November 28, 2018

Seaside Groundwater Basin
2018 Basin Management Action Plan

SEASIDE GROUNDWATER BASIN WATERMASTER
MONTEREY COUNTY, CALIFORNIA

DRAFT
UPDATED BMAP

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1 EXECUTIVE SUMMARY

1.1 Introduction

The Seaside Groundwater Basin's (the Basin) court-appointed Watermaster's primary role is to administer and enforce the provisions of the Decision filed February 9, 2007 by the Superior Court in Monterey County under Case No. M66343 - California American Water v. City of Seaside et al. (the Decision). One provision of the Decision is the requirement to develop a Monitoring and Management Plan (M&MP), which the Watermaster developed in May 2006. The M&MP included a recommendation to prepare a Basin Management Plan. The first Basin Management Plan, titled the *Seaside Groundwater Basin Management Action Plan* (BMAP) was completed in February 2009 (HydroMetrics LLC, 2009a). This current report updates the previous BMAP with the benefit of nine additional years' worth of groundwater data and an enhanced understanding of the Basin.

1.2 Description and State of the Seaside Groundwater Basin

The Basin as delineated in Exhibit B of the Decision is bounded by the Pacific Ocean on the west, faults and bedrock on the south, bedrock on the east, and a groundwater flow divide on the northern boundary. The Decision subdivides the subbasins into four subareas: Northern Inland, Northern Coastal, Southern Inland, and Southern Coastal. The northern and southern subbasins are separated by the Laguna Seca Anticline. This feature, including the segment of the Ord Terrace Fault that offsets the anticline, forms a subsurface hydraulic barrier to groundwater flow (**Figure ES-1**). The coastal and inland subareas are not separated by any geologic features, and groundwater flow is continuous between coastal and inland subareas.

The Basin comprises three aquifers: a deep aquifer, a shallow aquifer, and surficial Aromas Sands. The deep aquifer generally consists of the Purisima Formation and Santa Margarita Sandstone. The shallow aquifer refers collectively to numerous discontinuous lenses of sand and gravel in the Paso Robles Formation overlying the Santa Margarita Sandstone and below the surficial Aromas Sand layer.

EXPLANATION

- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary
- Monitoring Well
- Production Well
- ASR Well
- Laguna Seca Anticline
- Faults

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Figure ES-1. Seaside Basin Well Locations

Since the first BMAP, groundwater levels have continued to decline in all parts of the Basin except in the Southern Coastal Subarea and in shallow wells near the coast in the Northern Coastal Subarea. In those locations, groundwater levels remain stable. The continued groundwater level declines have not led to any observed seawater intrusion or other operational problems, other than the need to replace a monitoring well sampling pump so it can operate from a deeper depth. However, the declining groundwater level trend is not sustainable over the long-term.

The Basin's *Usable Stored Groundwater* is the amount of groundwater above protective groundwater elevations. It is estimated that the *Usable Stored Groundwater* is 6,350 acre-feet as of Fall 2017. The unsaturated area above the current groundwater table has approximately 90,600 acre-feet of *Total Usable Storage* space. Of the 90,600 acre-feet of total usable storage space, 62,020 acre-feet are in the Coastal and Northern Inland Subareas and 28,580 acre-feet are in the Laguna Seca Subarea. Using revised protective groundwater elevation surfaces, the sum of the *Usable Stored Groundwater* and the *Total Usable Storage* space is approximately 96,950 acre-feet.

The Basin has lost approximately 1,450 acre-feet per year of groundwater from storage since 1988. This equates to 43,500 acre-feet of groundwater lost from storage over 30 years. These losses are reflected in the lowered groundwater levels observed throughout the Basin.

A review of the Basin's Natural Safe Yield was conducted using the Basin's updated groundwater flow model. Using the same approach but different analysis period to that used in establishing the Natural Safe Yield in the Decision and in the first BMAP in 2009, the Natural Safe Yield was estimated to be 2,310 acre-feet per year over the past 30 years. This is less than the 2,850 acre-feet per year estimated in the 2009 BMAP, which was estimated over a six-year period between Water Years 2002 and 2007; and lower than the Natural Safe Yield of 3,000 acre-feet per year included in the Decision. Because the Natural Safe Yield estimate reflects the theoretical maximum amount of groundwater production that would have resulted in no decreases in groundwater in storage, it does not account for the uneven pumping distribution in the Basin which will cause localized groundwater level declines even at the lower Natural Safe Yield estimate.

Preventing future seawater intrusion requires raising groundwater levels near the coast to protective elevations. These groundwater elevations can be raised only if

replenishment water is recharged into the Basin and not recovered, or pumping is reduced to less than the Natural Safe Yield.

1.3 Supplemental Water Supplies

Long-term supplemental supplies are needed to reduce pumping in the Basin to at or below the Natural Safe Yield; and to provide water which can be used to replenish the Basin. Developing these supplemental supplies is the strategy that will have the greatest impact on the Basin and allows for its long-term management and use in the future. Since the first BMAP, a number of projects have been developed by various project proponents and are in various stages of planning, environmental assessment, or construction. Most of these supplies are part of other larger programs.

The largest agency producers of groundwater in the Basin are California American Water Company (CAWC) and the City of Seaside. Supplemental water supply projects that have progressed the farthest focus on providing supplemental supplies to these two producers in order to meet their water rights as established by the Decision. These projects additionally provide water for CAWC to return to the Basin to restore the water it has over-pumped since the date of the Decision. A summary of supplemental water supply projects that are currently being considered, some of which are in the construction phase, is provided in **Table 1**. **Table 2** provides a summary of supplemental supply projects that have been implemented since the first BMAP was prepared in 2009. **Table 3** summarizes Basin management actions that have been implemented since 2009.

All of the projects and management actions, except one, are physical projects with capital costs associated with them. The exception is water conservation which does not produce additional supply but rather results in a demand reduction. Water conservation is already being given high priority by the Seaside Groundwater Basin Watermaster's (Watermaster) and its member agencies.

Table 1. Summary of Supplemental Water Supply Projects Currently Being Considered

Project	Project Proponent	Project Type and Capacity	Benefit to Seaside Basin	Status
Monterey Peninsula Water Supply Project (MPWSP)	California American Water Company (CAWC)	Desalinate (6.4 mgd plant capacity) saltwater extracted by slant wells; 7,167 AFY desalinated water, plus ASR wells for additional storage of desalinated water	Supplemental supply for CAWC so they can meet their adjudicated right, plus return to the Basin by in-lieu recharge, over a period of 25 years, the volume that they have historically over pumped Modeling predicts an increase in Basin groundwater levels	Draft EIR approved by California Public Utilities Commission (CPUC) in August 2018 CPUC approved project in September 2018
	Monterey One Water (M1W)	Inject purified wastewater from Pure Water Monterey (PWM) Project into the Seaside Basin; 3,500 AFY		EIR complete and infrastructure currently being constructed
Regional Urban Water Augmentation Project (RUWAP)	Marina Coast Water District (MCWD)	Distribute recycled water from the M1W Reclamation Plant; total of 1,727 AFY of recycled water to identified urban areas	Supplemental supply for two City of Seaside golf courses (Blackhorse and Bayonet, 450 AF) and 250 AF for a proposed golf course in Del Rey Oaks; total of 700 AFY supplemental supply to offset over-pumping of the Basin	Phase 1 under construction in 2018
Monterey Bay Regional Water Project (MBRWP or DeepWater Desal)	Deepwater Desal LLC (DWD)	Desalinate ocean water from a deep open ocean intake within the Monterey Canyon; 25,000 AFY potable water	Supplemental supply to meet water demand and keep pumping below the Safe Yield	Notice of Preparation/ Notice of Intent to prepare a Draft EIR/EIS issued in June 2015
People's Moss Landing Water Desalination Project (People's Project)	Moss Landing Green Commercial Park, LLC	Desalinate ocean water from an open ocean intake; 13,400 AFY potable water	Water to be used to meet needs of Monterey Peninsula area	Notice of Preparation for the People's Project issued in June 2015
Greater Monterey County Storm Water Resource Plan (SWRP)	Multiple entities	Provide more source water for PWM by identifying storm water capture opportunities and/or direct recharge of storm water	Water for use in recharging, or reducing pumping from the Basin	Planning stage

