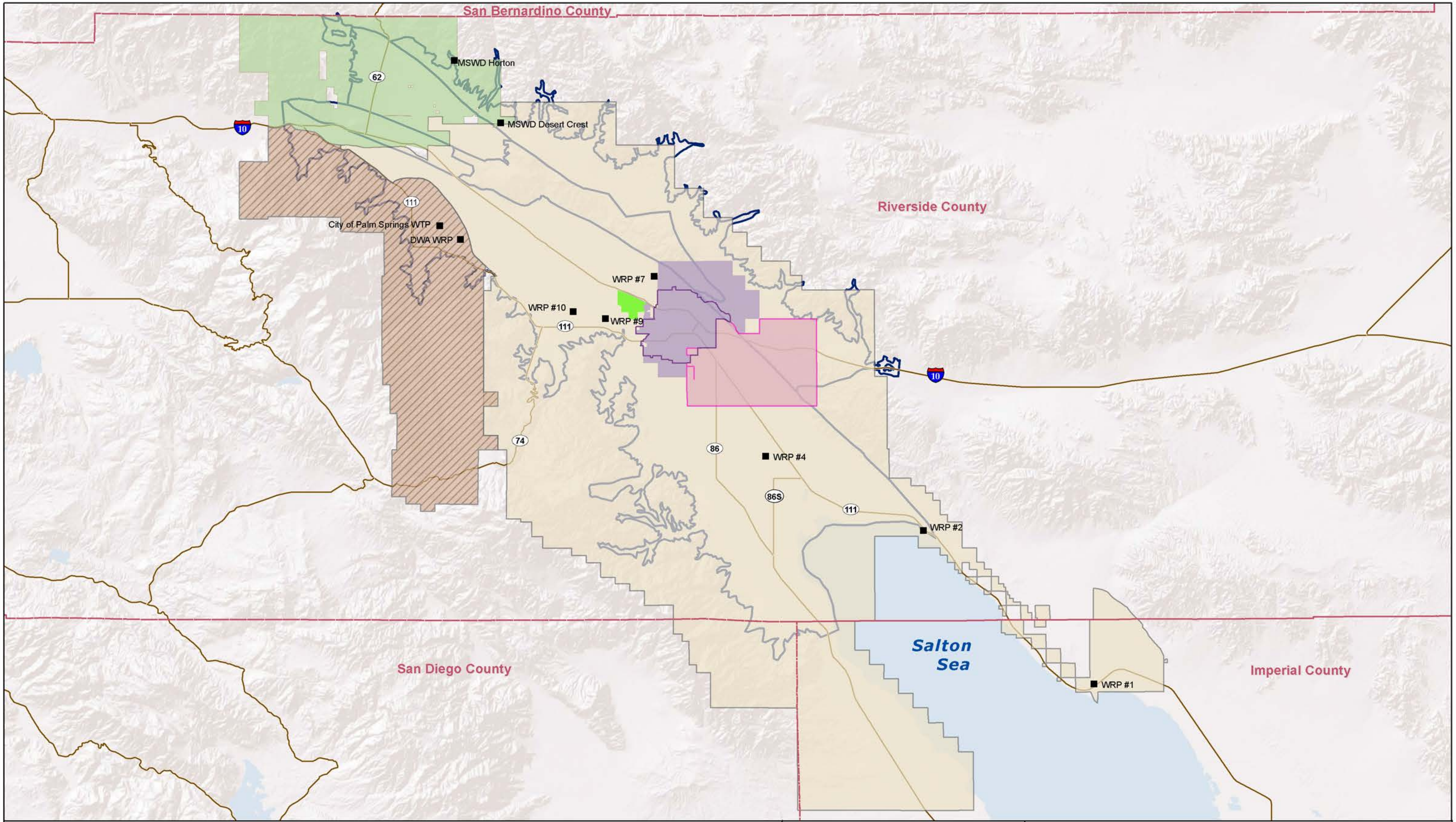
Figure 1-3



Key to Features

- Highway
- County Boundary
- Groundwater Subbasin
- ▭ Coachella Valley Water District
- ▨ Desert Water Agency
- 🟩 Mission Springs Water District
- 🟩 Myoma Dunes Mutual Water Company
- 🟥 Coachella Water Authority
- ▭ Valley Sanitary District
- ■ Water Treatment / Reclamation Plant

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Service Area Boundaries

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Figure 1-4

1.4 SALT AND NUTRIENT MANAGEMENT PLAN DEVELOPMENT

A coordinated group of agencies has organized to evaluate regional water management issues in the Coachella Valley. The Coachella Valley Regional Water Management Group (CVRWMG), whose purpose is to coordinate water resource management efforts, consists of CVWD, CWA, DWA, IWA, and MSWD.

The CVRWMG initially held a series of three public workshops educating stakeholders on the SNMP process. As part of the development of the SNMP-related work that has been completed to date, the current CVRWMG and Stakeholders explored several of the issues that are likely to be addressed as part of the SNMP process. One of the challenges identified for this SNMP was the number of issues and size/scale of the SNMP, especially given the current Basin Plan's lack of subbasin distinction. Therefore, the SNMP process is being developed using a phased approach that will allow it to be completed over time in an incremental manner.

1. Phase I: Initial SNMP Scoping and Work Plan Development
2. Phase II: SNMP Development
3. Phase III: SNMP Monitoring and Other Follow-Up Work such as additional monitoring and data collection (if necessary and dependent on outcomes of Phase II)

Phase I of the SNMP development was completed by the CVRWMG; the result was a work plan for Phase II of the SNMP development. Phases II and III are being completed by CVWD, CWA, DWA and IWA outside the framework of the CVRWMG. Phases II of the SNMP development is the preparation of the plan, including the monitoring plan, and is currently being conducted. Phase III of the process is the implementation of the monitoring plan.

Within Phase II, the process has been divided into three stages, preliminary data review and determination of quantitative methods, determination of ambient water quality and documentation of salt and nutrient sources and sinks, and identification of water management goals and salt and nutrient management strategies. Each of the first two stages will have a technical memorandum documenting the work completed. This technical memorandum, TM-1, represents the documentation of the first stage of the plan development. The final stage will culminate in the preparation of the SNMP. TM-1 is organized as follows:

Section 1 – Introduction: This section provides an introduction to this technical memorandum, defines the role it plays in the development of the SNMP, specifies the requirements of the SNMP, and defines the SNMP study area.

Section 2 – Regulatory Framework: A regulatory framework exists that drives how the SNMP must be completed. This section provides background for the components of the framework which includes the Recycled Water Policy, Porter Cologne Act, State Antidegradation Policy, and the Basin Plan.

Section 3 – Preliminary Basin Characterization: This section defines the geologic and hydrologic properties of the basin that pertain to salt and nutrient management.

Section 4 – Preliminary Data Review: This section provides a summary of data collected to date relevant to the determination of existing water quality within the Basin. Ambient water quality is needed to determine assimilative capacity as defined in the Policy.

Section 5 – Proposed Methods: Methods are described to calculate the ambient water quality within management zones given the available data. Methods are also described to .

2 Regulatory Framework

The SWRCB adopted Resolution No. 2009-011 in February 2009 (later updated in January 2013) that established the Recycled Water Policy. It requires the SWRCB and the nine Regional Water Quality Control Boards (RWQCBs) to exercise the authority granted to them by the Legislature to encourage the use of recycled water, consistent with state and federal water quality laws. To achieve this goal, the Policy provides direction to California's nine RWQCBs on appropriate criteria to be used in regulating recycled water projects (SWRCB, 2013). The purpose of the policy is to increase the use of recycled water, augmenting existing supplies, while meeting applicable state and federal water quality laws. This section summarizes the Recycled Water Policy and the most applicable laws.

2.1 RECYCLED WATER POLICY

In California, declining imported water availability has led to the need to increase local water supplies and has encouraged water purveyors to develop water resources, technology, and policy. California water agencies are on the leading edge of the water resource management, supply portfolio diversification, and development of supplemental sources such as stormwater and recycled water. California agencies need to develop sustainable water supplies that meet economic and policy requirements. Based on file data from CVWD and DWA, recycled water usage in the Valley is approximately 12,400 acre-feet per year (AFY) (8,200 AFY CVWD usage, 4,200 AFY DWA usage). Recycled water usage in the East Valley is approximately 700 AFY and is mainly for agricultural irrigation, duck clubs and fish farms. The amount of municipal wastewater available for reuse is expected to increase 150 percent by 2045 (MWH, 2013; IWA, 2011).

In an effort to encourage the diversification of water supply portfolios and encourage the beneficial uses of water, the SWRCB developed a Recycled Water Policy in 2009, and later updated in 2013. The purpose of the Recycled Water Policy is to increase the use of recycled water while meeting state and federal water quality requirements. The policy provides direction to the RWQCBs and recycled water advocates regarding the appropriate criteria to be used by the SWRCB and the RWQCBs in issuing permits for recycled water projects. The objective of this requirement is to “facilitate basin-wide management of salts and nutrients 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 Policy compels stakeholders to develop implementation plans to meet objectives for salts and nutrients. These plans will then be adopted by a RWQCB as amendments to the region's Water Quality Control Plan (Basin Plan). The Policy also requires that SNMPs be completed by May 2014; although an extension can be granted (and has been) by the RWQCB if that the stakeholders have made substantial progress towards completion of an SNMP. On May 28, 2014, the Colorado River RWQCB granted a time extension for completion of the Coachella Valley SNMP until March 31, 2015.

2.2 PORTER-COLOGNE ACT

The Porter-Cologne Water Quality Control Act is the California law designed to protect water quality and beneficial uses of the state's water. Under the law, the SWRCB has the ultimate authority over State water rights and water quality policy. It requires the adoption of water quality control plans (the Basin Plans) and water quality objectives by the nine RWQCBs their regions. California Water Code §13050(f) describes the beneficial uses of surface and ground waters that may be designated by the State or RWQCB for protection as follows:

> "Beneficial uses of the waters of the state that may be protected against quality degradation include, but are not necessarily limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves."

Also under the law, the SWRCB and nine RWQCBs, under the auspices of the U. S. Environmental Protection Agency, have the responsibility of granting Clean Water Act National Pollutant Discharge Elimination System (NPDES) permits for certain point-source discharges to surface waters. The RWQCBs are also responsible for issuing and enforcing waste discharge requirements for discharges affecting water quality. The nine RWQCBs differ somewhat in the extent they choose to apply waste discharge requirements and other regulatory actions based on the unique hydrologic conditions of each region.

2.3 BASIN PLAN

The Water Quality Control Plan (Basin Plan) for the Colorado River Basin – Region 7 establishes beneficial uses and water quality objectives for the Colorado River Basin Region.

The Basin Plan is designed to preserve and enhance water quality and protect the beneficial uses of all waters within the region (RWQCB, 2014). Specifically, the Basin Plan:

- Designates existing and potential future beneficial uses for surface and ground waters;
- Sets water quality objectives that must be maintained to reasonably protect the designated beneficial uses and conform to the state's anti-degradation policy;
- Describes implementation programs to protect the beneficial uses of all waters in the Region;
- Describes monitoring activities to evaluate the effectiveness of the Basin Plan (Water Code §13240 through 13244, and 13050); and
- Incorporates all applicable State and RWQCB plans and policies.

The Colorado River Region, the region encompassing the planning area, incorporates all of Imperial County and portions of San Bernardino, Riverside, and San Diego Counties. For planning and reporting purposes, the Basin Plan area of coverage can be divided into seven major planning areas on the basis of different economic and hydrologic characteristics: Lucerne Valley, Hayfield, Coachella Valley, Anza-Borrego, Imperial Valley, Salton Sea, and East Colorado River Basin. This SNMP covers the Coachella Valley.

The designation of beneficial uses for the waters of the State by the RWQCB is mandated under California Water Code §13240. The federal Clean Water Act Section 303 requires that the State adopt designated beneficial uses for surface waters. The requirements of both Acts relative to the designation of beneficial uses are summarized below (RWQCB, 2014).

The state must maintain the highest water quality which is reasonable while considering all demands being made and to be made on the water source and the total values involved. These values may be beneficial and detrimental, economic and social, tangible and intangible. In order to maintain a balance between water quality and total value, RWQCBs are required to consider the following issues when determining water quality objectives (California Water Code §13241):

- Past present and probable beneficial uses;
- Environmental characteristics of the hydrographic unit under consideration, including water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality in the area;
- Economic considerations;
- The need for developing housing in the region; and
- The need to develop and use recycled water.

The implementation portion of a Basin Plan must contain a description and nature of specific actions that are needed to achieve the water quality objectives, a time schedule, and a plan for monitoring compliance (California Water Code §13242).

2.3.1 Beneficial Uses

Beneficial uses are established in the Basin Plan for surface waters, groundwaters, and springs. Beneficial use categories, as defined in the Basin Plan, are summarized in **Table 2-1**.

The intent of beneficial use establishment as defined in California Water Code §13241, Division 7 is as follows:

> *"Beneficial uses of the waters of the State that may be protected against quality degradation include, but are not necessarily limited to, domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves."*

The Basin Plan designates three beneficial uses for groundwater in the Coachella Valley Planning Area: municipal, agricultural, and industrial supply. Beneficial use designations for individual aquifers have not been defined at this time. The presumption in the Basin Plan is all groundwaters in Coachella Valley either are or could potentially be used for these purposes. The Regional Board identified "Beneficial Use Designations of Aquifers" as a potential water quality issue for investigation and review in the 2007 Triennial Review of the Basin Plan. The Regional Board envisioned "recommending changes to the beneficial use designations of groundwater to correspond to individual groundwater aquifers within hydrologic units." This SNMP will document the existing beneficial uses of groundwater within the Coachella Valley. To the extent of available data, beneficial uses will be identified by aquifer within the Plan area.

Beneficial uses of surface waters for this region are designated by the California Regional Water Quality Control Board, Colorado River Basin Region. **Table 2-2** summarizes the designated beneficial uses of surface waters within the study area as identified in the Basin Plan for the region (RWQCB, 2014).

Table 2-1
Definitions of Beneficial Use Categories

Category		Definition
MUN	Municipal and Domestic Supply	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
AGR	Agriculture Supply	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
AQUA	Aquaculture	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.
IND	Industrial Service Supply	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.
GWR	Groundwater Recharge	Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting salt water intrusion into fresh water aquifers.
REC I	Water Contact Recreation	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.
REC II	Non-Contact Water Recreation	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
WARM	Warm Freshwater Habitat	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
COLD	Cold Freshwater Habitats	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
WILD	Wildlife Habitat	Uses of water that support terrestrial ecosystems including, but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
POW	Hydropower Generation	Uses of water for hydropower generation.
FRSH	Freshwater Replenishment	Uses of water for natural or artificial maintenance of surface water quantity or quality.
RARE	Preservation of Rare, Threatened, or Endangered Species	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Source: RWQCB, 2014; Table 2-1

Table 2-2
Beneficial Uses for Study Area Surface Waters and Ground Waters Designated by the RWQCB Region 7

Beneficial Use	Use Code	Surface Water							Ground-water
		Salton Sea	Coachella Valley Storm-water Channel[1]	Coachella Valley Drains	Coachella Canal	White-water River[2]	Colorado River Aqueduct[4]	Unlisted Perennial and Inter-mittent Streams	Coachella Hydrologic Subunit
Municipal and Domestic Supply	MUN				P	X	X	P	X[6]
Agricultural Supply	AGR				X	X			X
Aquaculture	AQUA	X							
Freshwater Replenishment	FRSH		X	X					
Industrial Service Supply	IND	P							X
Groundwater Recharge	GWR				X	X	X	I X	
Water Contact Recreation	REC I	X	X[3]	X[3]	X[3]	X	P[3]	I P X	
Non-Contact Water Recreation	REC II	X	X[3]	X[3]	X[3]	X		I X	
Warm Freshwater Habitat	WARM	X	X	X	X	I	X	I X	
Cold Freshwater Habitats	COLD					X			
Wildlife Habitat	WILD	X	X	X	X	X	X	I X	
Hydropower Generation	POW					X	P		
Preservation of Rare, Threatened, or Endangered Species	RARE	X	X[5]	X[5]	X[5]			[5]	

Source: RWQCB, 2014.

Notes:
X – Existing Use
P – Potential Use
I – Intermittent Use
1 – Section of perennial flow from approximately Indio to the Salton Sea
2 – Includes the section of flow from the headwaters in the San Gorgonio Mountains to (and including) the Whitewater Spreading Facility recharge basins near Indian Avenue crossing in Palm Springs
3 – Unauthorized Use
4 – Metropolitan's Colorado River Aqueduct
5 – Rare, endangered, or threatened wildlife exists in or utilizes some of these waterway(s). If the RARE beneficial use may be affected by a water quality control decision, responsibility for substantiation of the existence of rare, endangered, or threatened species on a case-by-case basis is upon the California Department of Fish and Game on its own initiative and/or at the request of the RWQCB; and such substantiation must be provided within a reasonable time frame as approved by the RWQCB.
6 - At such time as the need arises to know whether a particular aquifer which has no known existing MUN use should be considered as a source of drinking water, the RWQCB will make such a determination based on the criteria listed in the "Sources of Drinking Water Policy" in Chapter 2 of this Basin Plan. An "X" placed under the MUN in this Table for a particular hydrologic unit indicates only that at least one of the aquifers in that unit currently supports a MUN beneficial use. For example, the actual MUN usage of the Imperial hydrologic unit is limited only to a small portion of that ground water unit.

Several inconsistencies are apparent in the Basin Plan regarding the existing and potential beneficial uses. For example, several "existing" uses for the Coachella Canal such contact and non-contact recreation are listed; however, these uses are prohibited by CVWD. A similar situation exists regarding potential contact recreation in the Colorado River Aqueduct where contact recreation is both dangerous and illegal. It may be appropriate to designate these uses as "prohibited." Power generation is an existing beneficial use for Colorado River Aqueduct water released at the Whitewater turnout. Future Basin Plan updates should reflect these changes.

2.3.2 Region Water Quality Objectives

Water quality objectives (WQO) are established by the Basin Plan to protect and maintain the integrity of each type of Beneficial Use. Objectives may be narrative or numeric, and vary by location, Beneficial Use category, and surface water body/groundwater basin.

General objectives that apply to the entire planning region include the antidegradation provision of the Basin Plan, which states:

> *"Wherever the existing quality of water is better than the quality established herein as objectives, such existing quality shall be maintained unless otherwise provided for by the provisions of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California."*

The Basin Plan recognizes the lack of available data to develop specific numeric groundwater objectives for each Subbasin in the Region. Therefore, groundwater objectives are typically referenced at the applicable numeric objectives related to their Beneficial Use. A summary of referenced codes and narrative objectives for groundwater is summarized in **Table 2-3**.

Table 2-3
Basin Plan Groundwater Objectives

Constituent	Water Quality Objective
Taste and Odors	Ground waters for use as domestic or municipal supply shall not contain taste or odor-producing substances in concentrations that adversely affect beneficial uses as a result of human activity.
Bacteriological Quality	Section 64426.1 of California Code of Regulations, Title 22.
Chemical and Physical Quality	Sections 64431 (Inorganic Chemicals), 64444 (Organic Chemicals), and 64678 (Lead and Copper) of California Code of Regulations, Title 22.
Brines	Discharges of water softener regeneration brines, other mineralized wastes, and toxic wastes to disposal facilities which ultimately discharge in areas where such wastes can percolate to ground waters usable for domestic and municipal purposes are prohibited.
Radioactivity	Sections 64442 and 64443 of California Code of Regulations, Title 22.

For the purpose of estimating assimilative capacity, numeric objectives may be required for individual constituents of concern. The Title 22 primary maximum contaminant level (MCL) of 45 mg/L nitrate (as NO_3) will be used as the water quality objective for nitrate. As TDS is a taste and odor constituent, the basin plan lists no specific numeric objective. It is recommended that a range of water quality objectives be considered for TDS. A major source of water currently being used to augment groundwater supplies is the Colorado River. A protective water quality objective of 879 mg/L TDS is currently being used for this surface water at Imperial Dam and will be considered for the groundwater numeric objective. Additionally, the Title 22 upper consumer acceptance contaminant level for TDS of 1,000 mg/L will be considered.