Table 2. Summary of Supplemental Supply Projects Implemented since 2009

Project	Project Proponent	Project Type and Capacity	Benefit to Seaside Basin	Status
Sand City Water Supply Project	Owner: City of Sand City Operator: CAWC	Desalinate brackish source water; up to 300 AFY desalinated water	Supplemental water supply helps reduce pumping from the Basin	Facilities completed and placed into operation in 2010
Carmel River Water Aquifer Storage and Recovery Project (aka Seaside ASR) – Phases 1 & 2	Monterey Peninsula Water Management District (MPWMD)	Divert excess Carmel River winter flows during high flow periods, treat, and inject into four ASR wells for recovery by CAWC during dry periods; Phase 1 (2 wells) = up to 2,400 AFY stored, with an average annual yield of 920 AFY; Phase 2 (2 wells) = up to 2,900 AFY stored, with an average annual yield of 1,050 AFY	Supplemental water supply for the Basin	Phase 1 completed in 2007 and operational in 2008; Phase 2 completed in stages with one ASR well operational in 2012 and the second ASR well operational in 2015
Pacific Grove Wastewater Reuse Project	City of Pacific Grove	Treat and distribute reclaimed waste water for irrigation; 100 – 125 AFY	No benefit to Basin	Facilities completed and placed into operation in 2017

Table 3. Summary of Management Actions Implemented since 2009

Action	Proponent	Project Type and Capacity	Benefit to Seaside Basin	Status
Water Conservation	All municipal suppliers	Public awareness	Reduced water demand	Ongoing.
Irrigate the Bayonet and Blackhorse Golf Courses with Water from the Ord Community Water System	City of Seaside	MCWD temporarily provided 2,160 AF to City of Seaside over a period of six years	Temporary supplemental water supply for the Basin used in-lieu of pumping by the City of Seaside	This source was used from 2010 – 2015

1.4 Groundwater Management Actions

A number of management actions could be implemented by various water agencies to delay the onset of seawater intrusion and maximize the use of existing groundwater. Any action that assists in appropriate management of the Basin should be encouraged and supported by the Watermaster.

Of the near-term management actions reviewed in this BMAP, the following appear to be the most cost-effective, most likely to be implemented, and provide the greatest benefit to the Basin:

- Install Southern Coastal Subarea wells in coordination with the Watermaster to determine optimal pumping locations that do not cause groundwater levels to fall below protective elevations,
- Use recycled water in the Laguna Seca Subarea for golf course irrigation,
- Support water conservation,
- Coordinate with the Salinas Valley Basin Groundwater Sustainability Agency and Marina Coast Water District Groundwater Sustainability Agency to ensure that sustainable management criteria included in the neighboring Groundwater Sustainability Plans (GSPs) do not limit the Watermaster's sustainable management of the Basin, and
- Enhance storm water recharge of the City of Seaside's storm water.

The recommended near-term actions are not intended to provide long-term solutions for restoring groundwater levels in the Basin, although some near-term solutions may have long-term benefits.

1.5 Other Recommendations

This updated BMAP identifies other recommendations that need to be addressed and pursued by the Watermaster.

- Use the groundwater flow model to evaluate the combination of Basin management actions and supplemental water supply projects to determine their ability to raise groundwater levels to protective elevations.
- Re-evaluate the Basin's natural safe yield given the impacts of various projects currently being implemented.

- Continue ongoing groundwater monitoring of groundwater levels, quality and production. These data will allow Basin impacts from management actions and supplemental water supply projects to be evaluated over the long-term.
- Continual annual analyses of groundwater levels and quality.

2 BACKGROUND AND PURPOSE

In 2006, an adjudication process was conducted by the State Water Resources Control Board (SWRCB) to determine water rights and establish management procedures for the Basin. This process led to the issuance of the Decision that created the Seaside Groundwater Basin Watermaster (Watermaster). The Watermaster's role is to administer and enforce the provisions of the Decision (California American Water v. City of Seaside et al., 2007). One provision of the Decision was the requirement to develop a Monitoring and Management Plan (M&MP). The Seaside Basin M&MP was prepared in May 2006, and included a recommendation to develop a Basin Management Plan.

The first Basin Management Plan, titled the *Seaside Groundwater Basin Management Action Plan* (BMAP) was completed in February 2009 (HydroMetrics LLC, 2009a). This current report updates the 2009 BMAP with nine additional years of groundwater data, an enhanced understanding of the Basin, and inclusion of the ongoing planning and construction of supplemental water supplies.

Included in this updated BMAP are:

- A description of the state of the Basin that has been updated with over nine years of groundwater data, annual reports, and other modeling reports. The state of the Basin section also covers Basin properties that are required by the Decision, e.g. groundwater storage, and which have an impact on basin management.

- Potential supplemental water supply alternatives that are currently being considered. Discussion of some of the alternatives previously considered in the 2009 BMAP is included with reasons why those alternatives are no longer feasible.

- Potential management actions and interim water supplies that could be implemented in the short-term, prior to developing supplemental supplies. A discussion of some of the alternatives considered in the 2009 BMAP is included with reasons why those alternatives are no longer feasible.

- A discussion of management actions that have been implemented in the Basin since the 2009 BMAP and the impacts of those actions. Additional

management actions and strategies that the Watermaster should support and/or encourage are recommended as a means to help meet groundwater pumping reductions required by the Decision, and to help prevent seawater intrusion.

Also discussed in this updated BMAP are items from the Decision that the Watermaster is required to address. The relevant Decision sections are shown in parenthesis in the following bullets, and include:

- Determining total useable storage space and allocated storage for each producer in the Basin (III.H.4);
- Addressing efficiencies of storage (III.H.5); and
- Monitoring and studying the Basin and all Basin activities (III.L.3.j.xxi).

The updated BMAP is one of a number of documents and actions necessary for managing the Basin. The updated BMAP functions as a seawater intrusion prevention plan by focusing on providing groundwater management options to control groundwater levels that, if allowed to decline, would lead to seawater intrusion. This document is intended to be used in coordination with the Watermaster's ongoing activities and the Seawater Intrusion Response Plan (HydroMetrics LLC, 2008). Implementing the recommendations included in this plan will result in a number of actions and strategies necessary for effective groundwater management in the Basin.

3 STATE OF THE SEASIDE GROUNDWATER BASIN

This section details pertinent geologic and hydrogeologic aspects of the Basin. These hydrogeologic details are presented as background for the ensuing discussions of supplemental supplies and potential groundwater management actions. Furthermore, paragraph III.H.4 of the Decision requires that the Watermaster make a determination of the total usable storage space, which in turn can be used to establish the storage allocation for each producer. This section reevaluates the initial estimate of total usable storage space developed in 2009, and compares recent natural safe yield values with the Natural Safe Yield of the Basin prescribed in the Decision.