2.4 RESOLUTION NO. 68-16 - STATE ANTI-DEGRADATION POLICY

SWRCB Resolution No. 68-16 is a state policy that establishes the requirement that discharges to waters of the state shall be regulated to achieve the "highest water quality consistent with maximum benefit to the people of the State". Under SWRCB Resolution No. 68-16, the RWQCB and the SWRCB must have sufficient grounds to adopt findings which demonstrate that any water quality degradation will:

- Be consistent with the maximum benefit to the people of the State;
- Not unreasonably affect existing and potential beneficial uses of such water; and
- Not result in water quality less than described in the Basin Plan (RWQCB, 2014).

In addition, any activity that results in discharges to existing high quality waters are required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that a) a pollution or nuisance will not occur, and b) the highest water quality consistent with the maximum benefit to the people of the State will be maintained.

Resolution No. 68-16 establishes a general principle of non-degradation. The policy does allow for flexibility as water quality pertains to the best interests of the people of the State. Changes in water quality are allowed only where it is in the public interest and beneficial uses are not unreasonably affected. The SWRCB has interpreted Resolution No. 68-16 as incorporating the three part principles set forth in the federal anti-degradation policy. These three principles include: 1) Existing in-stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected; 2) where the quality of the waters exceed levels necessary to support propagation of wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process that allowing lower water quality is necessary to accommodate important economic or social development in the area. By allowing such degradation, the State shall assure water quality adequate to protect existing uses fully; and 3) where high quality waters constitute an outstanding National resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected (40 C.F.R.§131.12a). The terms and conditions of Resolution No. 68-16 serve as a general narrative water quality objective in all state water quality control plans (RWQCB, 2014).

The Resolution does not require that existing high quality water always be maintained. It states that any change must be consistent with maximum benefit to the people of the State; it cannot unreasonably affect beneficial uses, and must comply with applicable water quality control policies (SWRCB, 1994). To be consistent with the resolution, discharges may range between ambient or background and the water quality objectives in the Basin Plan. The resolution assumes the discharger must use best practicable treatment and control technology (BPTC). If a treatment or control method results in a discharge that maintains the existing water quality, then a less stringent level of treatment or control would not be in compliance with the Resolution. If the discharge, even after treatment, unreasonably affects beneficial uses or does not comply with the Basin Plan, the discharge is prohibited. The discharge is not required to be treated to levels that are better than ambient background water quality (SWRCB, 1994).

In November 2012, the California Third District Court of Appeal ruled in the case *Asociacion de Gente Unida Por El Agua v. Central Valley Regional Water Quality Control Board* (210 Cal.App.4th 1255) that the anti-degradation policy applies whenever there is “an existing high quality water” and “an activity which produces or may produce waste … that will discharge into such high quality water.” The appeals court interpreted an existing high quality water to exist where the baseline water quality (that existed in 1968) is better than the water quality objective.

While this case related to waste discharges from dairies in the Central Valley, the SWRCB Chief Counsel issued a memorandum on the case in February 2013. That memorandum stated “The Court … based its analysis on existing State Water Board guidance, so the case does not establish new rules or legal principles. [The case] is nevertheless significant because it gives precedential effect to some of this guidance. The decision also underscores the importance of documenting the steps to support an antidegradation analysis or to support a finding that an antidegradation analysis is unnecessary.”

The Court relied extensively on existing State Water Board guidance, including Administrative Procedures Update (APU) 90-004 and the 1995 Question and Answer document on Resolution 68-16. While APU 90-004 technically only applies to NPDES permitting, the Court found it instructive in applying Resolution 68-16 in other contexts stating:

> APU-90-004 sets forth a procedure for determining whether the existing water quality is to be protected: “The baseline quality of the receiving water determines the level of water quality protection. Baseline quality is defined as the best quality of the receiving water that has existed since 1968 when considering Resolution No. 68-16, … unless subsequent lowering was due to regulatory action consistent with State and federal antidegradation policies.”
>
> When undertaking an antidegradation analysis, the RWQCB must compare the baseline water quality (the best quality that has existed since 1968) to the water quality objectives. If the baseline water quality is equal to or less than the objectives, the objectives set forth the water quality that must be maintained or achieved. In that case the antidegradation policy is not triggered. However, if the baseline water quality is better than the water quality objectives, the baseline water quality must be maintained in the absence of findings required by the antidegradation policy.

The SWRCB Chief Counsel offered several additional observations regarding the effect of this decision:

- Time schedules or phased implementation of anti-degradation requirements are appropriate. As with other requirements, time schedules must be justified by facts in the record and supported by findings.
- The case confirms that what constitutes BPTC can vary in different situations involving the same type of discharge only if the board finds that any lesser treatment or control requirements were necessary to accommodate important economic or social development in the area, would avoid pollution or nuisance (i.e., would not cause water quality objectives to be exceeded) and would maintain the highest water quality consistent with the maximum benefit to the people of the state.
- “Maximum benefit” findings must consider the costs to the affected public, such as costs to treat water supplies affected by a discharge. When cost savings to the discharger are part of the justification for allowing degradation, a Water Board must also demonstrate how the cost savings are necessary to accommodate important social and economic development.
- The decision does not require regulated facilities in other programs to conduct groundwater quality monitoring in addition to or instead of other types of monitoring. Specific monitoring requirements must be based on the facts of each case. Orders authorizing discharges of waste should include findings demonstrating that the order as a whole provides adequate assurance that only the authorized amount of degradation, if any, will occur, and that monitoring and reporting requirements are adequate to detect degradation or to prevent any additional degradation if it were to occur.
- BPTC determinations may consider relative benefits of proposed treatment or control methods to proven technologies; performance data; alternative methods of treatment or control; methods used by similarly situated dischargers; and/or promulgated BAT or other technology-based standards. Costs of treatment or control should also be considered.

The effect of this decision on development of the SNMP has not been determined.

2.5 ASSIMILATIVE CAPACITY

The assimilative capacity of a surface water or groundwater is the ability of the water body to receive and accommodate natural and anthropogenic sources of pollutants, while maintaining water quality standards that are protective of the beneficial uses of the water resource. The SNMP coverage of assimilative capacity is focused exclusively on groundwater. Factors that affect the assimilative capacity of a basin depend on the contaminant, the soil type, and the groundwater chemistry and hydraulic parameters.

The available assimilative capacity of a water body or management zone is also defined as the difference between the applicable water quality objective for a pollutant parameter and the ambient water quality for that pollutant parameter (where it is lower than the objective). This is illustrated on **Figure 2-1**. Ambient water quality is the representative concentration of a water quality constituent within a water body or management zone. If the ambient water quality exceeds, the water quality objective, the presumption is that assimilative capacity does not exist.

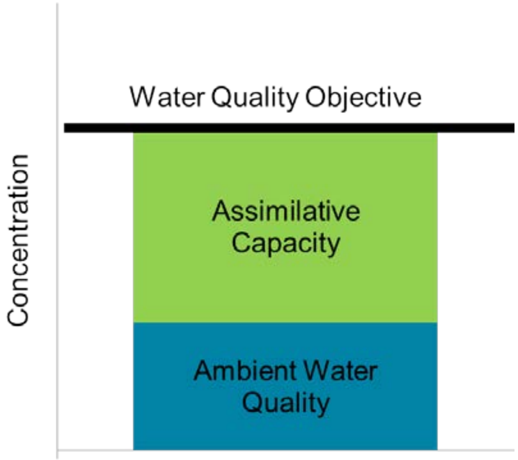


Figure 2-1
Assimilative Capacity Relationship to Ambient Water Quality

Resolution No. 68-16 satisfies the federal requirement that each state establish its own anti-degradation policy consistent with the federal Anti-Degradation Policy. While the federal Anti-Degradation Policy addresses water quality of surface waters, Resolution No. 68-16 applies to both surface waters and groundwater. The basic policy directions of Resolution 68-16 are that whenever the ambient water quality is a lower concentration than the water quality objectives established in the Basin Plan, the existing high quality shall be maintained, or it can be "demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water ... ." This is often referred to as maximum benefit. The resolution also states that "... any activity ... which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

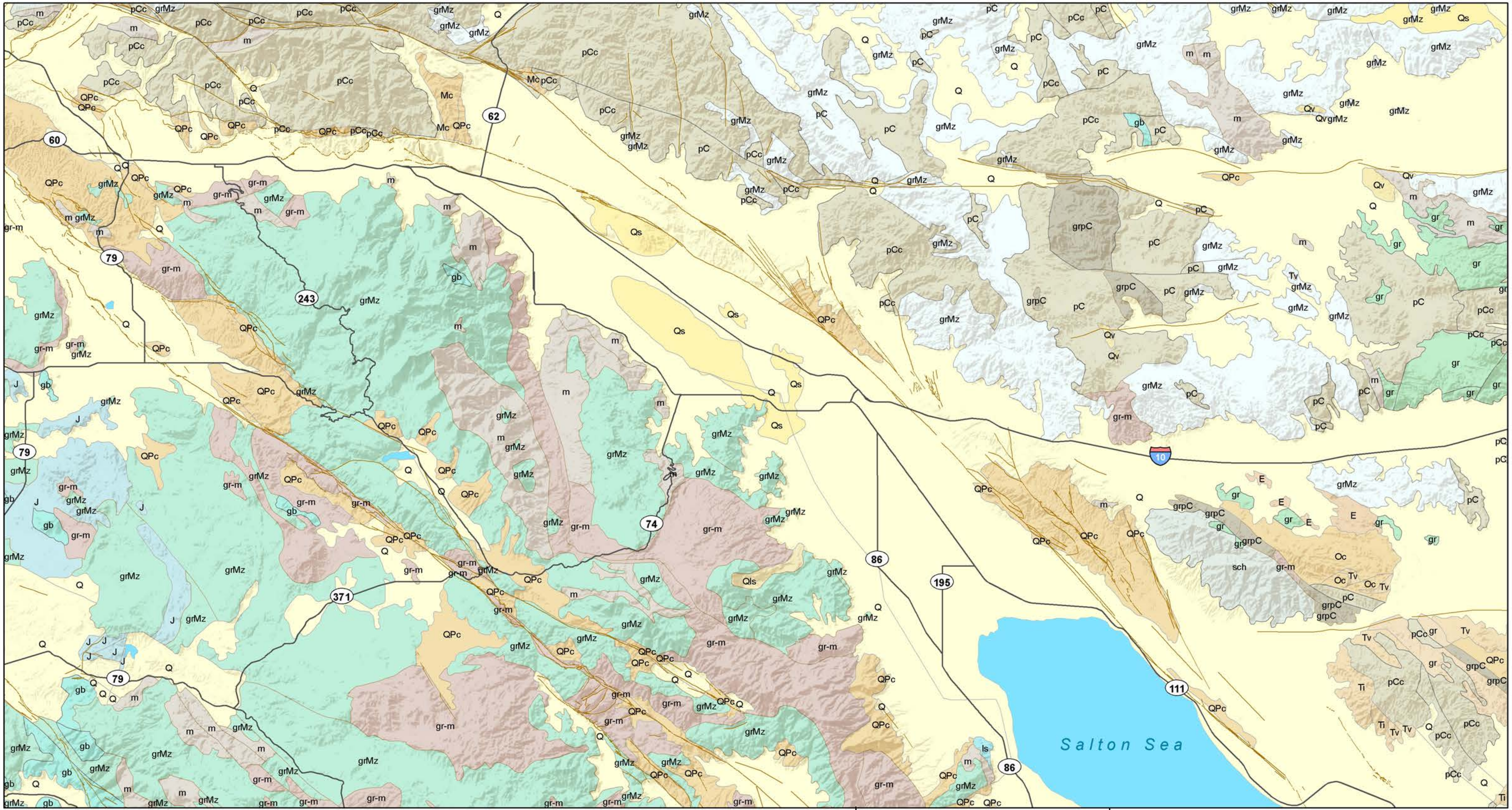
3 Initial Basin Characterization

This section summarizes the geologic and hydrologic properties of the Basin that pertain to salt and nutrient management. This includes a description of the Coachella Valley, groundwater basins within the Valley, and groundwater quality. This discussion is primarily based on Bulletin 108 (DWR, 1964), Bulletin 118 (DWR, 2003), the Coachella Valley Water Management Plan and Plan Update (Water Consult and MWH, 2002; MWH, 2012), the Mission Creek and Garnet Hill Subbasins Water Management Plan (MWH, 2013), and Engineers Reports on Water Supply and Replenishment Assessment (CVWD 2010; CVWD 2014). Water quality data gathered for SNMP development, discussed in Section 4, is included to summarize the historical and current groundwater quality within Coachella Valley.

3.1 DESCRIPTION OF THE COACHELLA GROUNDWATER BASIN

Coachella Valley lies in the northwestern portion of the Salton Trough, which extends from the Gulf of California in Mexico northwesterly to the Cabazon area. The Basin is bounded on the north and east by crystalline bedrock of the San Bernardino and Little San Bernardino Mountains and on the south and west by the crystalline rocks of the Santa Rosa and San Jacinto Mountains. The Basin is bounded on the west end of the San Gorgonio Pass groundwater divide. The southern boundary is the Salton Sea. Geologic faults and structures generally divide the Basin into four subbasins (Tyley, 1974); these faults and limit groundwater flow between them. The four subbasins include: the Whitewater (Indio), Garnet Hill, Mission Creek, and Desert Hot Springs.

The primary aquifer system in the Valley is unconsolidated Pleistocene-Holocene valley fill. **Figure 3-1** illustrates the Valley geology. Groundwater recharge is primarily runoff from the surrounding mountains, local precipitation, irrigation return, stream flow from the Whitewater River and other rivers and creeks, and from imported Colorado River water supplied to spreading grounds throughout the Valley. Groundwater discharge is to evapotranspiration, to underflow to the Salton Sea and Imperial Valley areas, and to pumping wells.



Key to Features

—	Quaternary Fault
—	Major Roadways
🟦	Water

Geology (USGS OFR 2005-1305, Updated 2007)

Age	Symbol	Unit
Quaternary	Qv	Basalt
	Qs	Dune Sand
	Qls	Landslide
Tertiary	Q	Alluvium
	Ti	Basalt
	E	Mudstone
	Tv	Rhyolite
	QPc/Oc/ Qc/Mc	Sandstone
Cretaceous	sch	Schist
Jurassic	gr	Plutonic rock
	grMz	Tonalite
Triassic	gb	Gabbro
Permian	grMz	Diorite
Paleozoic	J	Argillite
	ls	Limestone
PreCambrian	pC/pCc	Gneiss
	grpC	Granite
	gr-m	Plutonic rock
	m	Schist

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Coachella Valley Geology

MWH.

Figure 3-1

3.2 WHITEWATER RIVER (INDIO) SUBBASIN

The Whitewater River Subbasin, designated the Indio Subbasin (Basin No. 7-21.01) in DWR Bulletin No. 118 (DWR, 2003), underlies the major portion of the Valley floor and encompasses approximately 400 square miles. Beginning approximately one mile west of the junction of State Highway 111 and Interstate Highway 10, the Whitewater River Subbasin extends southeast approximately 70 miles to the Salton Sea. The subbasin underlies the cities of Palm Springs, Cathedral City, Rancho Mirage, Palm Desert, Indian Wells, La Quinta, Indio, and Coachella, and the unincorporated communities of Thousand Palms, Thermal, Bermuda Dunes, Oasis, and Mecca.

The Whitewater River Subbasin is divided into four subareas: Palm Springs, Thermal, Thousand Palms, and Oasis. The Palm Springs Subarea is the forebay or main area of recharge to the subbasin and the Thermal Subarea comprises the pressure or confined area within the basin. The other two subareas are peripheral areas having unconfined groundwater conditions (CVWD, 2010).

3.2.1 Geologic Structure and Water Levels

The geology of the subbasin varies with coarse-grained sediments located in the vicinity of Whitewater and Palm Springs, gradually transitioning to fine-grained sediments near the Salton Sea. From about Indio southeasterly to the Salton Sea, the subbasin contains increasingly thick layers of silt and clay, especially in the shallower portions of the subbasin. These silt and clay layers, which are remnants of ancient lake beds, impede the percolation of water applied for irrigation and limit groundwater recharge opportunities to the westerly fringe of the subbasin.

The subbasin is bordered on the southwest by the Santa Rosa and San Jacinto Mountains and is separated from Garnet Hill, Mission Creek, and Desert Hot Springs Subbasins to the north and east by the Garnet Hill and San Andreas Faults (CVWD, 2010; DWR, 1964). The Garnet Hill Fault, which extends southeastward from the north side of San Gorgonio Pass to the Indio Hills, is a relatively effective barrier to groundwater movement from the Garnet Hill Subbasin into the Whitewater River Subbasin, with some portions in the shallower zones more permeable. The San Andreas Fault, extending southeastward from the junction of the Mission Creek and Banning Faults in the Indio Hills and continuing out of the basin on the east flank of the Salton Sea, is also an effective barrier to groundwater movement from the northeast. Water placed on the ground surface in the West Valley will percolate through the sands and gravels directly into the groundwater aquifer. However, in the East Valley, several impervious clay layers lie between the ground surface and the main groundwater aquifer. Water applied to the surface in the East Valley does not easily reach the East groundwater aquifers due to these impervious clay layers. The only outlet for groundwater in the Whitewater River Subbasin is through natural subsurface outflow to the Salton Sea or through agricultural drains and transport to the Salton Sea directly or via the Coachella Valley Stormwater Channel (CVSC).

In 1964, the DWR estimated that the five subbasins that make up the Coachella Valley groundwater basin contained a total of approximately 39.2 million acre-feet (AF) of water in the first 1,000 feet below the ground surface; much of this water originated as runoff from the adjacent mountains. Of this amount, approximately 28.8 million AF of water was stored in the

Whitewater River Subbasin. However, the amount of water in the Whitewater River Subbasin has decreased over the years due to pumping to serve urban, rural and agricultural development in the Coachella Valley has withdrawn water at a rate faster than its rate of recharge.

The Whitewater River Subbasin is not adjudicated. From a management perspective, the subbasin is divided into two management areas referred to in this document as the West Valley and the East Valley. The dividing line between these two areas is an irregular trending northeast to southwest between the Indio Hills north of the City of Indio and Point Happy in La Quinta. The West Valley is jointly managed by CVWD and DWA under the terms of the 2014 Water Management Agreement. The East Valley is managed by CVWD. DWA and CVWD jointly operate a groundwater replenishment program whereby groundwater pumpers (other than minimal pumpers[1]) within designated management areas pay a per acre-foot charge that is used to pay the cost of importing water and recharging the aquifer.

The conceptual hydrostratigraphic section for the Valley consists of four zones (DWR, 1964):

- Semi-perched aquifer and intervening retarding layers (correlated with Recent lake deposits and alluvium)
- Upper aquifer (correlative with Upper Pleistocene alluvium)
- Aquitard
- Lower aquifer (correlative with the Pleistocene Ocotillo Conglomerate)

Each of the four water-bearing zones, from shallowest to deepest, are described briefly below. **Figure 3-2** illustrates the approximate area of semi-perched and confined aquifers and **Figure 3-3** illustrates the generalized hydrogeologic section of the Whitewater River Subbasin. The following sections provide a brief description of each stratigraphic zone based upon the work of DWR (DWR, 1964 and 1979), United States Geological Survey (USGS) (1974) and more recent data collected as part of the 2010 CVWD Water Management Plan Update (MWH, 2012).

3.2.1.1 Semi-perched aquifer

The Semi-perched aquifer is characterized by fine-grained Holocene and Recent lake deposits and alluvium that form an effective barrier to the deep percolation of surface runoff and applied water within the central portion of the East Valley where present. This zone is not present in the West Valley. In the East Valley, the Semi-perched aquifer extends across the central portion of the basin but is absent from the basin margins. The general extent of the Semi-perched aquifer is shown in **Figure 3-2**; **Figure 3-3** shows a generalized hydrogeologic profile of the Valley. Groundwater flow is generally from the northwest to the southeast. More detailed cross-sections are presented in **Appendix B** and **Appendix C** (MWH, 2010). The thickness of this aquifer unit is as much as 100 feet in the center of the basin. The Semi-perched aquifer consists of interbedded layers of fine sand and clay and is separated from the underlying Upper aquifer by a laterally discontinuous clay zone (DWR, 1964). Where the clay zone is absent in portions of the East Valley, the Semi-perched aquifer merges with the underlying Upper aquifer.