3.1 Jurisdictional Framework

In addition to the water management framework established by the Decision, two public agencies have statutory powers over water resources in the Basin: the Monterey County Water Resources Agency (MCWRA) and the Monterey Peninsula Water Management District (MPWMD). MCWRA is organized and exists under the Monterey County Water Resources Agency Act, Water Code Appendix, Chapter 52 (Agency Act), and its territory consists of "all of the territory of the county lying within the exterior boundaries of the county." (Agency Act, Section 52-4). Under the Act, MCWRA has broad powers to plan, design and implement flood control and water supply projects within its territory, including the power to "appropriate and acquire water and water rights, and import water into the agency and conserve within or outside the agency, water for any purpose useful to the agency." (Agency Act Section 52-9(d)(3)). While MCWRA retains its statutory powers in the Basin, it does not unilaterally enforce its powers in the Basin. MCWRA is actively participating in Watermaster-directed efforts to address water supply issues in the Basin.

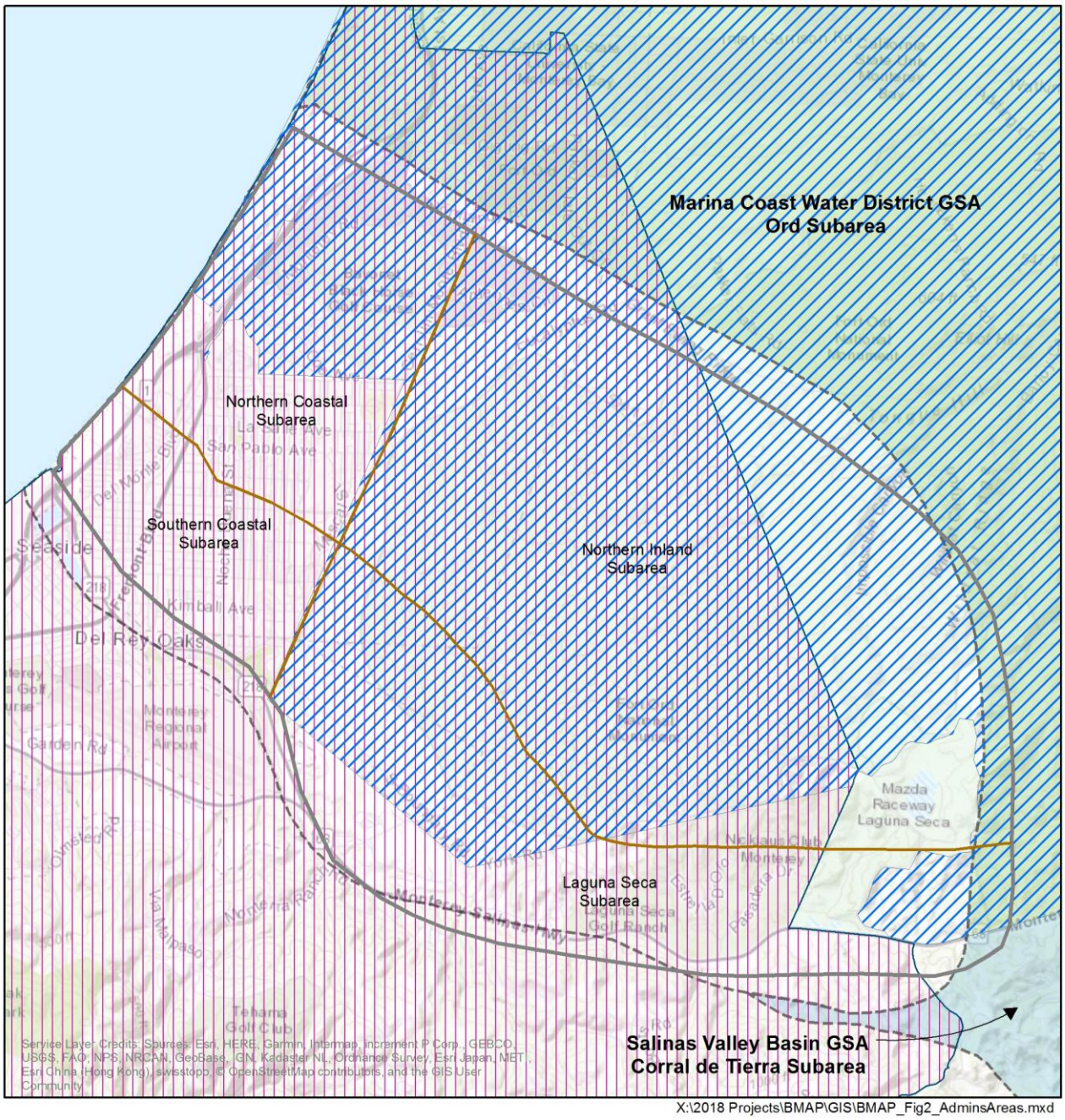
MPWMD is organized and exists under the Monterey Peninsula Water Management District Law, Water Code Appendix Chapter 118 (District Law) and its territory covers an area within the Monterey Peninsula as more particularly described in Section 118-102 of the District Law. MPWMD has the "power as limited in this law to do any and every lawful act necessary in order that sufficient water may be available for any present or future beneficial use or uses of the lands or inhabitants within the district, including, but not limited to, irrigation,

domestic, fire protection, municipal, commercial, industrial, recreational, and all other beneficial uses and purposes." (District Law, Section 118-325). While MPWMD retains its statutory powers in the Basin, it does not unilaterally enforce its powers in the Basin. MPWMD is actively participating in Watermaster-directed efforts to address water supply issues in the Basin. Historically, MPWMD and MCWRA have undertaken water monitoring and management activities within the Basin pursuant to a Memorandum of Understanding between the two agencies.

Figure 1 includes a map depicting MCWRA's Zone 2C and the overlapping territories of MCWRA and MPWMD in the Basin. The lands within Zone 2C are subject to certain restrictions, including but not limited to restrictions on water exportation, which may limit the nature and scope of supplemental water supply projects or recommended groundwater management actions.

Figure 1 also includes two neighboring Groundwater Sustainability Agencies (GSAs) established under the Sustainable Groundwater Management Act (SGMA):

- The Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA) who is responsible for management of the Corral de Tierra subarea of the Monterey Subbasin of the Salinas Valley, and
- The Marina Coast Water District Groundwater Sustainability Agency (MCWDGSA) who is responsible for management of the Ord subarea of the Monterey Subbasin of the Salinas Valley.



EXPLANATION

- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary
- Monterey County Water Resources Agency (MCWRA) Zone 2C
- Monterey Peninsula Water Management District (MPWMD)
- DWR Bulletin 118 Basin Boundaries

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Figure 1. Administrative Jurisdictions in the Basin

3.2 Geologic Framework

The Basin is divided into three hydrostratigraphic units: a deep aquifer, a shallow aquifer, and surficial Aromas Sands. A complete geologic description of these aquifers can be found in Yates et al. (2005). The surficial Aromas Sands are unsaturated in many parts of the Basin, and are not pumped for municipal use. The main aquifers that are the subject of this updated BMAP are the shallow and deep aquifers.

The shallow aquifer is part of the Paso Robles Formation. It consists of a mixture of continentally-derived sand, silt and clay sedimentary deposits. The shallow aquifer is an unconfined aquifer that is overlain by unsaturated surficial Aromas Sand.

The deep aquifer is part of the Santa Margarita Sandstone. It consists primarily of a pale, marine-derived, sedimentary sandstone. Due to overlying low conductivity sediments, the deep aquifer is confined. Based on observed groundwater level behavior in the deep aquifer, there appears to be limited groundwater flowing into the deep aquifer from the shallow aquifer.