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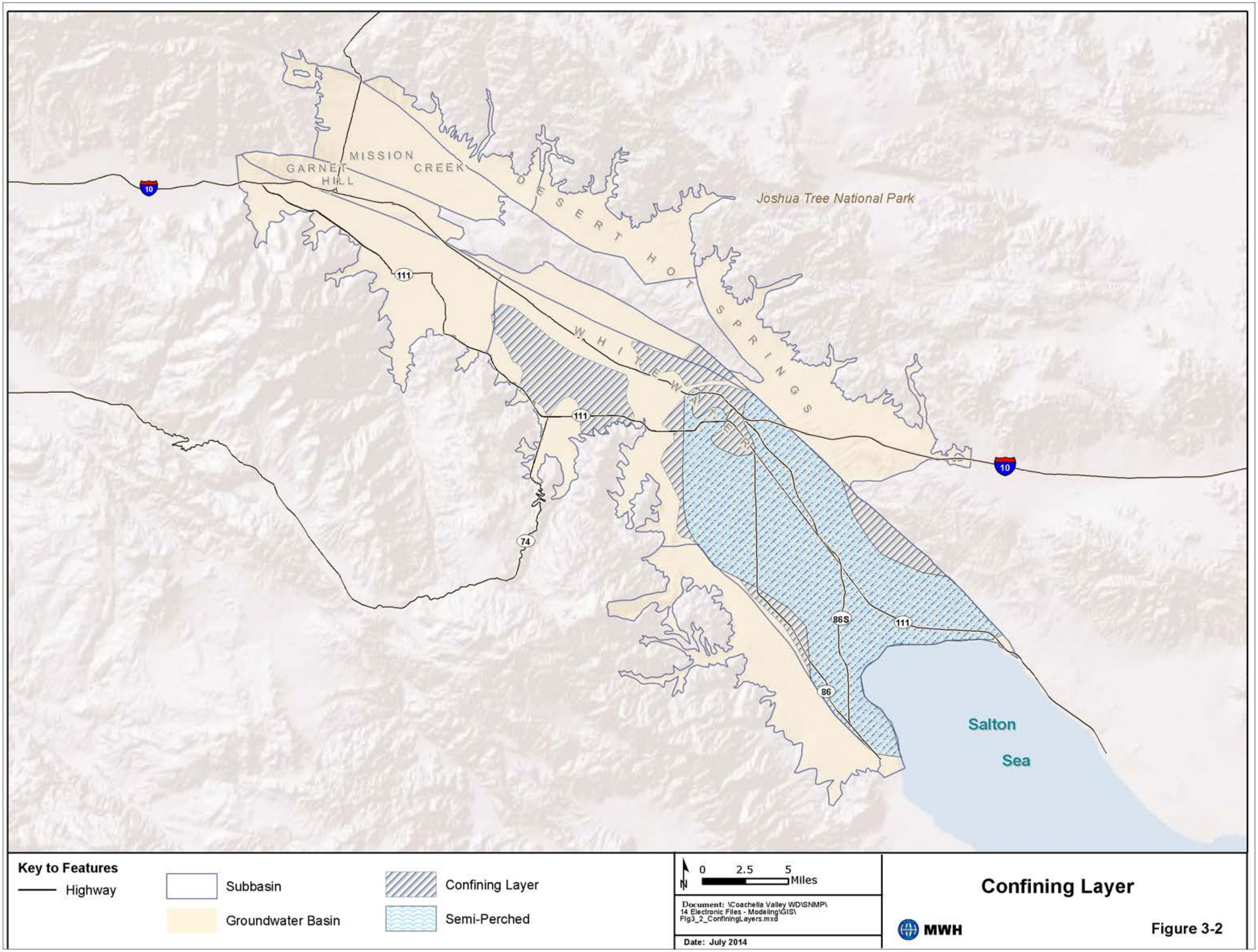
[1] CVWD's enabling legislation defines a minimal pumper as any producer who produces 25 or fewer AF in any year. DWA's legislation defines a minimal pumper as any producer who produces 10 or fewer AF in any year.



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Confining Layer

Figure 3-2

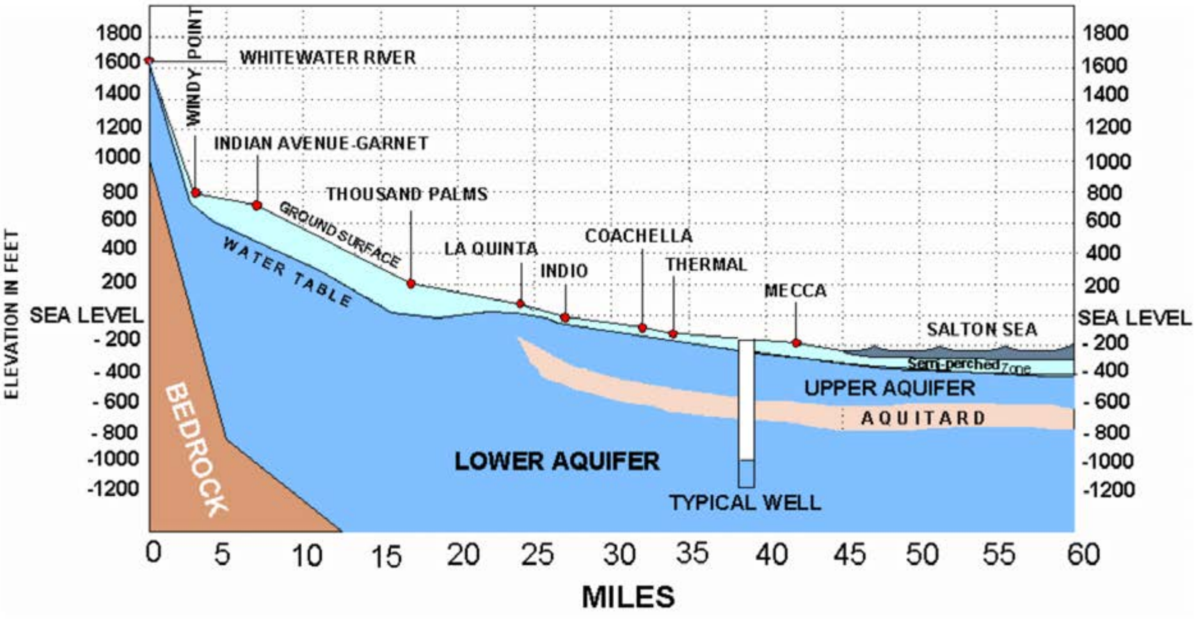


Figure 3-3
Coachella Valley Groundwater Basin Generalized Profile

Recharge of the Semi-perched aquifer is largely from percolation of surface runoff and return flows of applied water. Groundwater leaves the Semi-perched aquifer as surface flow into agricultural drains, evapotranspiration and vertical leakage to the Upper aquifer.

3.2.1.2 Upper Aquifer

Based on DWR (1964), the Upper aquifer, which is formed of Upper Pleistocene alluvium, underlies the Semi-perched aquifer. The Upper aquifer typically consists of coarse sand and gravel with discontinuous clay lenses in the West Valley and the northern part of the East Valley. Finer sand and sandy clay dominate in the southern part of the East Valley. The Upper aquifer is believed to be unconfined or semi-confined in most of the West Valley, and is confined in most of the East Valley by the Semi-perched aquifer and a discontinuous clay layer (referred to as the aquitard).

The Upper aquifer is approximately 150 to 300 feet thick (DWR. 1964). It is relatively flat in the central part of the Coachella Valley and is upturned and thin along the basin margins, sub-parallel to the ground surface. In the northern portion of the East Valley, the top of the Upper aquifer is located at elevations ranging from 100 feet above mean sea level (MSL) along the basin margins to 200 feet below MSL in the central portion of the basin. In the southern portion of the basin, the top of the Upper aquifer is encountered at elevations ranging from approximately 100 feet above MSL along the basin margins to 500 feet below MSL in the center of the basin. Recharge to the Upper aquifer is by:

- Percolation of streamflow runoff, particularly near the margins of the Valley
- Percolation of agricultural irrigation water from the Semi-perched aquifer

- Subsurface inflow from outside the study area, both beneath the San Gorgonio Pass and, to a lesser extent, across the Banning Fault.

Groundwater leaves the Upper aquifer primarily by percolation into the underlying Lower aquifer, particularly where the aquifers merge in the West Valley and at the margins of the East Valley. Additional groundwater discharge occurs by water supply wells throughout the Coachella Valley.

3.2.1.3 Aquitard

A discontinuous aquitard separates the Upper and Lower aquifers in the East Valley. The aquitard typically consists of clay and sandy clay with discontinuous sand lenses having low permeabilities. Sand is more common in the northern portion of the aquitard, which thins in the West Valley but is identifiable as far north as Cathedral City. The aquitard cannot be found in all well construction logs, it is absent at the basin margins and reaches a maximum thickness of approximately 200 feet in the portions of the East Valley; in small areas adjacent to the Salton Sea, it is as much as 500 feet thick (DWR, 1964). It is underlain by the Lower aquifer. The fine-grained materials making up the aquitard are not tight enough or persistent enough to completely restrict the vertical flow of water between the Upper and the Lower aquifers (DWR, 1964). The lateral extent of the aquitard is presented in **Figure 3-2.**

3.2.1.4 Lower Aquifer

The Lower aquifer is formed of the Ocotillo conglomerate and is the deepest and principal water-bearing zone of the East Valley. Rocks of the semiwater-bearing group and nonwater-bearing group underlie it. In the area generally described as the West Valley, the northern portion of the East Valley and the basin margins, the Lower aquifer typically consists of coarse sand and gravel. In most of the East Valley, the Lower aquifer is composed of sandy clay. One or two lower-permeability layers subdivide the Lower aquifer through most of its extent.

Like the overlying units, the edges of the Lower aquifer are upturned along the basin margins. The top of the Lower aquifer is encountered at elevations ranging from -100 to -300 ft MSL in the northern portion of the basin and at elevations ranging from -400 to -600 ft MSL in the southern portion of the basin. The aquifer dips in the direction of the Salton Sea. It is typically 100 to over 1,000 ft thick.

The Lower aquifer is recharged by percolation from the Upper aquifer, particularly in areas where the two aquifers merge. Near the margins of the East Valley, where the Semi-perched aquifer and the aquitard are absent, runoff from mountain streams percolates into the alluvial fans at the base of the mountains and provides an additional source of recharge to the merged Upper and Lower aquifers. Through most of the West Valley, the two aquifers are not clearly distinguishable and groundwater levels are approximately equal. The water levels in the aquifers begin to diverge where they become separated by the aquitard. With increased groundwater pumping to supply increasing urbanization and agricultural use, groundwater levels have declined in the area in which the aquifers are merged.

Outflow from the Lower aquifer is primarily through water supply wells. Historically, some groundwater migrated out of the Lower aquifer flowing into the area beneath the Salton Sea. Basin overdraft, however, has reversed the direction of this subsurface flow in some portions of the basin. As overdraft is eliminated, outflow under the Salton Sea is expected to resume.

3.2.2 Palm Springs Subarea

The triangular area between the Garnet Hill Fault and the east slope of the San Jacinto Mountains southeast to Cathedral City is designated the Palm Springs Subarea, and is an area in which groundwater is unconfined. The Valley fill materials within the Palm Springs Subarea are essentially heterogeneous alluvial fan deposits with little sorting and little fine grained material content. The thickness of these water bearing materials is not known; however, it exceeds 1,000 feet (CVWD, 2010). The probable thickness of recent deposits suggests that Ocotillo conglomerate underlies recent fanglomerate in the Subarea at depths ranging from 300 to 400 feet (DWR, 1964).

Natural recharge to the aquifers in the Whitewater River Subbasin occurs primarily in the Palm Springs Subarea. The major natural sources include infiltration of stream runoff from the San Jacinto Mountains and the Whitewater River, and subsurface inflow from the San Gorgonio Pass and Garnet Hill Subbasins. Deep percolation of direct precipitation on the Palm Springs Subarea, and the entire Valley, is considered negligible as it is consumed by evapotranspiration.

3.2.3 Thermal Subarea

Groundwater of the Palm Springs Subarea moves southeastward through the interbedded sands, silts, and clays underlying the central portion of the Valley. The division between the Palm Springs Subarea and the Thermal Subarea is near Cathedral City. The permeabilities parallel to the bedding of the deposits in the Thermal Subarea are several times the permeabilities normal to the bedding and, therefore, movement of groundwater parallel to the bedding predominates. Confined or semi-confined groundwater conditions are present in the major portion of the Thermal Subarea. Movement of groundwater under these conditions is present in the major portion of the Thermal Subarea and is caused by differences in piezometric (pressure) level or head. Unconfined or free water conditions are present in the alluvial fans at the base of the Santa Rosa Mountains, as in the fans at the mouth of Deep Canyon and in the La Quinta area.

Sand and gravel lenses underlying this Subarea are discontinuous and clay beds are not extensive. However, two aquifer zones separated by a zone of finer-grained materials were identified from well logs (DWR, 1964). The fine-grained materials within the intervening horizontal plane are not tight enough or persistent enough to restrict completely the vertical interflow of water, or to assign the term “aquiclude” to it. Therefore, the term “aquitard” is used for this zone of less permeable material that separates the Upper and Lower aquifer zones in the southeastern part of the Valley. Capping the Upper aquifer at the surface are tight clays and silts with minor amounts of sands. Semi-perched groundwater occurs in this capping zone, which is up to 100 feet thick.

The Lower aquifer zone, composed in part of the Ocotillo conglomerate, consists of silty sands and gravels with interbeds of silt and clay. It is the most important source of groundwater in the

Whitewater River Subbasin. The top of the Lower aquifer zone is present at depths ranging from 300 to 600 feet below the surface. The thickness of the zone is undetermined, as the deepest wells present in the Valley have not penetrated it in its entirety. The available data indicate that the zone is at least 500 feet thick and may be in excess of 1,800 feet thick; depth information for Well 06S08E36M01S indicate a screened depth to 1,880 feet below ground surface. DWR (1964) inferred the depth to bedrock was in excess of 12,000 feet below ground surface based on gravity survey data.

The aquitard overlying the Lower aquifer zone is generally 100 to 200 feet thick, although in small areas on the periphery of the Salton Sea it is in excess of 500 feet in thickness. North and west of Indio, in a curving zone approximately one mile wide, the aquitard is apparently lacking and no distinction is made between the Upper and Lower aquifer zones. This may be the result of erosion and deposition from Whitewater River flood flows. The aquitard is also responsible for artesian groundwater conditions in the central portion of the Thermal Subarea. Wells perforating the Lower aquifer in this area experience artesian flowing conditions and require special construction to prevent the waste of groundwater.

Capping the Upper aquifer zone in the Thermal Subarea is a shallow fine-grained zone in which semi-perched groundwater is present. This zone consists of Recent silts, clays, and fine sands and is relatively persistent southeast of Indio. It ranges from zero to 100 feet thick and is generally an effective barrier to deep percolation. However, north and west of Indio, the zone is composed mainly of clayey sands and silts and its effect in retarding deep percolation is believed to be limited. The low permeability of the materials southeast of Indio has contributed to the irrigation drainage problems of the area. Semi-perched groundwater has been maintained by irrigation water applied to agricultural lands south of Point Happy. This condition causes waterlogged soils and the accumulation of salts in the root zone in agricultural areas. Surface drains were constructed in the 1930s to alleviate this condition. Subsurface tile drainage systems were installed in the 1950s to control the high water table conditions, allow reclamation of saline soils, and intercept poor quality return flows. CVWD operates and maintains a collector system of 166 miles of pipe, ranging in diameter from 18 inches to 72 inches, along with 21 miles of open ditches, to serve as a drainage network for irrigated lands. All agricultural drains empty into the CVSC except those at the southern end of the Valley, which flow directly to the Salton Sea. This system serves nearly 38,000 acres and receives water from more than 2,293 miles of on-farm drain lines (Water Consult and MWH, 2002).

3.2.4 Thousand Palms Subarea

The small area along the southwest flank of the Indio Hills is designated the Thousand Palms Subarea. The southwest boundary of the Subarea was determined by tracing the limit of distinctive groundwater chemical characteristics (DWR, 1964). Whereas calcium bicarbonate water is characteristic of the major aquifers of the Whitewater River Subbasin, water in the Thousand Palms Subarea is sodium sulfate in character.

These quality differences suggest that recharge to the Thousand Palms Subarea comes primarily from the Indio Hills and is limited in supply. The relatively sharp boundary between chemical characteristics of water derived from the Indio Hills and groundwater in the Thermal Subarea suggests there is little intermixing of the two waters.

The configuration of the water table north of the community of Thousand Palms is such that the generally uniform, southeast gradient in the Palm Springs Subarea diverges and steepens to the east along the base of Edom Hill. This historical steepened gradient suggests a barrier to the movement of groundwater, or a reduction in permeability of the water bearing materials. A southeast extension of the Garnet Hill Fault could also coincide with this anomaly. However, there is no surface expression of such a fault, and the gravity measurements taken during the 1964 DWR investigation do not suggest a subsurface fault. The residual gravity profile across this area supports these observations. The sharp increase in gradient is therefore attributed to lower permeability of the materials to the east. Most of the Thousand Palms Subarea is located within the upper portion of the Whitewater River Subbasin. Groundwater levels in this area show similar patterns to those of the adjacent Thermal Subarea, this suggests a hydraulic connectivity.

3.2.5 Oasis Subarea

Another peripheral zone of unconfined groundwater that differs in chemical characteristics from water in the major aquifers of the Whitewater River Subbasin is found underlying the Oasis Piedmont slope. This zone, named the Oasis Subarea, extends along the base of the Santa Rosa Mountains. Water bearing materials underlying the Subarea consist of highly permeable alluvial fan deposits. Although groundwater elevation data suggest that the boundary between the Oasis and Thermal Subareas may be a buried fault extending from Travertine Rock to the community of Oasis, the remainder of the boundary is a change from the coarse fan deposits of the Oasis Subarea to the interbedded sands, gravel, and silts of the Thermal Subarea. Little information is available as to the thickness of water bearing materials, but it is estimated to be in excess of 1,000 feet.

3.2.6 Surface Water Hydrology

Over geologic time, the Whitewater River and other local watercourses (including San Gorgonio, Snow, Falls, Chino, Tahquitz, and Andreas, Palm Canyon, Deep Canyon, Martinez Canyon, and smaller creeks) sent floodwaters into the Coachella Valley, discharging onto the floor of the desert. Early records indicate that the mouth of the Whitewater River was at what is now known as Point Happy in the City of La Quinta. Historically, floodwaters reaching Point Happy fanned out across the desert floor in this area, flooding areas downstream. DWR (1964) estimated the average seasonal mountain-front runoff to the Whitewater River (Indio) Subbasin totals 38,100 AFY. Subsequent hydrologic studies performed for the Coachella Valley Water Management Plan (Water Consult and MWH, 2002; MWH 2013) indicated the local surface and subsurface inflow from the mountain-front to the Whitewater River Subbasin has averaged 46,000 AFY, ranging from about 8,000 to more than 200,000 AFY.

The CVSC, a constructed extension of the Whitewater River that is managed and operated by CVWD, is the main drainage channel for the East Valley. This unlined earthen channel extends approximately 17 miles southeast from the City of Indio, through the agricultural communities of Coachella, Thermal and Mecca, to the north end of the Salton Sea. The construction of the CVSC was begun in the early 1920s to convey Whitewater River storm flows safely past Coachella Valley communities and to provide adequate drainage for agricultural return waters in the area of semi-perched groundwater (see **Section 5.6**). Its design capacity is 82,000 cfs (Dan

Farris, CVWD, pers. comm. 2000). In addition to agricultural drainage, the CVSC also receives treated effluent from three municipal wastewater treatment plants (CVWD's Water Reclamation Plant 4, Valley Sanitary District, and Coachella Sanitary District).

Throughout the East Valley, agricultural drains have been installed to drain shallow groundwater perched on fine-grained, ancient lakebed soils. Most of the drains empty into the CVSC; however, 25 smaller open channel drains at the southern end of the Coachella Valley discharge directly to the Salton Sea. The quantity of flow in the drains, and therefore in the CVSC, depends upon water levels in the underlying aquifers and the quantities of applied irrigation water.

3.2.6.1 The Coachella Canal and Distribution System

As agriculture in the Imperial and Coachella valleys developed during the early 1900s, alternative sources of water including the Colorado River were considered to meet growing demand. The Imperial Valley began receiving Colorado River water in 1901 via the Imperial Canal that was partially located in Mexico. In the Coachella Valley, the rapid rate of groundwater extraction led to a substantial decline in groundwater levels, limiting the groundwater supply. Local supplies were not adequate to meet future demands. These problems generated interest in construction of a storage reservoir on the river and a canal that would be located entirely in the United States.

Under the *Seven Party Agreement* dated August 18, 1931, executed by the California agencies already using or seeking to use Colorado River water, a system of priorities was established that defined certain amounts and places of use for the water. Water delivered to the Coachella Valley via the Coachella Canal is diverted from the Imperial Dam 18 miles upstream from Yuma, Arizona into the All-American Canal. Coachella's supply is then diverted into the 122-mile-long Coachella branch, which extends from near the Mexican border northwestward to Lake Cahuilla near La Quinta. This man-made lake, located at the terminus of the Coachella Canal, serves as a storage reservoir to regulate irrigation water demands and provides opportunity for recreation. The capacity of the Coachella Canal is approximately 1,300 cfs.

Colorado River water delivered to the Coachella Valley is diverted from the Imperial Dam 18 miles upstream from Yuma, Arizona, into the All-American Canal. The CVWD supply is then diverted into the 122-mile-long Coachella Canal, which extends from near the Mexican border northwestward to Lake Cahuilla near La Quinta. The Canal is concrete-lined. The capacity of the Coachella Canal is approximately 1,300 cubic feet per second (cfs) to 1,550 cfs. For a more detailed description of the Coachella Canal, the reader is referred to the Final EIS/EIR for the Coachella Canal Lining Project (USBR and CVWD, 2001).

3.2.6.2 Metropolitan's Colorado River Aqueduct

The Colorado River Aqueduct conveys river water from Lake Havasu to Lake Mathews in western Riverside County. Metropolitan Water District of Southern California completed construction of the aqueduct in 1941. The facility consists of 242 miles of canals, pipelines and tunnels along with five pumping stations that lift Colorado River water over 1,600 feet. The aqueduct has a capacity of 1,800 cfs or 1.3 million AFY. This aqueduct passes along the easterly side of CVWD and crosses the Whitewater River channel north of Palm Springs. The proximity of the aqueduct to the Coachella Valley made it a logical choice for delivering imported water to the valley. Consequently, beginning in 1973, CVWD and DWA commenced a program with Metropolitan to exchange the Valley's SWP water for Colorado River water delivered at Whitewater to avoid the cost of constructing an extension to the California Aqueduct. This exchange program was expanded to the Mission Creek Subbasin in 2002.

3.2.6.3 Salton Sea

The Salton Sea is a terminal body of saline water that occupies the bottom of the Salton Sink, a topographic low located between the Coachella and Imperial Valleys. The Salton Sink is a structural trough formed by the San Andreas fault zone, which filled with sediments from the surrounding mountains and marine deposits from the Gulf of California that inundated the Valley as far north as San Gorgonio Pass. Near the close of the Tertiary period, the Colorado River formed a delta that stopped the marine water invasion. Periodically, the Colorado River would change course over its delta and flow northward into the Coachella Valley, creating a large shallow lake that would exist until the river again changed course. This lake, known originally as Lake LeConte or later as Lake Cahuilla, would occur and disappear periodically flooding as far north as Indio as evidenced by a so-called "bath-tub ring" of travertine deposits on the mountains near La Quinta (DWR, 1964).

The current Salton Sea was formed when flood flows from the Colorado River broke through a temporary canal heading that had been designed to bypass a silted section of the Imperial Canal. The Imperial Canal, which was routed from the Colorado River to the Imperial Valley through Mexico, was completed in 1901, but by 1904, it had become blocked by sediment. A series of high flows from February through April 1905 destroyed the temporary heading resulting in uncontrolled flows into the Salton Basin for the next 18 months. It flooded the railroad line, railroad stations, and the salt works on the basin floor (DeBuys and Myers, 1999). When the breach was finally repaired in 1907, the elevation of the Salton Sea had reached 195 feet below mean sea level (MSL), and had a surface area of 520 square miles. Today, the Salton Sea has a surface elevation of -235 ft below MSL and occupies a surface area of about 365 square miles (233,000 acres) out of the total 8,360 square miles within the watershed (Salton Sea Authority, 2014).

Executive Order of Withdrawal (Public Water Reserve No. 114, California No. 26), signed by the President of the United States on February 26, 1928, withdrew from all forms of entry all public lands of the United States in the Salton Sea area lying below the elevation of 220 feet below sea level for the purpose of creating a reservoir in the Salton Sea for storage of wastes and seepage water from irrigated land in the Coachella and Imperial Valleys (RWQCB, 2014).

3.2.7 Groundwater Quality

Water quality is evaluated in terms of the historical quality of groundwater pumped from wells. Basin-wide groundwater quality is difficult to characterize because groundwater quality varies with such factors as depth (or the screened interval of a water supply well), proximity to faults, presence of surface contaminants, proximity to recharge basins, variable sedimentary characteristics, and other hydrogeologic or cultural features.

Total dissolved solids (TDS) and nitrate water quality data for the Whitewater River Subbasin to be used in SNMP development are summarized in **Table 3-1** and **Table 3-2**, respectively. Note that these tables present all water quality data points without filtering and may not be representative of conditions in the basin. For example, very high TDS appears in the Lower aquifer in Well 07S09E30R01S; this well is located next to the Salton Sea, is screened at a depth of 1,430 to 1,470 feet and is likely reading high salinity due to ancient salt water deposits. TDS and nitrate trends for the Whitewater River Subbasin are shown for select wells in **Appendix A**.

Table 3-1
Summary of Total Dissolved Solids in Whitewater River Subbasin

		Total Dissolved Solids (mg/L)						
Aquifer	**Value**	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-present**
Upper aquifer	**Range**	180 - 3,298	130 - 1,571	148 - 3,200	104 - 1,410	1 - 1,898	135 - 2,320	170 - 1,500
	Average	857	362	513	443	447	647	962
	Median	266	257	360	332	384	683	800
Lower aquifer	**Range**	188 - 427	121 - 1,996	100 - 2,420	108 - 1,130	104 - 19,500	19 - 12,100	140 - 7,100
	Average	313	280	254	238	1,202	847	301
	Median	308	191	183	194	211	227	210

Table 3-2
Summary of Nitrate in Whitewater River Subbasin

		Nitrate (as NO_3) (mg/L)						
Aquifer	**Value**	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-present**
Upper aquifer	**Range**	ND - 142	ND - 110	ND - 97	ND - 143	ND - 145	ND - 190	ND - 260
	Average	5	11	16	10	4	11	27
	Median	1	4	10	4	1	2	3
Lower aquifer	**Range**	ND - 19	ND - 68	ND - 69	ND - 127	ND - 152	ND - 221	ND - 61
	Average	4	4	7	20	8	12	15
	Median	2	2	3	4	3	4	6

ND = non-detect

3.2.7.1 Total Dissolved Solids

During the 1930s, total dissolved solids (TDS) concentrations throughout the Coachella Valley were typically less than 250 mg/L except in localized areas (DWR, 1979). In the 1970s, the groundwater typically contained 300 mg/L TDS in the Upper aquifer and 150 to 200 mg/L TDS in the Lower aquifer (DWR, 1979).

Higher TDS concentrations in the Upper aquifer are typically detected along the Valley margins, particularly in the vicinity of the San Andreas Fault system and in an area southeast of Oasis.

Groundwater in areas south of Indio and east of Mecca also contain higher TDS concentrations. The water quality of the Upper aquifer has decreased since the 1930s.

In general, the Lower aquifer has lower TDS concentrations than the Upper aquifer. TDS concentrations in some areas of the Lower aquifer may more representative of Upper aquifer quality in areas where the Upper and Lower aquifers are merged (e.g., along the western margin of the Valley). Similarly, in other areas adjacent to major faults, the TDS content of the Lower aquifer is greater than 1,000 mg/L TDS. One of these areas is along the fault zone separating the Thousand Palms and Fargo Canyon Subareas from the Thermal Subarea. Along this northern fringe of the basin, near the San Andreas Fault and the presumed extension of the Garnet Hill Fault, the TDS concentrations exceed 1,000 mg/L. Isolated wells near Indio and Coachella exhibit similar TDS concentrations. In portions of the Oasis Subarea, groundwater also ranges from 500 to 1,000 mg/L TDS. Unlike the shallower zones, the TDS concentrations in much of the Lower aquifer have remained relatively constant since the 1930s.

3.2.7.2 Nitrate

Elevated nitrate concentrations have been a relatively localized problem in the Coachella Valley. Nitrate concentrations during the 1930s were typically less than 4 mg/L (as nitrate) throughout the Valley (DWR, 1979). A notable exception was the high nitrate content of some wells in the Palm Desert-Indian Wells area (Huberty, 1948). Huberty, et al. evaluated the source of nitrate and concluded that the area was at one time covered by extensive mesquite forests. Mesquite is known to fix atmospheric nitrogen in its roots and accumulate nitrogen in its leaves and stems. Huberty, et al. discovered high amounts of nitrate in the soils under similar mesquite forests. Under natural conditions, there was insufficient moisture for the leaf and twig litter to decompose. However, when these lands were leveled and irrigated, the organic matter decomposed and nitrates appear to have leached into the shallow groundwater (Huberty, 1948). By the late 1970s, a greater number of wells adjacent to the Whitewater River in this area exhibited elevated nitrate concentrations of more than 45 mg/L (DWR 1979). The area of high nitrate shallow groundwater follows the approximate trace of the Whitewater River from Cathedral City to east of La Quinta. Municipal wells generally avoid this high nitrate groundwater by using deep perforations.

In addition, a cluster of high nitrate concentrations is present northwest of the community of Oasis. These elevated concentrations may be a result of fertilizer use in the unconfined area.

Municipal wells belonging to DWA in Palm Springs have experienced nitrate concentrations above the MCL. Discharges of wastes from individual domestic septic tank/leachfield systems, water recycling, widespread application of fertilizers, and discharges of domestic wastes to evaporation/percolation ponds may be the source of the elevated nitrate. However, it is noted that studies conducted by the University of California, Riverside concluded most nitrogen applied to turfgrass usually stays within the “turfgrass system”. Fertilizer nitrogen applied to a dense, mature and well-maintained turf is normally rapidly used by the turfgrass plant and by soil microorganisms. There appears to be little chance of downward movement of nitrogen, other than on pure sand (Gibeault, et al., 1998). Uptake of nitrogen by managed turf should be addressed in this SNMP and future Basin Plan updates.

3.2.8 Other Potential Constituents of Concern

Key constituents, TDS and nitrate, were discussed in the groundwater quality section above. Listed below are other potential constituents of concern, all of which are naturally occurring.

3.2.8.1 Hexavalent Chromium

Chromium is a heavy metal that occurs throughout the environment. Ultramafic sediments commonly found along the margins of fault systems throughout California contain elevated levels of chromium that are released through natural erosion. In July of 2014, the California Department of Public Health (CDPH) 10 µg/L MCL for hexavalent chromium became effective; hexavalent chromium occurs naturally in the Coachella Valley Groundwater Basin at background levels above the MCL. The extent of hexavalent chromium occurrence in the Coachella Valley Groundwater Basin is well known and is currently a large focus area for water managers and purveyors within the Valley. About half of the public water wells in the Coachella Valley produce water with naturally-occurring hexavalent chromium above the new MCL. As a result of this new regulation, more than half of the groundwater in the Coachella Valley is no longer potable without costly treatment; the cost impact from hexavalent chromium to maintain municipal beneficial use may exceed the combined impact from all the remaining contaminants that occur in the Coachella Valley Groundwater Basin.

3.2.8.2 Fluoride

Fluoride is a naturally-occurring constituent in groundwaters within the Coachella Valley. Wells possessing fluoride levels above the MCL of 2 mg/L are generally limited to two groups of wells in the East Valley and along the fault in the Thousand Palms Subarea. The first group of wells is located to the east of the communities of Indio and Coachella. These concentrations may reflect the influence of the San Andreas Fault Zone, located immediately to the east. The second cluster of wells with elevated fluoride concentrations is located between the communities of Oasis and Mecca.

3.2.8.3 Arsenic

Arsenic is a naturally occurring element found in the earth’s crust. The primary MCL for arsenic is 10 µg/L. Throughout much of the East Valley, from Coachella to Oasis, concentrations of arsenic in the groundwater exceed the MCL. Many of these wells are used for agricultural irrigation. Most of the elevated arsenic concentrations occur in wells perforated solely in the Lower aquifer.

3.3 MISSION CREEK SUBBASIN

The Mission Creek Subbasin is located in the northwestern Coachella Valley in the north-central portion of Riverside County, California. DWR has designated this basin as No. 7-21.02 in Bulletin 118 (DWR, 2003). Groundwater is naturally replenished by subsurface flow from the Desert Hot Springs Subbasin to the north. The Mission Creek Fault and the Banning Fault form the northern and southern boundaries of the subbasin, respectively. Both act to limit groundwater movement as these faults have folded sedimentary deposits, displaced water-bearing deposits, and caused once permeable sediments to become impermeable (DWR, 1964). The main water bearing units of the Mission Creek Subbasin are relatively undisturbed and unconsolidated Holocene and late Pleistocene alluvial deposits. These detritus deposits are eroded from the surrounding San Bernardino and Little San Bernardino Mountains, first as filled topographic depressions and then as deposits on the piedmont alluvial fans. The individual beds are lens shaped and not extensive, but coalesce with other beds to form larger water bearing areas. Hydrogeologic units included in these water-bearing deposits are: Ocotillo conglomerate, Cabazon fanglomerate and Holocene alluvial and sand dune deposits.

The Mission Creek Subbasin is considered an unconfined aquifer with a saturated thickness of 1,200 feet or more and an estimated total storage capacity of approximately 2.6 million AF (DWR, 1964). The volume of groundwater estimated to be in storage for the subbasin is 1.4 million AF (MSWD, 2006). The subbasin is naturally recharged by surface and subsurface flow from the Mission Creek, Dry, and Big Morongo Washes, the Painted Hills, and surrounding mountain drainages. Subsurface flow also occurs across the Mission Creek Fault from the adjacent Desert Hot Springs Subbasin. Return flow from applied water and discharges from municipal and individual subsurface wastewater disposal systems also contribute to recharge.

The principal outflows from the subbasin are groundwater production for municipal and private uses, evapotranspiration and subsurface outflow across the Banning Fault into the Garnet Hill Subbasin. Groundwater generally flows from the northwest to the southeast until about mid-basin where the contour lines curve indicating a southerly flow on the eastern side of the subbasin.

CVWD, DWA, and MSWD jointly manage this subbasin under the terms of the Mission Creek Settlement Agreement (CVWD-DWA-MSWD, 2004). This agreement and the 2014 Mission Creek Groundwater Replenishment Agreement between CVWD and DWA specify that the available SWP will be allocated between the Mission Creek and Whitewater River Subbasins in proportion to the amount of water produced or diverted from each subbasin during the preceding year (CVWD-DWA, 2003). In 2009, production from the Mission Creek Subbasin was about 7 percent of the combined production from these two subbasins. A water management plan was prepared for the Mission Creek and Garnet Hill Subbasins in 2013 (MWH, 2013).

3.3.1 Surface Water Hydrology

Surface water flow in the Study area consists of ephemeral or intermittent streams that originate in the San Bernardino and Little San Bernardino mountains. Mission Creek is the only stream that flows to the valley floor on a consistent basis, but the stream usually disappears underground a short distance from its entrance into the Study area. The only stream gauge currently operated by the USGS in the Study area is on Mission Creek. Based on 44 years of record (1967-2011), this creek has an average annual streamflow of 2,160 AFY. Streams flowing through Morongo Valley, Big Morongo, Little Morongo, and Long Canyon periodically reach the valley floor for short periods when there are localized, intense storms in the mountains (Mayer and Mays, 1998). Investigations conducted for the Mission Creek-Garnet Hill Water Management Plan concluded the natural inflow to the Mission Creek Subbasin averages about 7,500 AFY (Psomas, 2013). None of the surface flow from the local watercourses is used directly for municipal, industrial, or agricultural uses in the Study area.

3.3.2 Groundwater Level

DWR Bulletin 118 identifies the Mission Creek Subbasin to be in an overdraft condition. However, since the commencement of the groundwater recharge program at the Mission Creek Spreading Facility, groundwater levels have generally stabilized in the Mission Creek Subbasin. Groundwater level increases in the Mission Creek Subbasin are observed in areas closer to the Mission Creek Recharge Facility as compared to the locations of the groundwater production wells.

The San Andreas Fault system has a dramatic impact on groundwater levels in the subbasin. Previous studies have shown that the various faults that make up the fault system act as partially effective barriers to groundwater flowing from north to south through the area. Groundwater levels and at times groundwater temperatures on either side of the fault trace are significantly different. Groundwater levels are generally higher on the northeast side of the fault because of its barrier effect, to the extent that springs have been recorded on the north. Thus, the groundwater levels within the Mission Creek Subbasin are generally higher in the southern portion of the subbasin than the northern portion of the subbasin because of the influence of the Banning Fault. On the other hand, groundwater temperatures in the subbasin are generally higher to the north because of the influence of the Desert Hot Springs Subbasin (GSi/water, 2005; URS, 2006).

In 1936, groundwater pumping in the subbasin was significantly lower than current conditions and groundwater is believed to have flowed under generally natural conditions. Water levels in the Mission Creek Subbasin have been declining since the early 1950s due to scarce annual precipitation and groundwater extractions (DWR, 2003). Valley-wide groundwater level data indicate that since 1952, water levels have declined at a rate of 0.5 to 1.5 feet per year (CVWD, 2000). MSWD monitoring data indicates a rate of decline of about 3 feet per year between 1999 and 2007.

Groundwater levels in the subbasin have increased since 2003 as a result of the artificial recharge activities (including normal and advanced deliveries) coupled with reduced pumping. Wells in the subbasin have shown varying responses to recharge. Water levels in a MSWD well located 0.5 mile south of the recharge facility responds similarly to the DWA monitoring well located at the recharge facility, increasing as much as 250 ft since 2004. However, MSWD wells located 1.2 miles south and 1.1 miles to the southeast show 20 and 50 ft increases, respectively. Prior to recharge, water levels in these two wells were 200 ft lower than levels near the recharge facility. The difference in level is now more than 400 ft. These differences in basin response may be the result of mounding near the recharge facility, a previously unknown geologic structure (fault or change in bedrock depth), insufficient transmissivity near the recharge facility or a combination of these factors (Psomas, 2013). Water levels in a CVWD well located 4.4 miles southeast of the recharge facility shows a 4 ft increase since 2004. Continued monitoring and investigation near the recharge facility may explain these observations.

3.3.3 Groundwater Quality

In general, groundwater quality for the Mission Creek Subbasin meets all current drinking water standards except for the newly established limit for hexavalent chromium. A review of historical and recent water quality data indicates that the parameters that have exceeded either primary or secondary drinking water standards within the groundwater basins in the Study area include TDS, nitrate, hexavalent chromium, uranium, and gross alpha.

TDS and nitrate water quality data for the Mission Creek Subbasin to be used in SNMP development are summarized in **Table 3-3** and **Table 3-4**, respectively. Note that these tables present all water quality data points without filtering and may not be representative of conditions in the basin. TDS and nitrate trends for the Mission Creek Subbasin are shown for select wells in **Appendix A**.

Table 3-3
Summary of Total Dissolved Solids in Mission Creek Subbasin

	Total Dissolved Solids (mg/L)						
Value	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-current**
Range	300 - 910	173 - 1,087	176 - 880	374 - 478	278 - 1,096	270 - 1,100	300 - 540
Average	597	561	539	423	501	520	412
Median	607	527	455	425	445	458	420

Table 3-4
Summary of Nitrate in Mission Creek Subbasin

	Nitrate (as NO_3) (mg/L)						
Value	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-current**
Range	ND - 5	ND - 9	ND - 14	1 - 39	ND - 67	ND - 86	ND - 8
Average	1	2	3	7	8	32	4
Median	1	1	2	5	5	6	4

ND = non-detect

3.3.3.1 Total Dissolved Solids

In general, TDS concentrations in groundwater improve across the Mission Creek Subbasin towards the Garnet Hill Fault. Wells located closer to the Garnet Hill Subbasin have TDS concentrations ranging between 300 mg/L and 400 mg/L. Wells located closer to the Desert Hot Springs Subbasin have higher TDS concentrations ranging between 400 mg/L and 500 mg/L. Wells in the southeastern portion of the subbasin show TDS concentrations as high as over 1,000 mg/L; this could be due to the flow of mineralized water from Desert Hot Springs Subbasin.