Geologic data from the Sentinel Wells, shown as SBWM-1 through SBWM-4 on the well location map (**Figure 2**), reveal that the Santa Margarita Sandstone does not extend north to the basin boundary as previously assumed. The Santa Margarita Sandston was only encountered in the southernmost of the four Sentinel Wells (SBWM-4). Therefore, the lower two-thirds of the Tertiary continental deposits have been reclassified as Purisima Formation and the deep aquifer near the northern Basin boundary is assigned to the Purisima Formation.

Exhibit B of the Decision demarcates the legal boundaries of the Basin, as shown on **Figure 2**. The Basin's southern boundary is defined by the Chupines fault (**Figure 2**). The Basin's northern boundary runs roughly parallel to a groundwater flow divide that acts as a groundwater ridge, separating groundwater flowing north into the Salinas Valley from groundwater flowing south into the Basin.

EXPLANATION

- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary
- Monitoring Well
- Production Well
- ASR Well
- Laguna Seca Anticline
- Faults

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Figure 2. Seaside Basin Well Locations

The Laguna Seca Anticline separates the northern and southern subbasins of the Basin (**Figure 2**). This feature, including the segment of the Ord Terrace Fault that offsets the anticline, forms a subsurface partial hydraulic barrier to groundwater flow. The northern and southern subbasins are further subdivided into coastal and inland subareas. The division between northern and southern subbasins is based on land use and has no hydrogeologic justification. As such, groundwater flow is continuous between inland and coastal subareas as discussed in Section 3.3.1 and 3.3.3.

The Basin's northern boundary as delineated in the Decision is not a structural boundary. The northern boundary is a flow divide that slightly changes position over time in response to changes in recharge and pumping. Pumping centers in the Seaside area, City of Marina, Salinas Valley and lower El Toro Creek area control the local movement of groundwater, and thus the resultant groundwater flow divide location. The groundwater flow divide in the shallow aquifer (**Figure 3**) is farther south than the flow divide in the deep aquifer (**Figure 4**) due to differing groundwater levels and hydraulic gradients in each of the aquifers. However, it is also possible to influence the location of the northern boundary through the use of management strategies such as deliberate placement of extraction wells to form a barrier that would prevent groundwater from flowing out of the Basin.

3.3 Groundwater Levels

3.3.1 Basinwide Groundwater Contour Maps

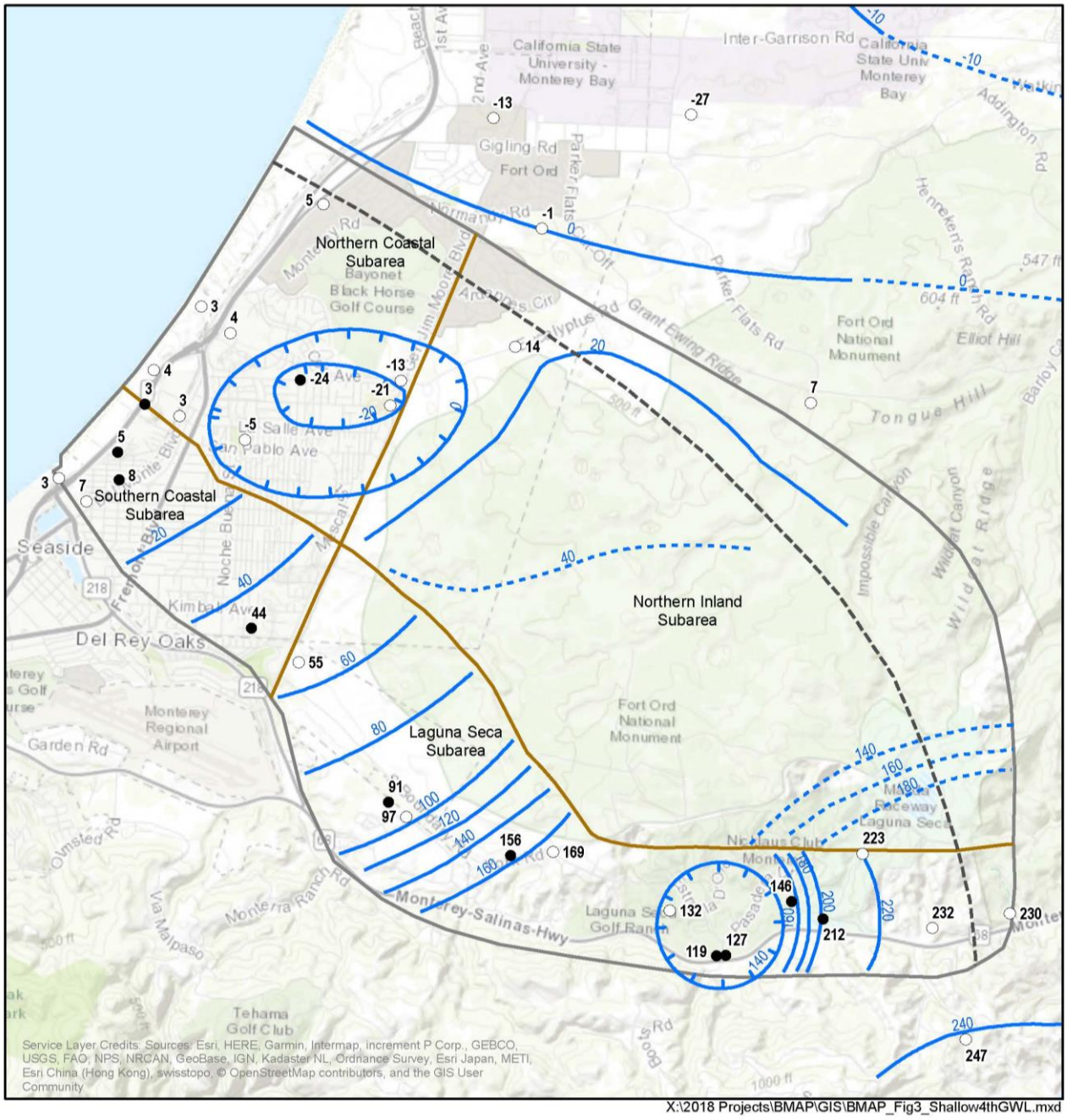
Basinwide contours of 2nd quarter (seasonal high) and 4th quarter (seasonal low) groundwater levels have been prepared annually since 2007 for the Watermaster's Seawater Intrusion Analysis Reports (SIAR). The most recent contour maps were produced for Water Year 2017 (HydroMetrics WRI, 2017). Consistent with previous studies, contour maps were produced for both the shallow and deep aquifers. These maps were contoured by hand from measured groundwater levels in wells.

Groundwater levels from the Basin's shallow aquifer and from the 180-Foot Aquifer and 400-foot Aquifer in the former Fort Ord and Salinas Valley areas are grouped together to represent shallow aquifer conditions. Groundwater levels from the Basin's deep aquifer are grouped with groundwater levels from the Watermaster's Sentinel Wells and the deep aquifer zone in the Marina area.

Figure 3 and **Figure 4** show the groundwater level contour maps for the 4th quarter of Water Year 2017, for the shallow and deep aquifers, respectively.

Groundwater contour maps indicate groundwater levels in the deep aquifer are generally lower than groundwater levels in the shallow aquifer. This is because the shallow aquifer receives direct recharge rainfall; and less groundwater is pumped from it. The deeper aquifer is confined and relatively little water infiltrates into it from above. Additionally, more water is pumped from the deeper aquifer than the shallow aquifer.

The recharge mechanism for the deep Santa Margarita Sandstone is poorly understood. There are limited surface outcrops of the Santa Margarita Sandstone along the Laguna Seca anticline, just north of the Laguna Seca Golf Ranch and just east of the Basin boundary. These limited outcrops provide for very little direct recharge to the aquifer. Additionally, it is unknown whether there is any Santa Margarita Formation occurring immediately beneath the dune sands within Fort Ord that could be recharged by rainfall infiltrating through the dune sands. It is likely that subsurface inflow from outside of the Basin is how the majority of recharge to this aquifer occurs.



EXPLANATION

Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary
- Monitoring Well
- Production Well

WY 2017 Shallow Zone Groundwater Elevation (feet MSL)
- Groundwater Elevation
- Pumping Depression
- Dashed where uncertain (no well data)
- Shallow Aquifer Northern Boundary

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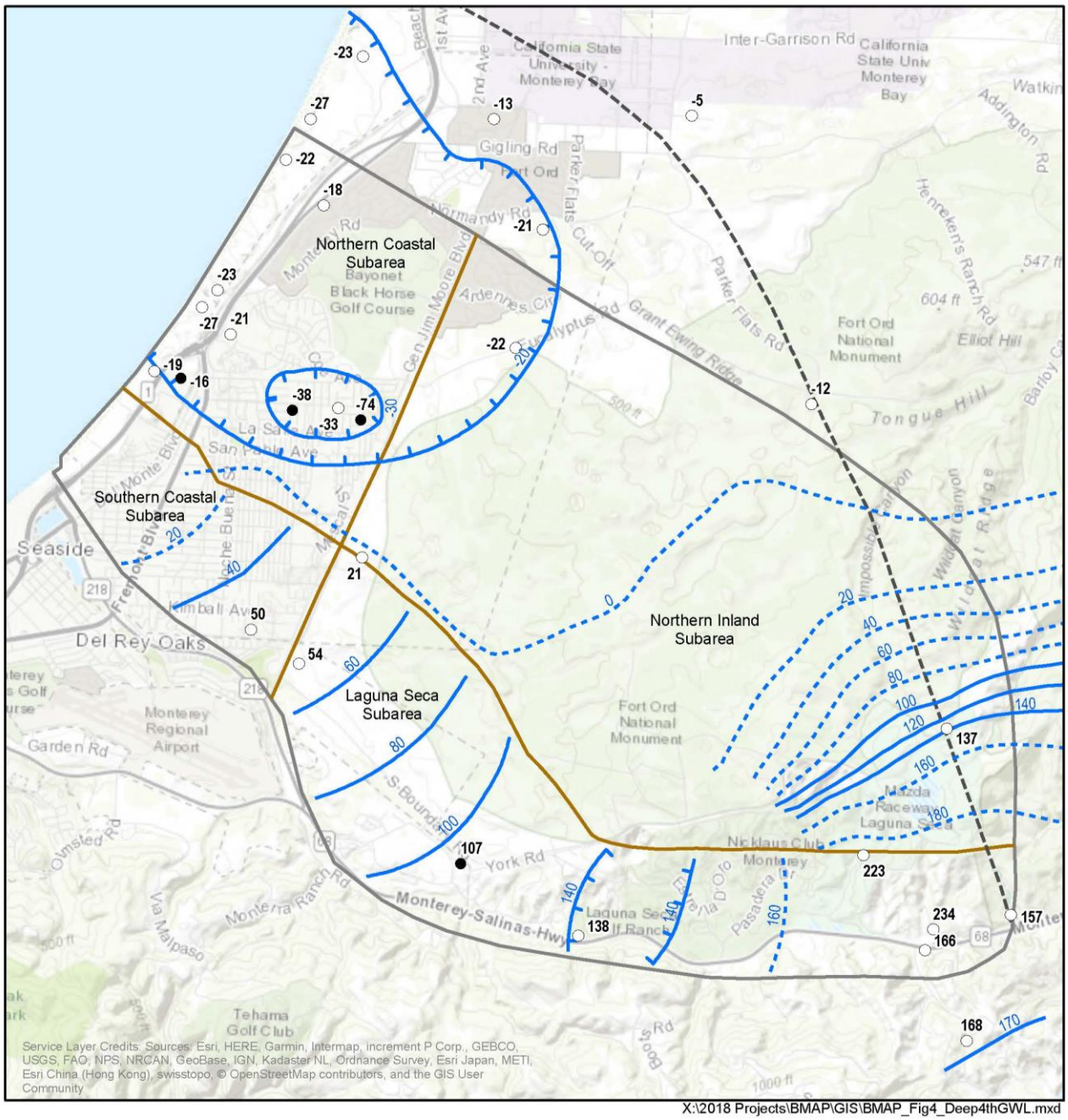
Figure 3. Shallow Zone Water Elevation Map – 4th Quarter WY 2017 (August-September 2017)



EXPLANATION

Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary
- Monitoring Well
- Production Well

WY 2017 Deep Zone Groundwater Elevation (feet MSL)
- Groundwater Elevation
- Pumping Depression
- Dashed where uncertain (no to limited well data)
- Deep Aquifer Northern Boundary

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Figure 4. Deep Zone Water Elevation Map – 4th Quarter WY 2017 (August-September 2017)

Contour maps included in past SIARs show that Basin groundwater contours for the shallow and deep aquifers have retained their general shape. The contour shape reflects the movement of groundwater, which flows from high to low elevations at right angles to the contours. In the Northern Coastal Subarea, groundwater contours are strongly influenced by the pumping depression caused by production wells in both the shallow and deep aquifers. In the shallow aquifer, groundwater elevations in the center of the pumping depression in late summer are about 25 feet below sea level, (**Figure 3**). In the deep aquifer, the center of the pumping depression in late summer is up to 75 feet below sea level, with the pumping depression extending across most of the subarea and causing elevations of most of the subarea's groundwater to be below sea level (**Figure 4**). The deep aquifer's northern flow divide is just over a mile north of the Basin boundary, as indicated by the dashed black line on **Figure 4**.

There are limited wells in the Northern Inland Subarea from which to contour groundwater levels. The data that are available indicate that groundwater flows from southeast to northwest. The Northern Coastal Subarea pumping depression, with groundwater levels below sea level, extends into the adjacent Northern Inland Subarea (**Figure 4**).

The Southern Coastal Subarea has limited groundwater pumping to influence groundwater levels and therefore groundwater flows from the inland areas to the coast without any major deviations (**Figure 3** and **Figure 4**). The direction of groundwater flow is similar throughout the year, although there are small seasonal fluctuations that cause groundwater levels to fluctuate up to a maximum of 1.5 feet.

Groundwater flow in the Laguna Seca Subarea is generally from east to west, but there are several pumping wells within the subarea that influence local groundwater levels. The primary pumping center, with an approximately 80-foot-deep cone of depression, is around golf course irrigation wells at the Nicklaus Golf Course (formerly Pasadera Golf Course). This cone of depression is most evident in the shallow aquifer (**Figure 3**). In the deep aquifer, a smaller pumping depression occurs around golf course irrigation wells at the Laguna Seca Golf Ranch (**Figure 4**).

3.3.2 Northern Subarea Hydrographs

Northern Coastal Subarea - Shallow Aquifer

Figure 5 includes hydrographs from multiple wells in the Northern Coastal subarea. Shallow aquifer groundwater levels in the Northern Coastal subarea are represented as dashed-line hydrographs on **Figure 5.** Groundwater levels in the shallow aquifer nearest the coast have risen slightly, while levels farther inland show slight lowering.