3.3.3.2 Nitrate

Generally, nitrate exists in the unsaturated and shallow aquifer zones above 300 to 400 feet below ground surface, and has not been observed in the deeper aquifer zones below 500 feet. Activities in the basin that could cause nitrate to leach into higher quality groundwater include recharge, pumping, and overdraft reduction. A study conducted by MSWD to assess groundwater quality indicates that the use of septic tanks for waste disposal is a primary contributor of high nitrates to the groundwater (GSi/water, 2011). Nitrate concentrations are below the MCL for all recorded public water supply samples in the Mission Creek Subbasin; however, several private wells have recorded nitrate exceeding the MCL. In general, no trends are observed with regards to nitrate concentrations over time.

3.3.4 Other Potential Constituents of Concern

Key constituents, TDS and nitrate, were discussed in the groundwater quality section above. Listed below are other potential constituents of concern, most of which are naturally occurring.

3.3.4.1 Hexavalent Chromium

Hexavalent chromium is detected in several groundwater wells in the Mission Creek Subbasin. It has been detected in MSWD and CVWD wells above the 10 µg/L MCL. The extent of naturally-occurring hexavalent chromium in the Coachella Valley Groundwater Basin is well known and is currently a large focus area for water managers and purveyors within the Valley. Currently, hexavalent chromium is the contaminant having the greatest impact on beneficial uses in the Valley.

3.3.4.2 Arsenic

Arsenic occurs naturally in the Coachella Valley and is detected in several groundwater wells in the Mission Creek Subbasin. Some CVWD monitoring wells indicate the presence of arsenic with concentrations above the 10 µg/L MCL. These elevated arsenic levels are found toward the southeastern portion of the subbasin close to the faults. Arsenic concentrations for production well samples collected since 1981 have remained below the MCL. Samples collected for MSWD wells in 2008 do not indicate the presence of arsenic.

3.3.4.3 Fluoride

Fluoride is present at elevated levels in the Mission Creek Subbasin in the southeastern portion of the subbasin. Concentrations have ranges from 0.2 to 9.9 mg/L. Fluoride is a naturally-occurring constituent in groundwaters within the Coachella Valley.

3.3.4.4 Radionuclides

Radionuclides are elements that emit radioactivity and may be naturally-occurring or artificially produced. The principal radionuclides of concern for the subbasin are uranium and gross alpha.

Uranium found in the Mission Creek Subbasin is naturally-occurring. The primary MCL for uranium is 20 picocuries/liter (pCi/L) based on a four-quarter average. Uranium is detected in several groundwater wells in the Mission Creek Subbasin. For samples collected in 2008, the presence of uranium was detected in MSWD wells. One MSWD well had uranium concentrations in excess of the primary MCL and was removed from service. Well-head treatment currently exists for uranium removal at select MSWD wells. Uranium was also detected in CVWD wells with concentrations below the MCL.

Gross alpha occurs naturally in drinking water sources, since it is present in the geologic formations of the groundwater basin. The primary MCL for gross alpha is 15 pCi/L based on a four-quarter average. For groundwater samples obtained in 2008, two MSWD wells exceeded the MCL for gross alpha with recorded samples having a concentration of 16 pCi/L, but none of the wells exceeded the four-quarter average MCL of 15 pCi/L at this time.

3.4 GARNET HILL SUBBASIN

The area between the Garnet Hill Fault and the Banning Fault, named the Garnet Hill Subarea by DWR (DWR, 1964), was considered a distinct subbasin by the USGS (Tyley, 1974) because of the effectiveness of the Banning and Garnet Hill Faults as barriers to groundwater movement. The Garnet Hill Fault is a branch of the San Andreas Fault system consisting of a series of northwest-trending right-lateral faults with active folds at each *en echelon* step. These folds are exhibited a series of small hills (West Whitewater Hill, East Whitewater Hill, Garnet Hill, Edom Hill, and several small unnamed hills) between each fault segment (Yule and Sieh, 2003). This is illustrated by a difference of 170 feet in groundwater level elevation in a horizontal distance of 3,200 feet across the Garnet Hill Fault, as measured in the spring of 1961. This subbasin is considered part of the Whitewater River (Indio) Subbasin in DWR Bulletin 118 (2003); however, CVWD and DWA consider it a separate subbasin based on the USGS findings and water level observations. In 1964 when the initial DWR evaluation was conducted, it was observed that limited data existed to characterize the hydrogeology of this subbasin (DWR, 1964).

The Garnet Hill Subbasin is considered an unconfined aquifer with a saturated thickness of 1,000 feet or more based on well depths and has an estimated total storage capacity on the order of 1.0 million AF. The subbasin is naturally recharged by subsurface flow from the Mission Creek Subbasin and runoff from the Whitewater River watershed on the west. Irrigation return flow and discharges from municipal and individual subsurface wastewater disposal systems also contribute to recharge but is considered very small.

Although some recharge to this subbasin may come from Mission Creek and other streams that pass through during periods of high flood flows, the main sources of recharge to the subbasin are channel infiltration and subsurface flow in the Whitewater River, subsurface flow through the semi-permeable deposits which underlie Whitewater Hill and from subsurface flow across the Banning Fault from the Mission Creek Subbasin. In general, there is subsurface flow from the Garnet Hill Subbasin across the Garnet Hill Fault to the Whitewater River Subbasin westerly of the Garnet Hill outcrop. Based on groundwater level measurements, this area is partially influenced by artificial recharge activities at the Whitewater Spreading Facilities at Windy Point.

3.4.1 Surface Water Hydrology

The lower reaches of Mission Creek and Morongo Wash flow across the Garnet Hill Subbasin and are believed to contribute to recharge primarily through subsurface flows. The Whitewater River appears to contribute significant recharge to of the Garnet Hill Subbasin through subsurface flow in the alluvial channel across the Banning Fault and through the semi-permeable deposits that underlie the Whitewater Hill (GSi/water, 2005). Much of this water flows across the Garnet Hill Fault into the Whitewater River Subbasin.

3.4.2 Groundwater Levels

The Garnet Hill Subbasin has groundwater elevations approximately 200 to 250 feet lower than the Mission Creek Subbasin along the Banning Fault indicating that the groundwater flow is partially restricted by the Banning Fault (DWR, 1964). Groundwater in the Garnet Hill Subbasin flows to the east-southeast until the southeastern end of the subbasin where groundwater flow direction turns south and presumably discharges into the Upper Whitewater River Subbasin across the Garnet Hill Fault. The outcropping Garnet Hill appears to create a partial flow restriction that affects movement of groundwater to the southeastern portion of the subbasin.

The upper portion of the Whitewater River Subbasin has groundwater elevations approximately 150 feet to 200 feet lower than what is observed in the Garnet Hill Subbasin, indicating that groundwater flow is partially restricted by the Garnet Hill Fault. Groundwater in the Whitewater River Subbasin flows in an east to southeast direction towards the Salton Sea.

Measured groundwater levels in portions of the Garnet Hill Subbasin have shown a response to recharge activities in the Whitewater River Subbasin (MWH, 2013) Water levels in Whitewater River Subbasin wells near the recharge basins (03S04E20K01S and 03S04E29R01S) show rapid response to increased recharge (gray line). Wells in the western portion the Garnet Hill Subbasin ((03S04E17K01S and 03S04E22A01S) also show response to larger recharge events as in 1984-86, 1996-2001, 2005-06 and 2010-12). Water levels in the central portion of the subbasin (03S04E13N01S/N02S and 03S04E14J01S) show a more muted and delayed response to the largest recharge events; while the well in the eastern portion of the subbasin (03S04E30G01S) shows minimal response. These data show a 250 ft gradient between the northwest and southeast portions of the subbasin. Monitoring of additional wells would provide a better picture of basin response and long-term water level trends.

3.4.3 Groundwater Quality

Information available on groundwater quality for the Garnet Hill Subbasin is limited. In several cases, for a given year data is available only at a single well. The available data are not sufficient to make any meaningful conclusions about temporal or spatial distribution of water quality constituents in the subbasin. This is a significant data gap for the Garnet Hill Subbasin.

TDS and nitrate water quality data for the Garnet Hill Subbasin to be used in SNMP development are summarized in **Table 3-5** and **Table 3-6Table 3-4**, respectively. Note that these tables present all water quality data points without filtering and may not be representative of conditions in the basin. TDS and nitrate trends for the Garnet Hill Subbasin are shown for select wells in **Appendix A**.

Table 3-5
Summary of Total Dissolved Solids in Garnet Hill Subbasin

	Total Dissolved Solids (mg/L)						
Value	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-current**
Range	164 - 219	157 - 933	190 - 217	-	156 - 390	186 - 376	-
Average	184	246	209	-	261	276	-
Median	181	211	211	-	255	278	-

Table 3-6
Summary of Nitrate in Garnet Hill Subbasin

	Nitrate (as NO_3) (mg/L)						
Value	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-current**
Range	ND – 5	ND - 5	ND - 3	7 - 7	ND - 5	ND - 14	-
Average	1	2	1	7	3	4	-
Median	1	1	1	7	2	3	-

ND = non-detect

3.4.3.1 Total Dissolved Solids

Historically, recorded TDS concentrations at different groundwater wells in the Garnet Hill Subbasin have ranged from a low of 156 mg/L to a high of 933 mg/L. TDS is generally low with averages below 300 mg/L. No significant trends are observed with regard to TDS concentrations over time.

3.4.3.2 Nitrate

In general, nitrate concentrations are relatively low with no MCL exceedances. Groundwater quality within the Garnet Hill Subbasin is suitable for domestic water use and meets current drinking water standards. No trend is observed for nitrate concentrations over time.

3.4.4 Other Potential Constituents of Concern

Key constituents, TDS and nitrate, were discussed in the groundwater quality section above. Listed below are other potential constituents of concern, most of which are naturally occurring.

3.4.4.1 Arsenic

Arsenic was detected in 1993 and 1999 at or above the MCL of 10 µg/L. Arsenic was not detected in samples collected in 2008.

3.4.4.2 Radionuclides

Samples collected in 2008 indicate the presence of uranium; however, the concentrations are below the primary MCL of 20 pCi/L.

3.5 DESERT HOT SPRINGS SUBBASIN

The Desert Hot Springs Subbasin is located adjacent to the Mission Creek and Whitewater River Subbasins and trends northwest-southeast along the foothills of Joshua Tree National Park. DWR Bulletin 118 (2003) has designated this subbasin as No. 7-21.03. The Desert Hot Springs Subbasin is bounded on the north by the Little San Bernardino Mountains and to the southeast by the Mission Creek and San Andreas Fault. The San Andreas Fault separates the Desert Hot Springs Subbasin from the Whitewater River Subbasin and serves as an effective barrier to groundwater flow. The subbasin has been divided into three subareas: Miracle Hill, Sky Valley, and Fargo Canyon. The subbasin is bounded on the southwest by the Banning and Mission Creek Faults and the semipermeable rocks of the Indio Hills. These faults act as groundwater barriers and direct the groundwater in a southeast direction. Hot thermal springs occur on the Mission Creek Fault and have been actively pumped for over 50 years. The subbasin is comprised of late Pleistocene and Holocene alluvium, coarse sand and gravel (DWR, 2003). Thermal mineral waters occur near active faults such as the Mission Creek Fault in the Miracle Hill subarea where the groundwater is used to supply local resorts.

The Desert Hot Springs Subbasin has little residential, industrial, or agricultural development with exception to the community of Desert Hot Springs; residential communities exist within the Sky Valley Subarea, and Indio Hills. The Miracle Hill subarea underlies portions of the City of Desert Hot Springs and is characterized by hot mineralized groundwater, which supplies a number of spas in that area. The Sky Valley Subarea underlies the central portion of the subbasin and is separated from the Fargo Canyon Subarea by the Indio Hills Fault. There is sparse data on this subarea. The Fargo Canyon Subarea underlies a portion of the study area along Dillon Road north of Interstate 10. This area is characterized by coarse alluvial fans and stream channels flowing out of Joshua Tree National Park. Based on limited groundwater data for this area, flow is generally to the southeast. Sand and gravel mining operations currently exist and urban development has been proposed within the Fargo Canyon Subarea.

3.5.1 Surface Water Hydrology

Long Canyon Creek and the Little Morongo Creek provide recharge in the Desert Hot Springs Subbasin. Other tributaries including those from the Painted Hills, White House Canyon, Midway Canyon, Blind Canyon, Long Canyon, and North Short Canyon appear to contribute much smaller amounts of water. DWR (1964) estimates that amount of seasonal tributary runoff into the Desert Hot Springs Subbasin to be roughly 2,900 AFY, while GSi/water (2005) estimated that these canyons may provide up to 2,200 AFY in groundwater recharge. Previous investigations indicated the amount of recharge contributed through these canyons is negligible compared to the recharge from the major canyons within the Valley (Tyley, 1974). Subsurface outflow from the Miracle Hill Subarea to the Mission Creek Subbasin is estimated to be about 1,800 AFY (Psomas, 2013).

3.5.2 Groundwater Levels

A lack of historic data together and the scarcity of wells outside the Miracle Hill Subarea prevent rigorous analyses of fluctuations and trends of the water table within Desert Hot Springs.

However, the available data suggest that water levels remain relatively unchanged except for a decline in water levels in the Miracle Hill Subarea (DWR, 1964).

3.5.3 Groundwater Quality

Limited water quality data is available, but from the few records reviewed the water quality is typically poor. This water quality has limited the use of this subbasin for groundwater supply (CVWD, 2014). Hot water wells, by the city of Desert Hot Springs, in the subbasin along the Mission Creek Fault, have groundwater temperatures averaging 118°F (DWR, 1964).

TDS and nitrate water quality data for the Desert Hot Springs Subbasin to be used in SNMP development are summarized in **Table 3-7** and **Table 3-8**, respectively. Note that these tables present all water quality data points without filtering and may not be representative of conditions in the basin. TDS and nitrate trends for the Desert Hot Springs Subbasin are shown for select wells in **Appendix A**.

Table 3-7
Summary of Total Dissolved Solids in Desert Hot Springs Subbasin

Value	Total Dissolved Solids (mg/L)						
	< 1961	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-current
Range	774 - 1,340	378 - 1,410	368 - 1,150	161 - 1,160	394 - 845	240 - 2,200	390 - 2,100
Average	1,008	916	834	827	521	1,384	1,377
Median	982	955	873	1,160	440	1,500	1,400

Table 3-8
Summary of Nitrate in Desert Hot Springs Subbasin

Value	Nitrate (as NO_3) (mg/L)						
	< 1961	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-current
Range	ND - 5	ND - 65	ND - 30	ND - 2	ND - 6	ND - 101	2 - 86
Average	1	3	4	1	3	19	18
Median	ND	1	1	ND	4	11	14

ND = non-detect

3.5.3.1 Total Dissolved Solids

TDS within the Desert Hot Springs Subbasin is among the highest in the Coachella Valley. Naturally-occurring high TDS groundwater exists upwards of 2,000 mg/L. This hot mineral water is pumped for use in spas or domestic use. High concentrations of TDS in the groundwater throughout the subbasin limits agricultural or domestic water resources (CVWD, 2000). No trend is observed with regard to TDS concentration over time.

3.5.3.2 Nitrate

In general, nitrate is not a large concern in the Desert Hot Springs Subbasin. Monitoring wells in Fargo Canyon Subarea have shown some high levels of nitrate exceeding the MCL after 2001. No trend is observed with regard to nitrate concentration over time.

3.5.4 Other Potential Constituents of Concern

Key constituents, TDS and nitrate, were discussed in the groundwater quality section above. Sulfate is another potential constituent of concern that is naturally occurring.

3.5.4.1 Fluoride

Fluoride is present at elevated levels in the Desert Hot Springs Subbasin. These concentrations may reflect the influence of the San Andreas Fault Zone. Fluoride is a naturally-occurring constituent in groundwaters within the Coachella Valley.

3.5.4.2 Arsenic

Naturally-occurring arsenic is found at elevated levels within the Desert Hot Springs Subbasin. The primary MCL for arsenic is 10 µg/L.

4 Preliminary Data Review

This section reviews and summarizes the data gathered to date. This includes an initial review of data pertaining to AWQ calculation as well as a brief discussion on salt and nutrient loading data requirements.

4.1 DATA REQUIREMENTS

SNMP development requires several datasets to determine current water quality within the basin as well as current and projected salt and nutrient loading. The Policy states that basin or subbasin assimilative capacity must be provided as a component of the SNMP. The SNMP will describe a process to evaluate new recycled water projects and a large consideration will be the ability for the Basin to absorb the salt and nutrient impacts these projects will have, the assimilative capacity. The assimilative capacity of a particular area of the groundwater basin or subbasin is determined as the difference between the water quality objective and the current water quality conditions, i.e., the AWQ.

For the methods described in Section 5, in addition to historical water quality data, basin hydrogeology is taken into consideration. Effective porosity, aquifer geometry, and groundwater levels are helpful together with groundwater quality to better approximate AWQ.

To develop salt and nutrient loading trends, the following data and reports are useful: water supply plans, groundwater production, waste discharge water quality, groundwater flow and drain flows, imported water and recharge operation, and water user waste increments.

4.2 DATA SOURCES

Groundwater quality, groundwater level, annual production, water supply plan, and disposal plan data were requested directly from CVWD, DWA, IWA, and CWA, to be used together with existing MSWD data. GeoTracker Groundwater Ambient Monitoring and Assessment (GAMA) data were retrieved to augment groundwater quality data with careful attention to removing duplicate records; GeoTracker GAMA provides access to digitized records of groundwater quality from multiple sources of well sample records across California. Additional groundwater production records were gathered from SWRCB and Psomas. General well information was collected from the agencies (i.e., well locations, status, screened interval, owner), as well as drain flows and quality, Coachella Valley Stormwater Channel flows and quality, and Coachella Canal water quality for varying periods of record from CVWD. Additional data to fill gaps is being collected from water and wastewater agencies in the Valley.

4.2.1 Groundwater Models

Two groundwater models were obtained for quantifying the vertical and horizontal extent of the groundwater systems. These models cover the Whitewater, Garnet Hill, and Mission Springs subbasins. CVWD (Fogg *et al.*, 2002) developed a groundwater model of the Whitewater and Garnet Hill Subbasins as part the 2002 Water Management Plan (MWH, 2002). The geometry (cell size, layering, and orientation) for this model was used as the base for the recently completed Mission Creek and Garnet Hill Subbasins groundwater model. These models can be used as the basis for AWQ. A summary of model characteristics is listed by subbasin in **Table 4-1**. Average layer depth and thickness by subbasin is shown on **Table 4-2**. The layering of these groundwater models was based on a best estimate of basin lithologic characteristics. The layering is used to categorize areas of the aquifer, e.g., perched aquifer, deep aquifer. When evaluating groundwater quality, well screen intervals are used to categorize a well into a particular model layer. This allows for a general quantification of measurements and quality with depth.

Table 4-1
Groundwater Model Characteristics for Mission Creek, Garnet Hill, and Whitewater River Subbasins

Model Characteristic	Mission Creek Subbasin[1]	Garnet Hill Subbasin[1]	Whitewater River Subbasin[2,3]
Calibration Period	1936-2009		1936 - 1996
Model Domain	75 rows x 86 columns		270 rows x 86 columns
Cell Size	1,000 feet x 1,000 feet		1,000 feet x 1,000 feet
Layers	4		4
Active Cells	12,360		48,396
Storage Coefficient	0.08 to 0.18		0.06 to 0.13

1. Psomas, 2013
2. Fogg *et al*., 2002.
3. The CVWD model was developed with the idea that it could be expanded to encompass the Mission Creek and Desert Hot Springs subbasins. However, the cells for those subbasins were left inactive in the original model.