Northern Coastal Subarea - Deep Aquifer

Deep aquifer groundwater levels in the Northern Coastal Subarea are represented by the solid-line hydrographs on **Figure 5**. Groundwater levels in the deep aquifer experienced an average net decline of about 1 foot per year between 1997 and 2009.

Notable groundwater level increases are observed in 2010, 2011, and 2017 in the Northern Coastal Subarea hydrographs. These increases correlate with periods when MPWMD injected Carmel River water into the deep aquifer using Aquifer Storage and Recovery (ASR) wells along General Jim Boulevard. (**Table 4**). The purpose of the ASR project is to store excess Carmel River water in the basin and to recover it from the same aquifer when it is needed. More information on the project is provided in Section 4.3.3.

Table 4. Summary of ASR Injection and Recovery by Water Year

Water Year	Volume Injected (acre-feet)					Volume Recovered (acre-feet)
	ASR-1	ASR-2	ASR-3	ASR-4	Total Injected	
2010	808.3	297.6	-	-	1,105.9	0
2011	560.1	554.3	-	-	1,114.4	1,110.5
2012	0	104.7	20.6	-	125.3	1,224.3
2013	0	188.7	102.5	0	291.2	643.6
2014	0	0	0	0	0	0
2015	38.6	130.9	45.2	0.5	215.2	0
2016	163.8	367.0	164.0	4.4	699.2	609.5
2017	542.8	981.7	577.9	242.9	2,345.3	1,501.3

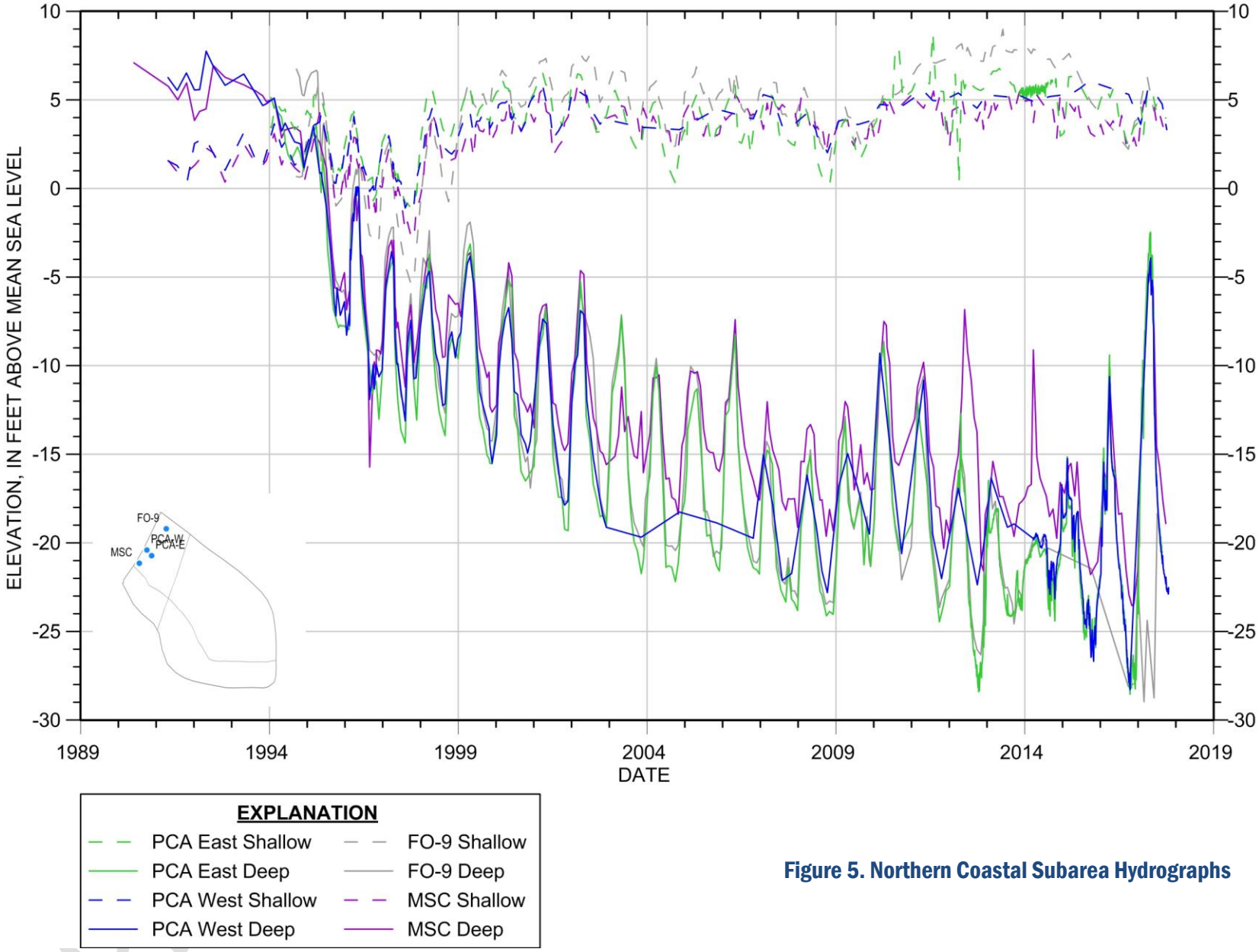


Figure 5. Northern Coastal Subarea Hydrographs

Figure 6 shows groundwater levels in all four of the Watermaster's Sentinel Wells have declined between 8 and 18 feet since the wells were constructed in 2007. The wells also all show groundwater level fluctuations that are similar seasonal to other monitoring wells in the Northern Coastal Subarea (**Figure 5**). This includes the larger fluctuations when MPWMD injects Carmel River water into the deep aquifer. Superimposed on the seasonal trend are daily fluctuations driven by ocean tides and variations in response to groundwater pumping at major production wells. The response to ocean tides observed in these hydrographs does not imply a direct hydraulic connection between the ocean and the Sentinel Wells. It is likely a pressure response from cyclic loading from tidal changes in the overlying shallow Paso Robles aquifer (Feeney and Rosenberg, 2003). In general, groundwater level responses are nearly simultaneous among the four wells, suggesting that the pressure drop propagates rapidly from the injection wells. Previous review of pumping data from MCWD's Wells 10 and 11 showed a lack of correlation between pumping responses from those wells in the Ord subarea of the Monterey Subbasin of the Salinas Valley with groundwater levels in the Sentinel Wells. This supports the finding that seasonal fluctuations observed in the Sentinel Wells are due to pumping in the Basin and not from wells in the Ord subarea of the Monterey Subbasin of the Salinas Valley (HydroMetrics LLC, 2009a).

Both the deep monitoring wells (**Figure 5**) and Sentinel Wells (**Figure 6**) demonstrate that there are ongoing, persistent declines in groundwater levels in the deep aquifer. These declines have continued despite triennial reductions in groundwater pumping. However, there is evidence that injection of over 1,000 acre-feet per year of Carmel River during wet years provides a temporary increase in groundwater levels. Declining groundwater levels continue in years when there is less than 1,000 acre-feet of injection.

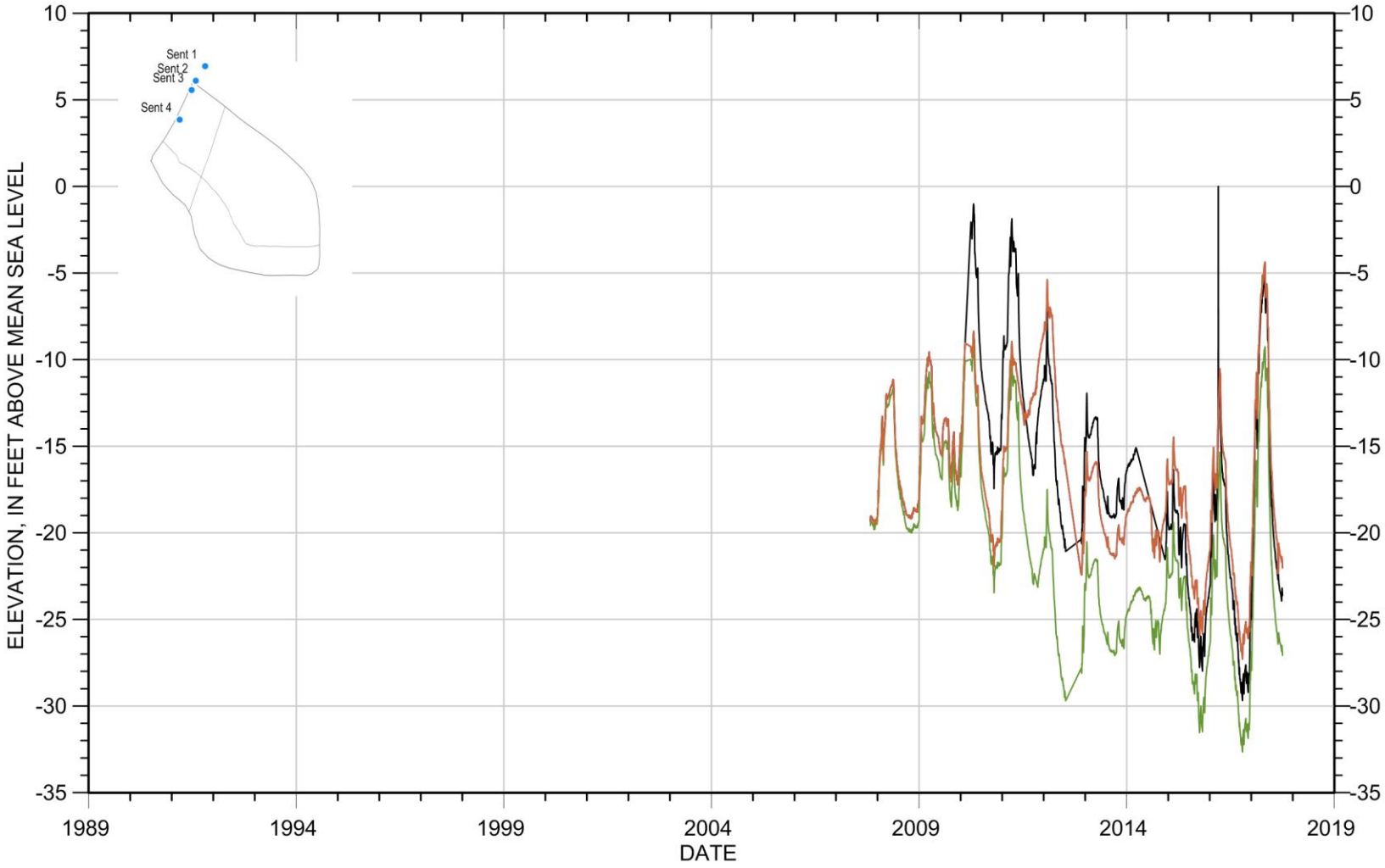


Figure 6. Sentinel Well Hydrographs

Northern Inland Subarea

Groundwater elevation data from the Northern Inland Subarea are shown on **Figure 7.** Groundwater level data is limited in the Northern Inland Subarea due to a lack of monitored wells. Groundwater levels in monitoring well Fort Ord 3 (FO-3), near the most-inland corner of the subarea, experienced declining groundwater levels at a rate of approximately 0.5 - 1 feet per year until 2010. Thereafter, groundwater levels have remained fairly constant. This indicates that groundwater levels throughout the Northern Inland Subarea, even though not pumped, are influenced by pumping in the Northern Coastal Subarea. Stabilized groundwater levels in 2010 may be due to high volumes of Carmel River water injected near the western edge of the subarea starting in Water Year 2010. Even though there was less injection between 2012 and 2016, plus a drought from 2012 through 2015, groundwater levels in the vicinity of FO-3 have remained relatively steady since 2010.

Fort Ord 7 (FO-7) located near the western boundary of the Northern Inland Subarea (**Figure 2**) is about 3,500 feet from the closest ASR wells. It experienced declining groundwater levels to below sea level until about 2010. After injection started in 2010, the well's hydrograph shows increases in times of substantial injection including Water Years 2010, 2011, and 2017 (**Figure 7**) of over 10 feet. It is important to note that even though injection of Carmel River water increases winter groundwater levels, summer/fall levels in 2016 were lower than they were before injection started in 2010. Shallow aquifer groundwater levels at well FO-7 also rise in response to injection during 2010 and 2011, but continue to decline after 2015 (**Figure 7**).

3.3.3 Southern Subarea Hydrographs

Southern Coastal Subarea

Hydrographs for selected wells in both the shallow and deep aquifers in the Southern Coastal subarea are shown on **Figure 8**. Groundwater levels in the Southern Coastal subarea have been stable in recent years, with flat to slightly rising hydrographs.