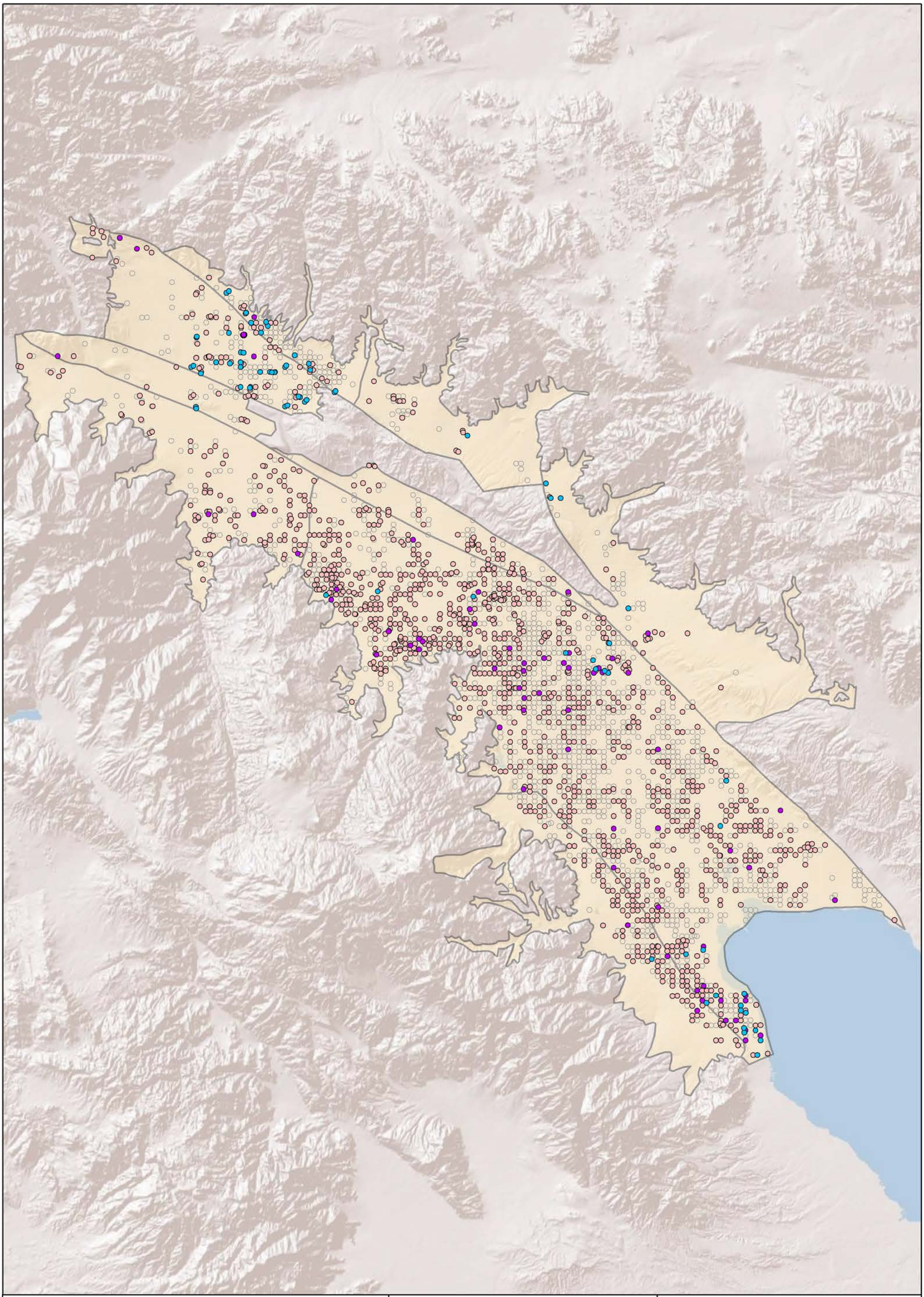
Table 4-2
Groundwater Model Average Layer Depth and Thickness by Subbasin

Subbasin	Layer Depth and Thickness (feet below ground surface)			
	Layer 1	Layer 2	Layer 3	Layer 4
Whitewater River	0 - 190	190 - 300	300 - 410	410 - 1,270
Mission Creek	0 - 810	810 - 880	880 - 960	960 - 1,290
Garnet Hill	0 - 730	730 - 800	800 - 870	870 - 1,340
Desert Hot Springs	0 - 480	480 - 590	590 - 700	700 - 1,360

At the June 4, 2014 stakeholder meeting, stakeholders were encouraged to provide additional data that might contribute to the SNMP development process.

4.2.2 Groundwater Quality Data

Groundwater quality data comes from a total of 1,909 wells in the Coachella Valley. These wells are illustrated on **Figure 4-1**. The overwhelming majority of wells for which there are groundwater quality data are located in the Whitewater River Subbasin. A summary of total wells and those with water quality within the Basin including percentage with depth information is shown on **Table 4-3**.



Key to Features

- ● TDS Data
- ● Nitrate Data
- ○ TDS and Nitrate Data
- ○ No TDS or Nitrate Data
- ▭ Groundwater Basin

N

0 5 10 Miles

Document: \\USIRV1S01\Projects\Coachella Valley WD\SNMP\GIS_files\wells.mxd

Date: 7/25/2014

Water Quality Data Availability by Well

MWH

Figure 4-1

Table 4-3
Summary of Known Groundwater Wells[1] by Subarea

Subbasin Subarea	**Wells**		**Wells with Water Quality Data**	
	Count	**Percent of Wells with Screen Interval Records**	**Count**	**Percent of Wells with Screen Interval Records**
Whitewater River	**4,481**	**58**	**1,701**	**69**
Oasis	298	58	149	70
Palm Springs	301	45	133	59
Thermal	3,755	59	1,369	70
Thousand Palms	127	58	50	66
Mission Creek	**326**	**64**	**115**	**41**
Garnet Hill	**37**	**59**	**17**	**53**
Desert Hot Springs	**412**	**71**	**76**	**38**
Fargo Canyon	60	62	20	**45**
Miracle Hill	313	73	38	29
Sky Valley	39	62	18	50
Total	**5,256**	**59**	**1,909**	**66**

Note: This summary includes all wells known from data received and gathered. This table does not imply that these wells are still active production or monitoring wells. Well screen data allows for water quality evaluation with depth.

1. Wells, in this context, are not necessarily unique; e.g., if two datasets include records from the same well but use different well identifiers that cannot be linked by either recognition of duplicate, overlapping records or some other reference, they are shown as two distinct wells.

Whitewater River Subbasin groundwater quality data include records from 1927 to 2013. In addition, records from the GeoTracker GAMA database, including data from CDPH, USGS, groundwater monitoring from cleanup sites, and the Department of Pesticide Regulation for both monitoring and supply wells, were retrieved and duplicate data points were filtered out. These data consist of 22,264 of groundwater quality records within the Whitewater River Subbasin. Of these, 16,027 records are from wells located within the Thermal Subarea, 4,225 from the Palm Springs Subarea, 1,814 from the Oasis Subarea, and the remaining 198 records from the Thousand Palms Subarea. The majority of the available groundwater quality records in this dataset exist between 1990 and 2010.

Groundwater quality data for Desert Hot Springs Subbasin include records from 1950 to 2013. In addition, records from the GeoTracker GAMA database were retrieved and duplicate data points were filtered out. These data consist of 954 groundwater quality records within the Desert Hot Springs. Of these records, 605 are from wells located within the Fargo Canyon Subarea, 330 from the Miracle Hill Subarea, and the remaining 19 records from the Sky Valley Subarea. The majority of the available groundwater quality records in this dataset exist between 1960 and 2013, with significant gaps between 1980 and 2000. It is expected that more data will be needed to determine ambient water quality within Desert Hot Springs, specifically within the Sky Valley Subarea. **Table 4-4** and **Table 4-5** summarize the number of TDS and nitrate records by period and subarea, respectively.

Table 4-4
TDS Records by Period and Subbasin/Subarea

Subbasin Subarea	**< 1960**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2009**	**2010-current**	**Total**
Whitewater River	**157**	**968**	**1,257**	**1,384**	**1,971**	**2,420**	**625**	**8,782**
Oasis	0	31	33	90	263	704	179	1,300
Palm Springs	26	273	384	626	660	344	134	2,447
Thermal	120	621	800	647	1,036	1,359	303	4,886
Thousand Palms	11	43	40	21	12	13	9	149
Garnet Hill	**8**	**48**	**12**	**0**	**5**	**15**	**0**	**88**
Mission Creek	**45**	**281**	**97**	**14**	**48**	**50**	**13**	**548**
Desert Hot Springs	**30**	**146**	**61**	**3**	**7**	**147**	**103**	**497**
Fargo Canyon	0	4	7	1	1	143	98	254
Miracle Hill	30	126	53	0	6	3	1	219
Sky Valley	0	16	1	2	0	1	4	24
Total	**240**	**1,443**	**1,427**	**1,401**	**2,031**	**2,632**	**741**	**9,915**

Table 4-5
Nitrate Records by Period and Subbasin/Subarea

Subbasin Subarea	**< 1960**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2009**	**2010-current**	**Total**
Whitewater River	**253**	**1,030**	**1,175**	**1,208**	**2,867**	**4,831**	**1,484**	**12,848**
Oasis	0	39	33	84	287	723	151	1,317
Palm Springs	65	283	271	259	836	664	232	2,610
Thermal	176	665	835	845	1,731	3,425	1,089	8,766
Thousand Palms	12	43	36	20	13	19	12	155
Garnet Hill	**8**	**53**	**12**	**1**	**4**	**15**	**0**	**93**
Mission Creek	**68**	**249**	**94**	**14**	**79**	**261**	**45**	**810**
Desert Hot Springs	**37**	**129**	**51**	**3**	**10**	**166**	**131**	**527**
Fargo Canyon	0	3	4	1	1	143	99	251
Miracle Hill	37	113	47	0	9	22	28	256
Sky Valley	0	13	0	2	0	1	4	20
Total	**366**	**1,461**	**1,332**	**1,226**	**2,960**	**5,273**	**1,660**	**14,278**

4.2.2.1 Vertical Distribution of Groundwater Quality Data

Groundwater quality can vary by both well location and depth. The extent to which wells and water quality can be classified by depth is a function of available perforated interval data and distinct zone or aquifer sampling. Typically, production wells are perforated in aquifer zones that are expected to provide the best production rates and water quality. Zones of known poor water quality are usually avoided. Wells are not usually perforated within distinct aquifers; instead, they may be perforated across multiple aquifer zones. This results in a pumped water quality that is a blend of the waters from each aquifer zone or perforated interval. In the absence of sampling from distinct aquifer zones, water quality classification by depth is difficult.

Well screen intervals may allow an evaluation of water quality with depth. Based on a review of available well data as summarized in **Table 4-3**, about one-third of all wells with water quality data have no known screened intervals. As discussed above, many of the wells with known screened intervals appear are perforated across multiple zones, making classification by aquifer difficult.

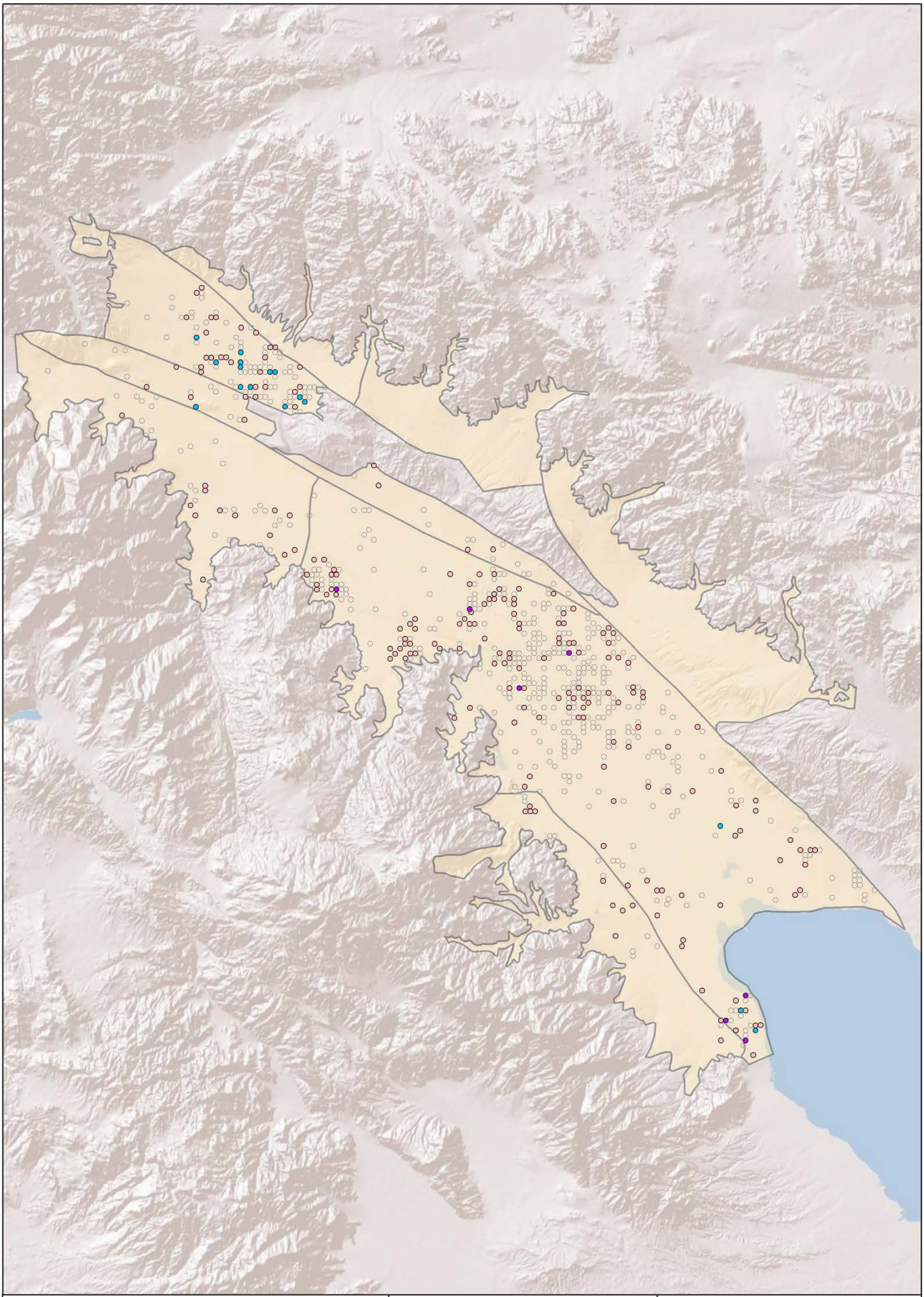
Another potential approach for assessing water quality by depth is to use information from the available groundwater models to classify wells by aquifer zone based on their location. Both groundwater models utilized four vertical layers to separate lithologic zones of differing flow parameters, or hydrostratigraphic units. Within the two models, wireline logs and drillers logs were used to determine the percentage of coarse material and clay to discretize the model layers (Psomas, 2013, Fogg *et al.*, 2002).

Fogg *et al.* (2002) used conceptual hydrogeologic data from earlier reports, notably DWR Bulletin 108 (1964) and USGS (Tyley, 1974; Swain, 1978. and Reichard and Meadows, 1992) that described areas containing multiple aquifers within the Whitewater River Subbasin. In the East Valley, the four layers represent the Semi-perched aquifer (Layer 1), the Upper aquifer (Layer 2), an aquitard zone (Layer 3), and the Lower aquifer (Layer 4). Isolated areas of multiple aquifer systems are also present from Cathedral City to Indian Wells in the West Valley (Fogg *et al.*, 2002). Outside of these multiple aquifer zones, the four model layers have no particular hydrogeologic significance, but the layering allows computation of vertical flow. The majority, if not all, of the groundwater pumping comes from model Layers 2 and 4.

Within the Mission Creek and Garnet Hill Subbasins, distinct hydrostratigraphic zones do not exist. The four layers used in the original CVWD model were maintained to permit potential basin-wide use of the model. For the Mission Creek and Garnet Hill Subbasins, a total aquifer thickness of 1,000 feet was used. Toward the Little San Bernardino Mountains, the 1,000 feet thickness was reduced due to rise in the basement bedrock. The minimum aquifer thickness in the upper reaches of the Mission Creek subbasin was approximately 700 feet (Psomas, 2013).

The model layers may allow grouping of wells by depth to quantify where records are plentiful and where there are data gaps. **Figure 4-2** and **Figure 4-3** show the wells with water quality records in model Layers 1 through 3 and Layer 4, respectively. **Figure 4-4** and **Figure 4-5** show the median concentrations for TDS and nitrate (as nitrate) with depth, i.e., model layers, respectively; note that these figures show median concentrations for each well's entire history of record and only wells screened strictly in model Layers 1 through 3 or Layer 4 are shown (wells with no screened interval data are not shown). Additional evaluation of well construction and water quality data may allow additional classification of wells by either depth or aquifer zone. This will be evaluated in TM-2.

Limited recent monitoring data exist within the Semi-perched aquifer (Layer 1 in the groundwater model). DWR and CVWD collected samples from a series of shallow piezometers (less than 100 ft) in 1975 (DWR, 1979). This sampling indicated electrical conductivity ranging from 620 to over 12,000 microsiemens per centimeter. The current status of these piezometers is unknown; no data on these piezometers exist within the current well database. The only water quality data that may represent the Semi-perched aquifer is surface quality for CVWD's drain system.



Key to Features

- ● TDS Data
- ● Nitrate Data
- ● TDS and Nitrate Data
- ○ No TDS or Nitrate Data
- ▭ Groundwater Basin

N

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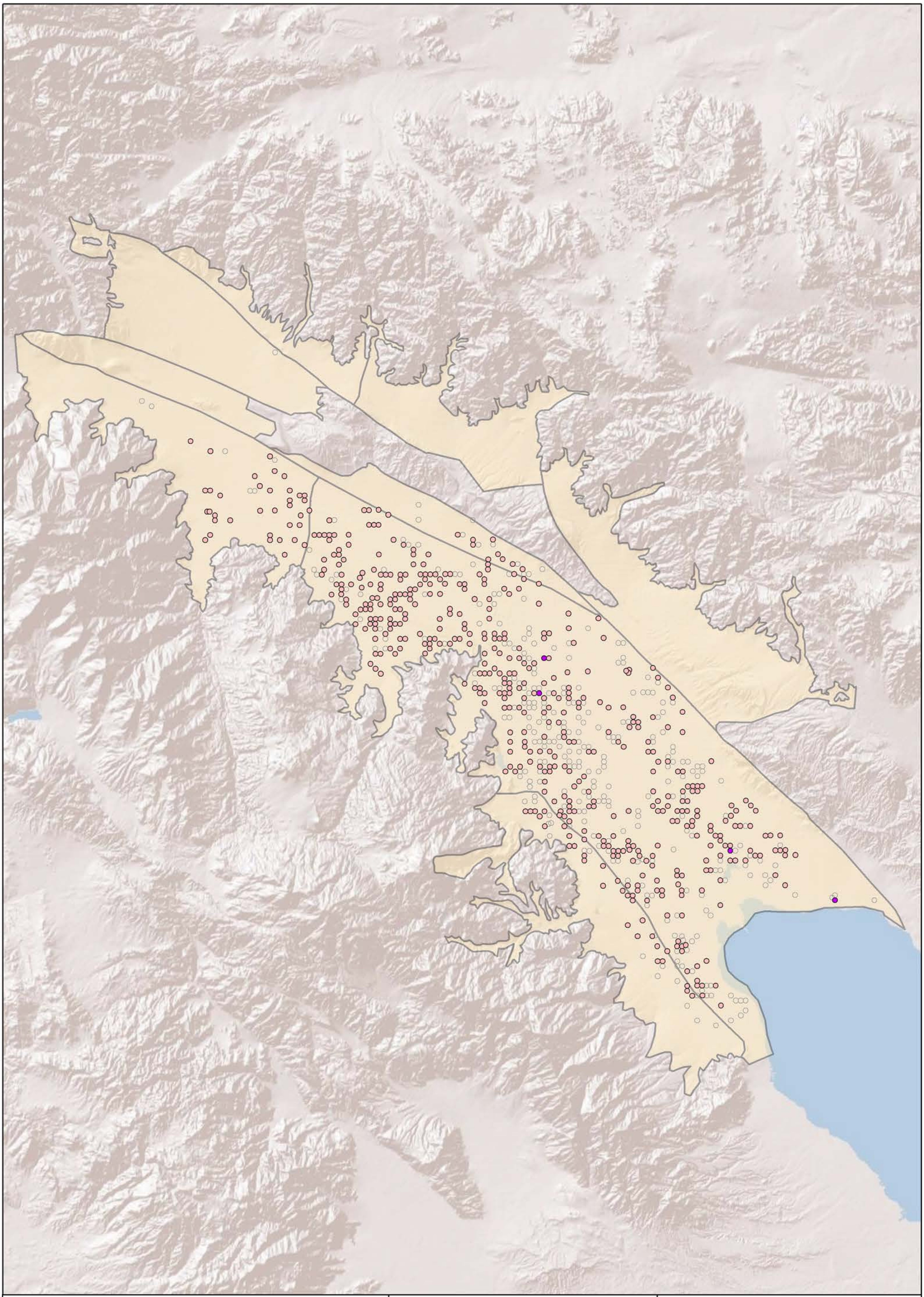
Date: 7/25/2014

Water Quality Data Availability by Well Model Layers 1, 2, & 3

MWH

Figure 4-2



Key to Features

- ● TDS Data
- ● Nitrate Data
- ○ TDS and Nitrate Data
- ○ No TDS or Nitrate Data
- ▨ Groundwater Basin

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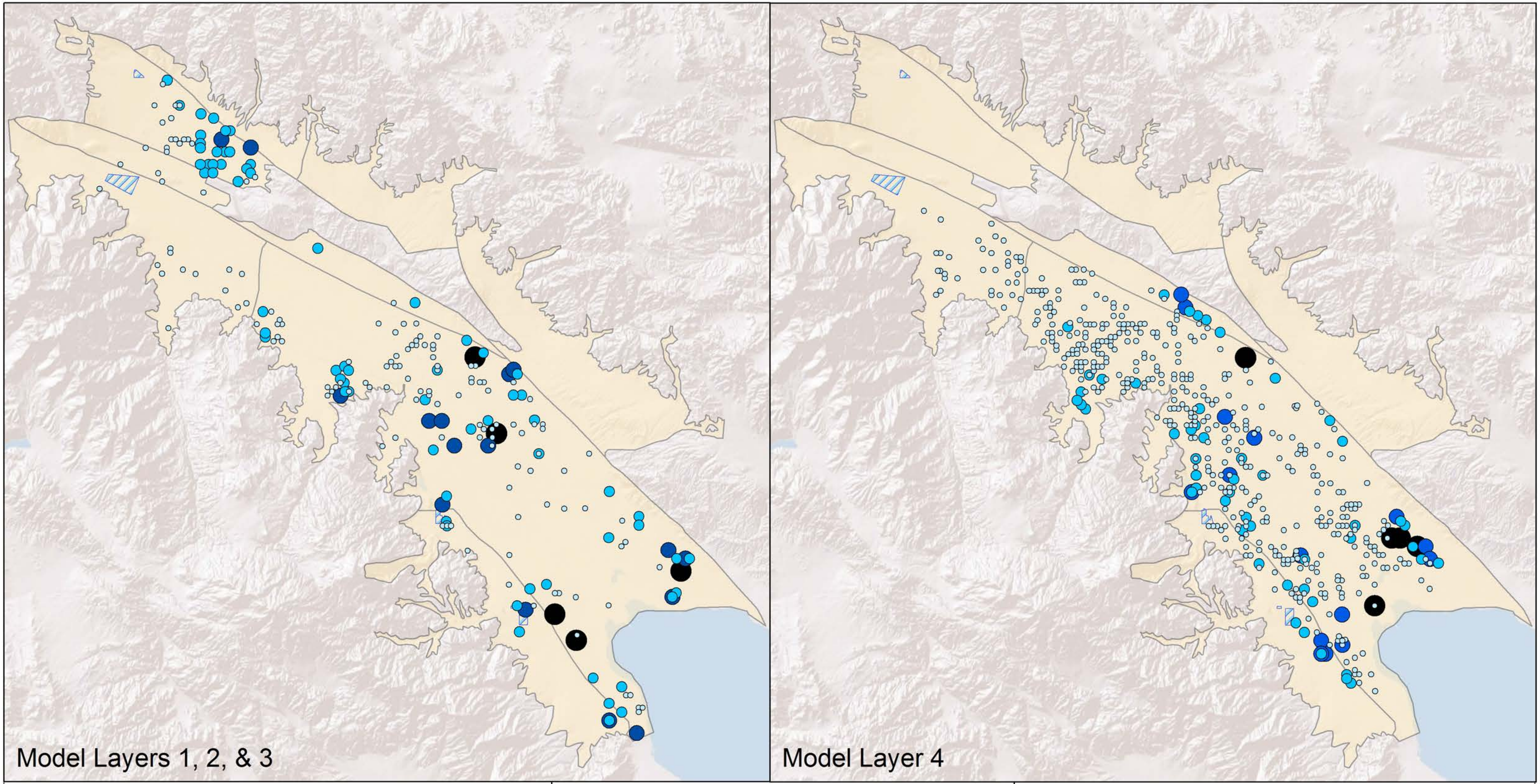
Date: 7/25/2014

Water Quality Data Availability by Well Model Layer 4

MWH

Figure 4-3



Total Dissolved Solids (mg/L)

- ○ < 500
- ● 500 - 1,000
- ● 1,000 - 1,500
- ● > 1,500
- ▨ Spreading Facilities
- ▭ Groundwater Basin

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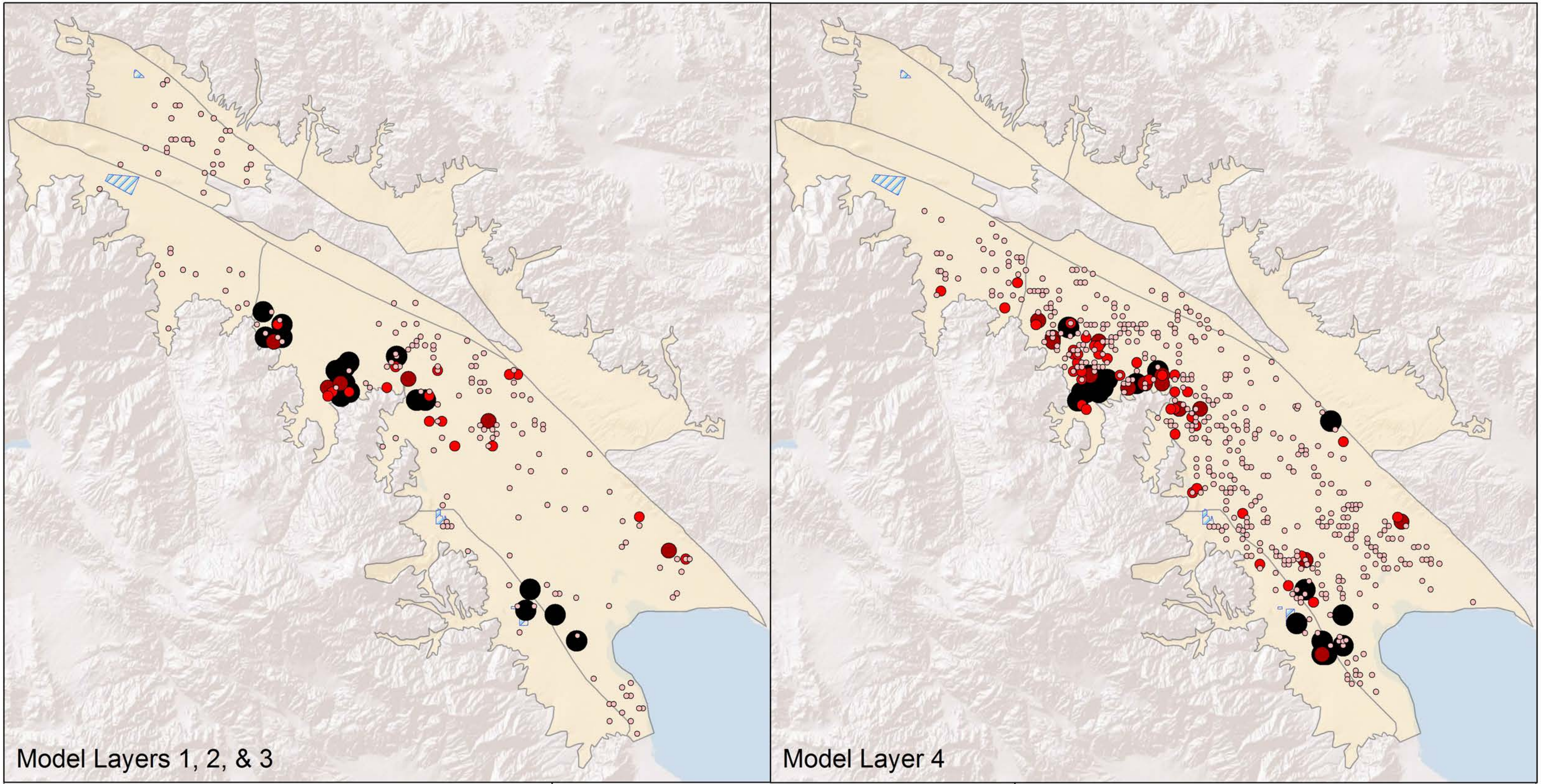
Date: 7/28/2014

Water Quality Median Concentrations by Model Layer

Figure 4-4



Nitrate (as Nitrate) (mg/L)

- ● < 15
- ● 15 - 30
- ● 30 - 45
- ● > 45
- ▨ Spreading Facilities
- ▭ Groundwater Basin

N

0 5 10 20 Miles

Document: \\USIRV1S01\Projects\Coachella Valley WD\SNMP\GIS_files\WQbyLayer.mxd

Date: 7/28/2014

Water Quality Median Concentrations by Model Layer

MWH

Figure 4-5

4.2.3 Groundwater Level Data

A total of 1,077 wells make up the currently available dataset of groundwater levels in the Coachella Valley. The availability of groundwater level data by subbasin and subarea is summarized in **Table 4-6**.

Table 4-6
Groundwater Level Records by Period and Subbasin/Subarea

Subbasin Subarea	**< 1961**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-current**
Whitewater River	**2,951**	**5,719**	**7,708**	**11,938**	**18,759**	**17,407**	**3,625**
Oasis	248	258	289	540	2,483	3,132	800
Palm Springs	386	901	1,624	2,872	2,213	2,205	506
Thermal	2,193	4,325	5,542	7,921	13,440	11,629	2,221
Thousand Palms	124	235	253	605	623	441	98
Mission Creek	**26**	**253**	**316**	**341**	**409**	**1,260**	**306**
Mission Creek	26	253	316	341	409	1,260	306
Garnet Hill	**28**	**117**	**149**	**142**	**161**	**181**	**57**
Garnet Hill	28	117	149	142	161	181	57
Desert Hot Springs	**10**	**192**	**409**	**421**	**375**	**402**	**74**
Fargo Canyon	0	14	33	64	55	60	22
Miracle Hill	1	100	235	225	224	261	34
Sky Valley	9	78	141	132	96	81	18
Total	**3,015**	**6,281**	**8,582**	**12,842**	**19,704**	**19,250**	**4,062**

4.3 DATA GAPS

In general, groundwater quality data is sparse for the Garnet Hill and Desert Hot Springs Subbasins. Most of the groundwater quality in Mission Creek Subbasin comes from wells in the southeast-most portion of the subbasin; when determining AWQ, this lack of spatial resolution will be an important consideration for the method chosen to determine AWQ. Vertical water quality data availability, specifically in Whitewater River Subbasin due to the presence of confining layers and consequent aquifer zones, may be important when considering the boundaries of management zones and AWQ methods.

Groundwater level data availability is generally sufficient to characterize the water table and subsequently the volume of groundwater in storage. Data gaps include southeast Whitewater River Subbasin, close to the Salton Sea, the northwestern portion of the Mission Creek Subbasin, and most of the Desert Hot Springs subbasin. Assumptions will be made if the volume of water in storage is necessary to calculate the AWQ for these areas.

5 Technical Approach

Section 5 outlines the technical approach and tool to assist in the development of the SNMP. The approach includes the determination of management zones (MZs), the calculation of AWQ, the calculation of assimilative capacity, and development of a salt loading tool to evaluate projects and programs. These components are shown with additional detail in in **Figure 5-1**.

The initial step in the process is data collection and evaluation. The primary data sources for the SNMP are described in Section 4. Additional data sources will likely be discovered and used during the process, but Section 4 provides the documentation for the bulk of data to be used. After pertinent data is gathered, MZs and constituents of concern (COCs) are identified. Delineation of MZs and determination of COCs provides the structure that the remainder of the SNMP is built on, what constituents to evaluate and where to evaluate them. The next step is to establish a baseline period to evaluate the AWQ for each MZ. The salt and nutrient analysis requires an understanding of the conceptual hydrogeologic models for each MZ, as well as an understanding of the connectivity between MZs. Conceptual hydrogeologic models provide the basis for the development of a tool to estimate future groundwater quality and effects of various management strategies and projects. The final step in the SNMP is to develop a comprehensive monitoring plan to assess compliance with water quality objectives as well as the effects of management strategy implementation. This monitoring plan can be updated after the evaluation of individual projects at a later date.

The technical approach to each step of SNMP development is discussed in detail in the following subsections.

5.1 APPROACH TO DEFINITION OF MANAGEMENT ZONES

Groundwater basins are typically the smallest unit of management identified within the Basin Plans. Given the size of Coachella Valley groundwater basins, it may be more useful to evaluate and manage groundwater quality on a scale commensurate with the regulatory and resource management decisions that must be made with surface and groundwater sources of salt and nutrient as well as the available data. A large basin could be partitioned into smaller subbasins where the relationship between land use activities, water sources and uses, and constituents of concern concentration levels can be more accurately described and managed. A basin could also be partitioned into shallow or deep zones to allow consideration of management decisions or implementation alternatives that may differ based on groundwater depth. Given the complexity of land uses, water resource management needs, and water quality goals and objectives, it may be appropriate to manage groundwater using a framework that takes into account surface and groundwater management linkages. Each area within the state of California is different, and therefore the development of MZs is not unique; some MZs may be based more on jurisdictional boundaries, such as regional management plans or natural jurisdictional relationships, rather than hydrologic boundaries.

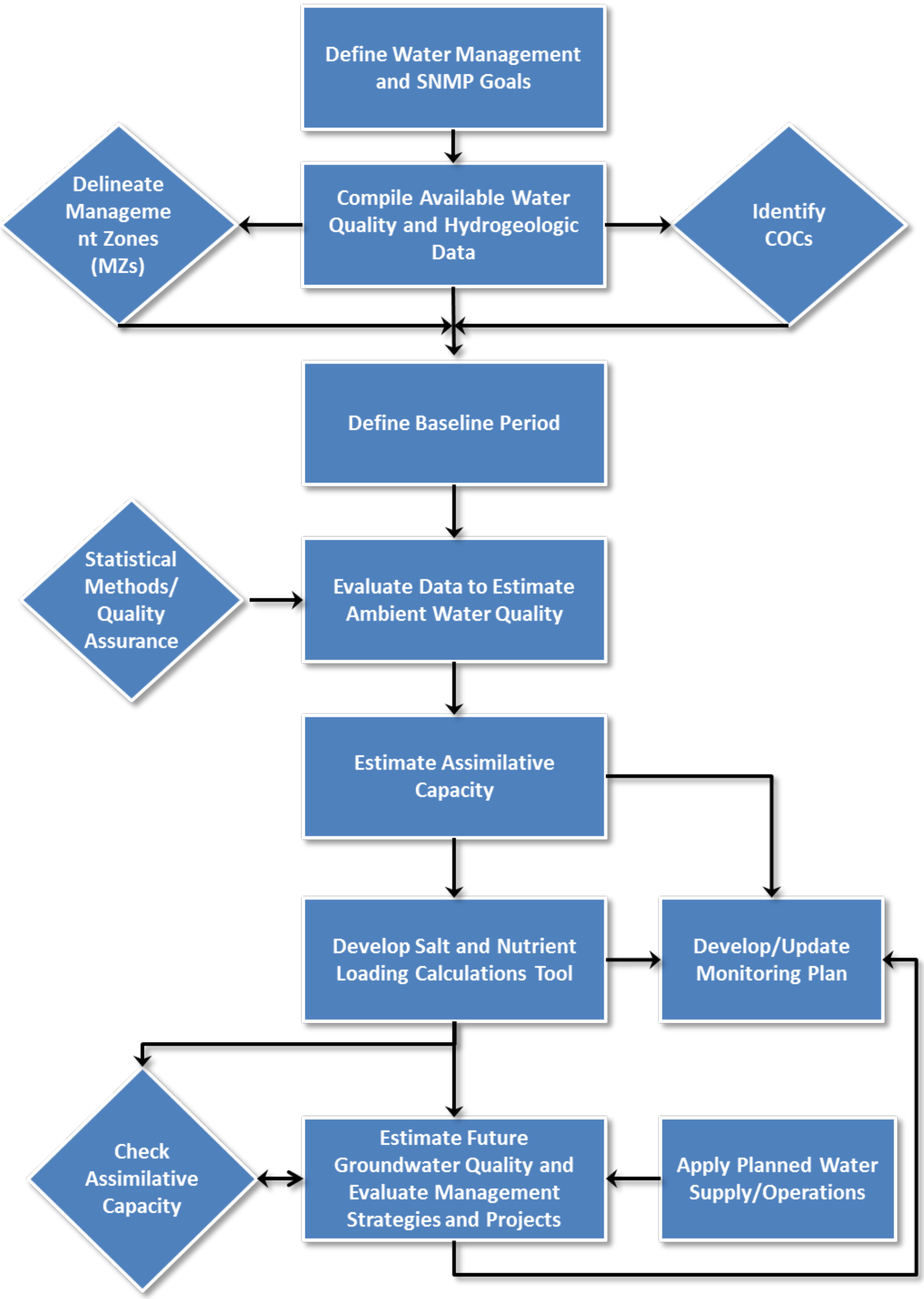


Figure 5-1
SNMP Technical Approach Flow Chart

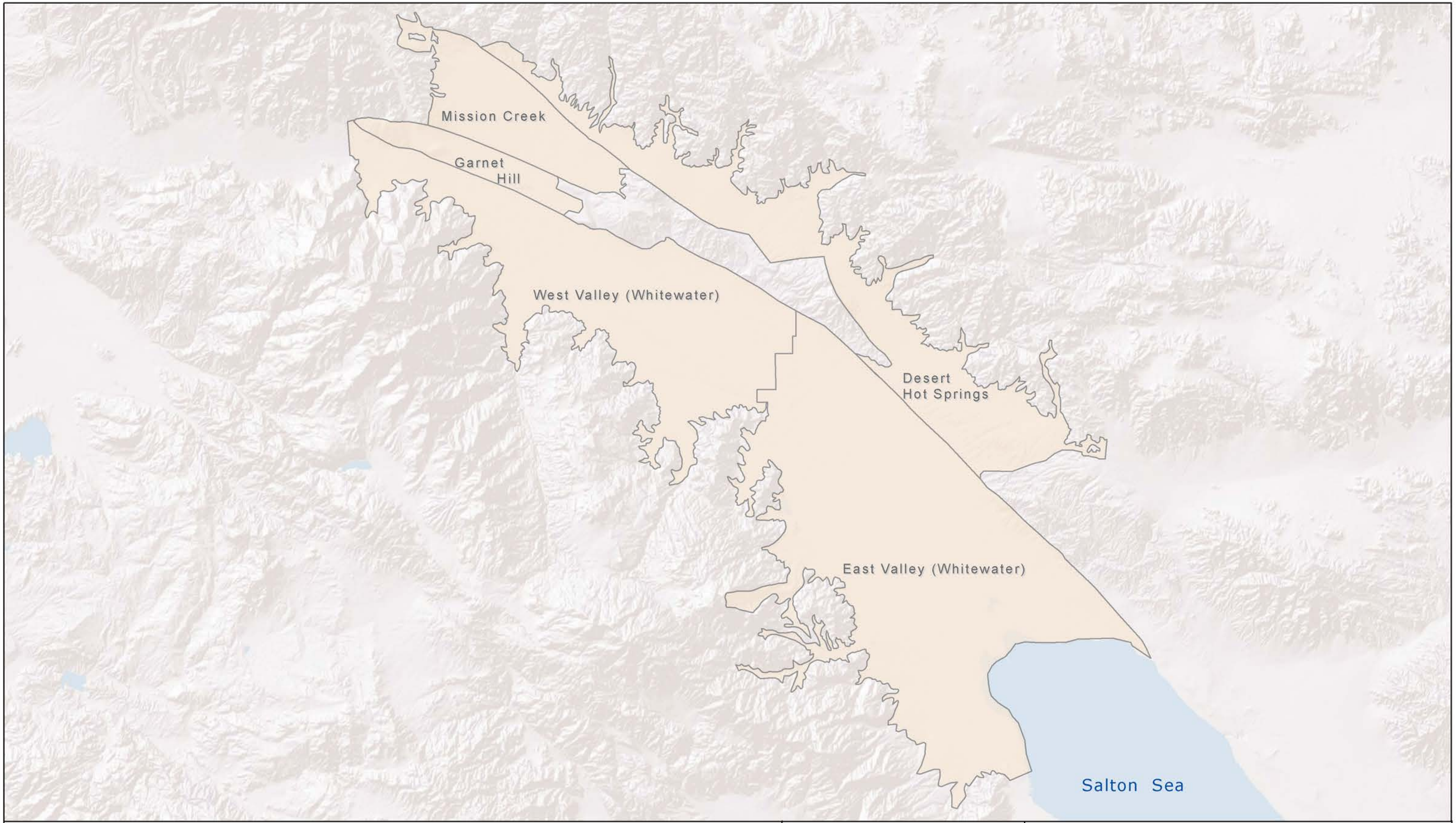
The RWQCB's objective is to protect zones of high-quality groundwater to the extent practical. Delineation of a MZ based on estimated AWQ would allow for higher resolution management strategies to protect the quality of the water. However, several considerations should be made before establishing a MZ. These considerations may include:

- What are the key geographic, jurisdictional, regulatory, or institutional considerations for establishment of a MZ approach to water quality management?
- What are the key considerations for establishment of a groundwater management approach that takes into account varying depths of groundwater?
- Can vertical changes in water quality be clearly documented?
- What types of implementation management strategies may be considered within a MZ if the SNMP provides opportunity to manage water quality from a zonal or depth perspective rather than as individual discharging entities, which is the current practice?
- What are the considerations regarding establishment of a monitoring program to collect the data required to assess water quality in a MZ?

To evaluate MZs, geologic maps, groundwater levels, and hydrogeologic conditions were reviewed and feedback was obtained from the RWQCB. Based on this information, MZs are proposed that are consistent with the groundwater subbasins, with exception to the Whitewater River Subbasin, and the Oasis and Thousand Palms Subareas. The Whitewater River Subbasin will be subdivided into two MZs, West Valley and East Valley. The East Valley MZ will include the Oasis Subarea and a portion of the Thousand Palms Subarea. The West Valley MZ will also contain a portion of the Thousand Palms Subarea. These subareas are included as they have not been shown to be hydrologically distinct groundwater systems. Being hydrologically distinct allows the areas of recharge and discharge to be well defined for each MZ and associated water quality of the recharge and discharge terms can be estimated, evaluated, and managed. The recommended MZs are shown in **Figure 5-2**, and listed below.

- Whitewater River (Indio) Subbasin
  - MZ1: West Valley
  - MZ2: East Valley
- MZ3: Mission Creek Subbasin
- MZ4: Garnet Hill Subbasin
- MZ5: Desert Hot Springs Subbasin

The separation of the East Valley and West Valley MZs is the Whitewater recharge area of benefit line of demarcation. This line extends northeast of Point Happy and is shown on **Figure 5-2**. The West Valley is predominantly a single aquifer system, while the East Valley is a multiple aquifer system. As additional data is collected over time it may be reason for further discretization of subbasins.



Key to Features

- Highway
- ▭ Management Zone

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Date: July 2014

Management Zones

MWH

Figure 5-2

5.2 IDENTIFYING CONSTITUENTS OF CONCERN

Constituents of concern were reviewed with the RWQCB and stakeholders. The following constituents were considered:

- Ammonia-nitrogen
- Arsenic
- Chloride
- Total Chromium and Hexavalent Chromium
- Fluoride
- Iron
- Manganese
- Nitrate
- Nitrite
- Selenium
- Sulfate
- TDS

Of the constituents identified in the initial review list, those of particular interest to salt and nutrient management within the Coachella Valley include:

- Arsenic
- Hexavalent Chromium
- Nitrate
- TDS

Nitrate and TDS were selected as the primary COCs as they are materially affected by recycled water use or other salt/nutrient loads. These parameters are most affected by human-induced activities. These constituents can be used as surrogates for other salt and nutrient constituents and also have a stronger monitoring history, which is a benefit, although not a requirement.

Arsenic and hexavalent chromium will be evaluated to determine how a recycled water project or management policy may impact the constituent concentration within a MZ.

5.3 BASELINE PERIOD

The baseline period is the time frame over which AWQ is evaluated. The period should be sufficiently long to reduce the effects of hydrologic or water supply variation and have sufficient data points to make reasonable statistical inferences. The baseline period serves as the starting point for evaluating the future effects of salt and nutrient loading on groundwater quality. Options available for the Coachella Valley include:

- Historical period –a pre- imported water recharge condition could be selected; however, data availability may be insufficient to properly characterize the water quality throughout the Valley.
- Recent period – a more recent period may have more data but would likely reflect the effects of water management activities implemented to reduce overdraft.

Section 9.c.1 of the SWRCB's Recycled Water Policy states that "available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the Regional Water Board Executive Officer." However, data availability and validity may require a longer baseline period in order to perform statistically meaningful calculations. Statistically, fewer data points results in greater uncertainty of the mean value (larger confidence interval). Most potable wells in the Coachella Valley are sampled and analyzed for TDS every three years. The baseline period should be at least ten years long to capture, at minimum, three rounds of water quality sampling as this is the minimum number of data points required to evaluate statistical trends.

Based on the requirements above and data availability of each subbasin, as described in Section 4, a baseline period from 1991 to 2010 is proposed. If recent data is not adequate to estimate AWQ for a particular MZ, historical data may be used to estimate AWQ. If availability or validity of data prohibits the estimate of AWQ, it will be stated so in the SNMP.

5.4 APPROACH TO DETERMINE AMBIENT WATER QUALITY

AWQ is an estimate of the representative current water quality within a MZ. One of two methods will be used depending on the availability of data within each MZ. Where sufficient data exists to characterize the spatial distribution of water quality, a volume-weighted approach will be used to determine AWQ for each MZ. If not enough data exists to reasonably use this method, a statistical summary of water quality will be prepared with monitoring recommendations. Regardless of the method, the water quality data is prepared for evaluation and filtered to minimize spatial and temporal bias.

5.4.1 Data Preparation

The raw groundwater quality data must be prepared prior to the analysis of AWQ. Several assumptions will be made to prepare the data into a usable format for AWQ calculation.

As groundwater quality comes from a variety of sources, duplicates will be removed as to not count a particular record more than once (duplicates may be the same measurement from two different databases). This is done by generating unique identifiers for each particular record that includes the well name, record date, and analyte. Those unique identifiers that occur more than once are removed such that only one record remains. In addition, data sources may report non-detect values in several different ways, particularly important for nitrate records. Some examples include:

- non-detect, i.e. "ND", with method detection limit;
- non-detect, i.e. "ND", with no method detection limit;
- zero value, i.e. "0"; and
- less than method detection limit, i.e. "< MDL".

For the AWQ calculation, all non-detects will be represented as true zeroes for three reasons: (1) not all the data may have the method detection limit available for each record; (2) numerical values for all results allow the calculation of summary statistics; and (3) all non-detects are treated in the same way. This does have the consequence that if the true value is greater than zero but less than the method detection limit, it will be treated as a zero. If the average of an entire dataset is calculated making this substitution, the concentration will be equal to or less than the true average concentration, thus introducing a bias. However, the filtering of data proposed will limit the effect of this bias on the AWQ calculation.

5.4.2 Temporal and Spatial Filter

Groundwater quality data will be filtered temporally and spatially to generate representative groundwater quality throughout the Basin. The reason for this filtering is to eliminate the bias introduced due to the nature of sampling. These biases are (1) frequency bias, (2) age/type bias, and (3) position bias.

5.4.2.1 Frequency Bias

A certain well may become more or less frequently sampled at any time. For example, consider that a production well produces water from 1991-2000 with nitrate below the MCL and so it is sampled once a year. The sample taken in 2000 shows nitrate above the MCL and it is decided that the well will be taken off line and sampled weekly until the nitrate concentration drops below the MCL. The well then continues to stay above the MCL. It is obvious that if all records are considered, AWQ will be skewed in the direction of poorer water quality than a time-weighted average suggests. To address this, the median of all records for a well within a particular year used as the yearly representative water quality. As the baseline period chosen includes 20 years from 1991-2010, each well will have at most 20 *yearly medians* for each constituent. If no records exist for a particular year, no annual value is recorded.

5.4.2.2 Age/Type Bias

Over the period of record, old wells may have become inactive and new wells may have been constructed, so their particular records start and stop at different times. Additionally, datasets include multiple types of wells (e.g., production and monitoring) that are sampled at different frequencies for dissimilar purposes. For example, most water purveyors measure the TDS of their production wells every three years for compliance with drinking water regulatory requirements, whereas monitoring wells near the Salton Sea are sampled much more frequently to perhaps assess intrusion or interactions between the Sea and the groundwater basin. Both water qualities are important but weighting water quality in the direction of the monitoring well because of the presence of many more records will not lead to a representative basin water quality. To address this, the yearly medians for a well are aggregated and the median is computed to establish a single value to represent that well’s water quality for the entire baseline period for each constituent, referred to as the *baseline well concentration*. For the example above, the monitoring well and the production well would then both contribute equally to the AWQ. Because median values are used in the temporal filter, using zero values for non-detects as discussed earlier will have less consequence as they tend to fall out.

5.4.2.3 Position Bias

In general, production wells are sited in areas of better water quality and close to the distribution system, i.e., near developed communities. As such, water quality data will cluster around these areas. Using all the wells in the calculation of AWQ will skew results towards the water quality around dense well zones. To address this, a 1,000 foot by 1,000 foot grid is applied to group well data within the same grid cell. The average of the baseline well concentrations of these wells is then calculated to get *cell means* for the baseline period; if sufficient screened interval data exist for wells in a particular MZ, groundwater model layers may be considered such that baseline well concentrations are averaged for a particular grid cell and layer combination to get *cell-layer means*.[2] Discretizing by layer would be the equivalent of determining the AWQ by aquifer.

5.4.2.4 Filter Summary

The following filters are applied for each constituent in each MZ:

- Temporal Filter 1: For each groundwater well, medians are computed for each year of the baseline period to get at most one concentration per year (maximum of 20 values), called a *yearly median*;
- Temporal Filter 2: For each groundwater well, a median of the yearly medians is computed to obtain one concentration for that well for the baseline period, called a *baseline well concentration*;
- Spatial Filter: A grid is applied to the MZ to aggregate temporally filtered data and the mean of the aggregated baseline well concentrations are taken for each cell. The result is a single concentration for each cell in the 1,000 foot grid for the baseline period. If this can be done by model layer/aquifer, it will as well.

5.4.3 Calculation of Ambient Water Quality

As discussed, two methods will be considered for the determination of AWQ. The availability of data within a particular MZ will drive the selection of the AWQ method that will be used for that MZ.

5.4.3.1 Volume-weighted Method

The volume-weighted method for determination of AWQ is used when an adequate amount of data exist for a particular MZ. This method considers the volume of water in storage to assign weights to water quality within the basin. Following the data preparation and filtering, the single cell concentration values are contoured, this will provide inferred concentration values where no well are present. The concentrations are multiplied by the water in storage with the grid cell and the results are totaled to obtain a volume weighted AWQ. If the data is available, this process can be completed at the model layer/aquifer level.

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[2] Depending on data availability, model layers may be grouped (e.g., layers 1 and 2 may be treated as one layer).

In addition to water quality, groundwater level data is also filtered and contoured in a similar fashion. The water level contours are then used to generate a water level surface and values from the surface at the cell centers are assigned to each cell within the MZ.

To determine the volume of water in each cell volume between the water level surface and the base of the aquifer), lithologic descriptions will be organized and grouped into categories. The categories would be expected to have similar hydraulic properties. This will be completed for each model layer, or aquifer if no model exists. For the purposes of this plan, the aquifer property that is needed is effective porosity. Once zones and categories have been established, the grid is overlain to delineate cells for calculations. Note the volume being approximated is not to total amount in storage (based on porosity) or the total that can be pumped (based on specific yield), but the amount available for mixing (based on effective porosity).

The volume of each cell combination is calculated as,

$$Vol_{i,j} = (n_e)_{i,j} \times Area_i \times (H_{sat})_{i,j} \, ,$$

where i is the cell, j is the layer, n_e is the effective porosity, and H_{sat} is the saturated thickness. The effective porosity will be corrected for lithostatic loading as a function of depth. **Figure 5-3** shows a conceptual representation of the cell-layers. AWQ is the total mass in all cell-layers divided by the total volume of water in storage in all cell-layers,

$$AWQ_{volume-weighted} = \frac{\sum_i \sum_j \left(C_{i,j} \times Vol_{i,j}\right)}{\sum_i \sum_j Vol_{i,j}} \, ,$$

where C is the concentration. This method requires sufficient water quality data for wells with known depth information; aquifer properties such as layer thickness, effective porosity, and groundwater level; and well-spaced data in both the horizontal and vertical.

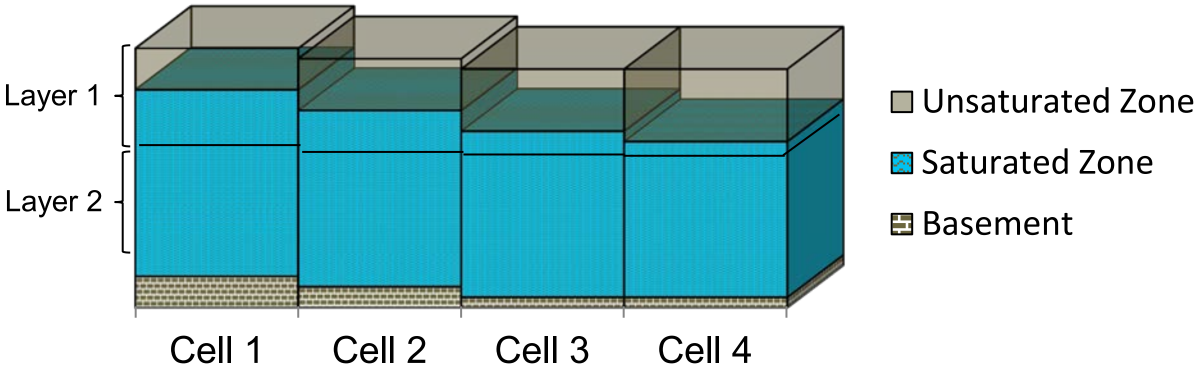

Figure 5-3
Conceptual Representation of Model Cells and Layers

5.4.3.2 Statistical Method

The statistical method for AWQ determination is used when less data is available; this may be due to a lack of well depth information or limited water quality data. Similar to the volume-weighted method, water quality data is filtered temporally and spatially, except aquifer layers are not considered.

All baseline well concentrations are aggregated for each cell, using these data the mean and median is calculated to describe the cell water quality. AWQ is calculated as the average of all cell medians.

5.5 CALCULATING ASSIMILATIVE CAPACITY

Assimilative capacity represents the difference between the MZ numerical water quality objective and the AWQ, as described in Section 2. If the current or projected water quality is better than the defined objective or threshold, then capacity exists for a MZ to assimilate additional salt or nutrients. To determine each MZ assimilative capacity, the AWQ will be subtracted from the water quality objective for the MZ.

5.6 APPROACH FOR SALT AND NUTRIENT LOADING CALCULATIONS

Salt and nutrient loading calculations will be based on spreadsheet-based planning tools that use a constantly stirred reactor model concept within each MZ. Salt and nutrient loading is largely driven by the water balance in the Coachella Valley. **Figure 5-4** shows a conceptual diagram of water interactions in the Coachella Valley. Each element of the water balance will be quantified and a concentration of salt and nutrients applied. Listed below is a description of the steps to prepare the salt and nutrient loading tool:

1. Determine aquifer storage volume from model geometry and storage properties
2. Determine groundwater inflows, including:
    a. Deep percolation of precipitation
    b. Subsurface inflows from adjacent aquifers/MZs
    c. Deep percolation of applied water (i.e., return flows, including potable and recycled)
    d. Deep percolation of wastewater
    e. Deep percolation from surface water bodies
    f. Inflows from recharge facilities
3. Determine groundwater outflows, including:
    a. Groundwater pumping
    b. Evapotranspiration from groundwater dependent vegetation
    c. Subsurface outflow to adjacent aquifers /MZs
    d. Groundwater outflow to surface water bodies
    e. Drain flows to the Salton Sea
4. Establish a water balance, determine net inflow/outflow from the basin, and rate of change of storage of the MZ
5. Assign a concentration to each inflow to the MZ
    a. Monitoring data will be used to the extent available to determine concentrations.

    b. Use-specific waste increments are applied to applicable basin inflows to account for salt and nutrient addition through use
6. Assign a concentration to outflows from the MZ
    a. Monitoring data will be used to the extent available to determine concentrations.
    b. Subsurface outflows from groundwater basins will be based on the volume-weighted average computed with the constantly stirred reactor model
7. Determine baseline salt and nutrient trends for each MZ
8. Perform sensitivity analysis to determine effects of variability in the calculations

To the extent data is available, subsurface flow between adjacent MZs will be estimated using existing groundwater modeling results.

Ideally, the tools will be completed for a 10 year historical period. The end of the period should approximate the current ambient water quality. This allows for a check of reasonableness of the tool. To use the tool into the future, elements of the water balance are estimated for future conditions, assuming long-term average hydrologic conditions.

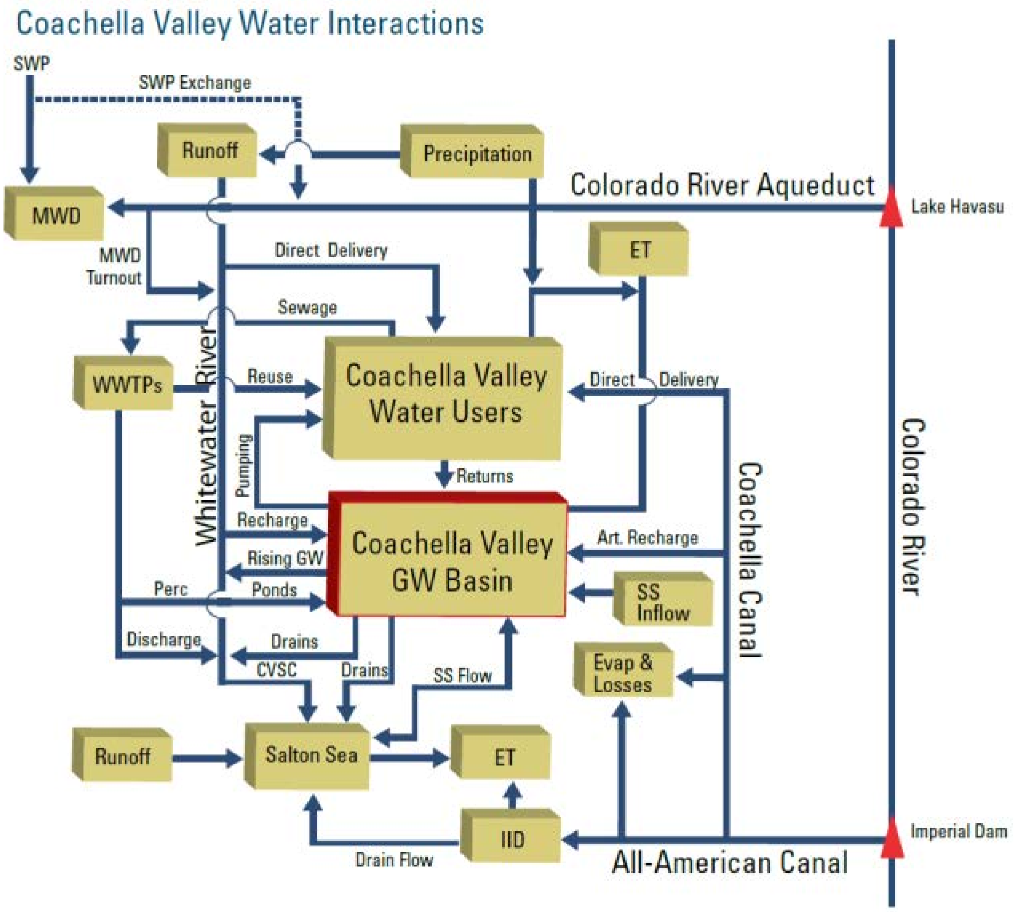

Figure 5-4
Water Interactions in the Coachella Valley

5.7 APPROACH TO ESTIMATING FUTURE GROUNDWATER QUALITY AND ASSIMILATIVE CAPACITY

To evaluate projects into the future, planned water supply conditions will be used along with average hydrologic conditions (i.e. recharge and discharge). The projected water quality conditions of each MZ will be evaluated using the Salt and Nutrient loading calculations tool moving forward with projected conditions. The current AWQ and groundwater storage in each MZ will be used as the starting point for the simulations. The results will be compared to water quality objectives to determine a project's impact on water quality and assimilative capacity. The salt and nutrient loading calculations tool can be used to evaluate various management strategies and scenarios in each MZ. The tool will provide an estimation of the effects of implementing various strategies and projects over future planning time steps. The tool will project average water quality by MZ for a 25-year period.

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