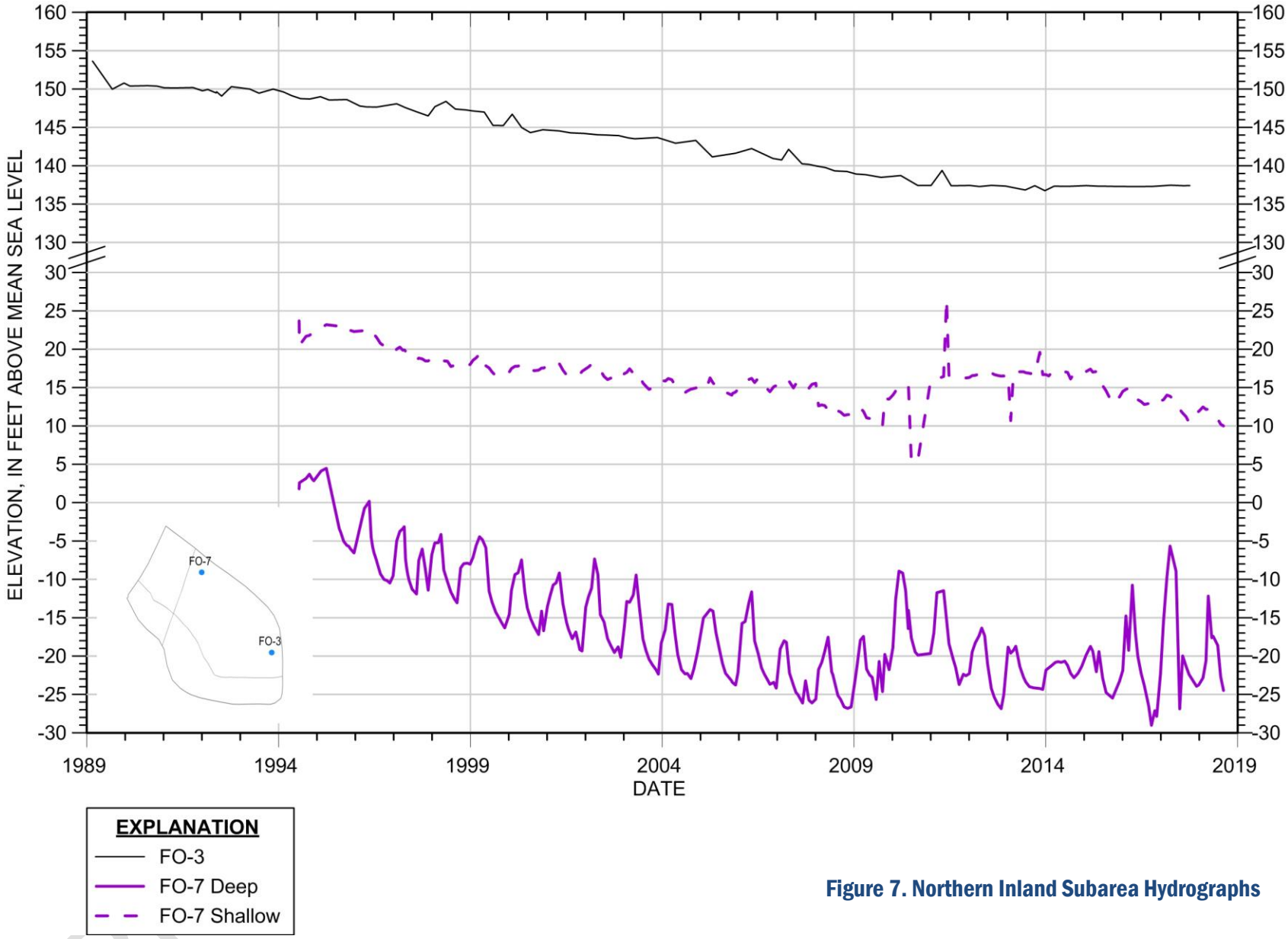


Figure 7. Northern Inland Subarea Hydrographs

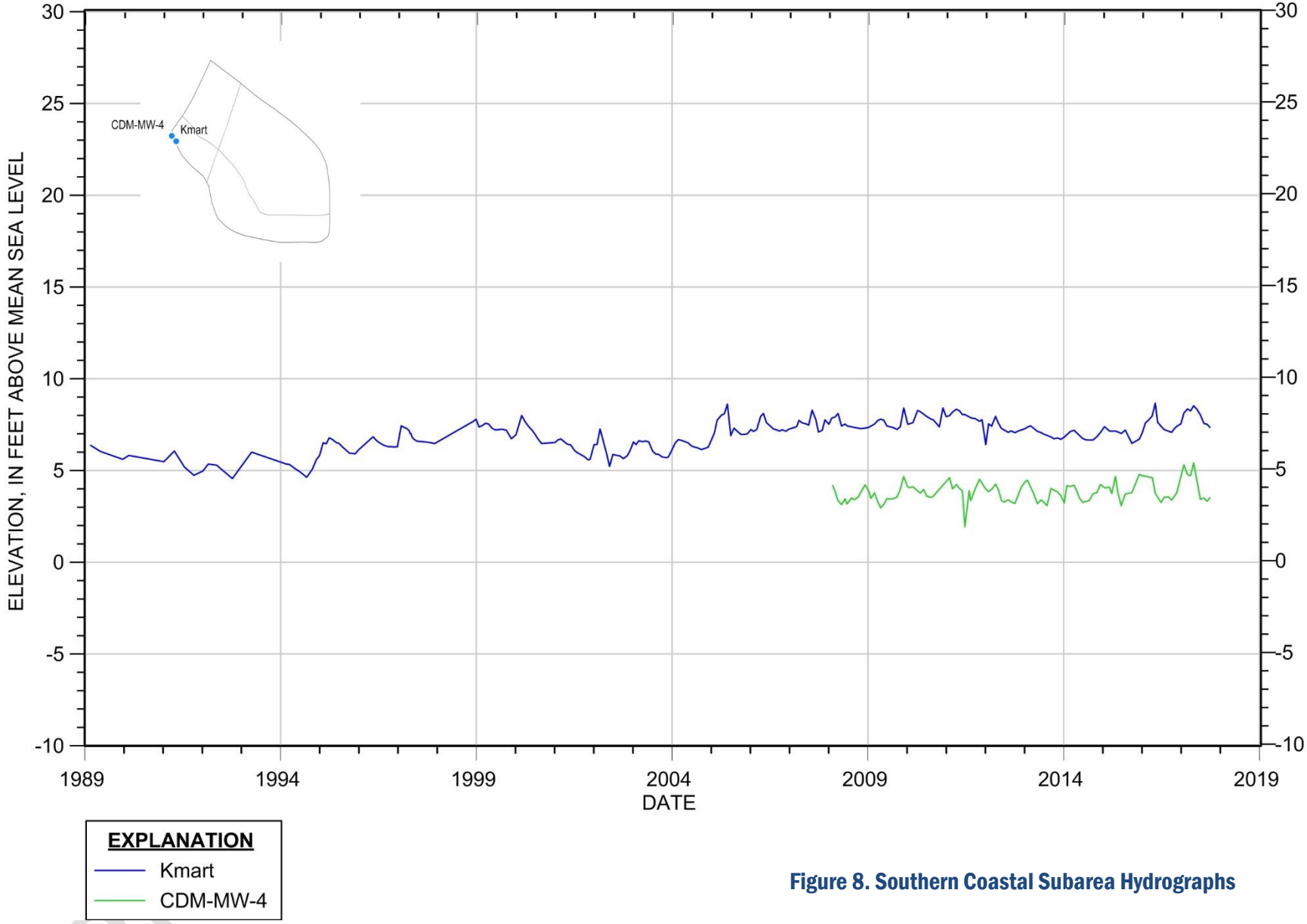


Figure 8. Southern Coastal Subarea Hydrographs

Laguna Seca Subarea

Hydrographs for selected wells in the Laguna Seca subarea are shown on **Figure 9**. Groundwater levels in both the shallow and deep aquifers in the central and eastern portions of the subarea, including the FO-5, FO-6 and York Road wells have declined at rates averaging as high as 4 feet per year, from 1999 through 2014 (**Figure 9**). Since 2014, the decline is less and appears close to stabilizing.

To better understand ongoing declining groundwater levels in the Laguna Sea Subarea, the Watermaster evaluated the subarea's Natural Safe Yield (HydroMetrics WRI, 2013) and the location of groundwater flow divides within the subarea (HydroMetrics WRI, 2016). The Seaside Basin groundwater model was used in these studies. The studies' conclusions included:

- The modeled water budget estimated an average annual Natural Safe Yield of 240 acre-feet per year. This is considerably lower that the Decision's Natural Safe Yield of 608 acre-feet per year. Even if pumping is reduced to the Natural Safe Yield of 240 acre-feet per year, stable groundwater levels are not achieved in all Laguna Seca Subarea wells because of the uneven distribution of pumping. Furthermore, model simulations suggest that even eliminating all pumping from the subarea will not completely halt the predicted decline in groundwater elevations in the easternmost monitoring wells: FO-6-Shallow and FO-6 Deep. These declining groundwater elevations appear to result from the presence of nearby pumping wells east of the subarea. Because no level of pumping will stabilize all groundwater levels, it is not possible to determine an operational Safe Yield for the Laguna Seca Subarea.

- Two prominent groundwater flow divides influence flow within the subarea. The flow divides are shown with purple lines on **Figure 10**. One of the flow divides begins southeast of the Laguna Seca Anticline, which at this location forms the boundary between the Laguna Seca and Northern Inland Subareas. The flow divide runs east-southeast to just outside of the Seaside Basin. The northern portion of this divide appears to be relatively well defined, but the southern portion of the divide is weakly defined. It is likely that the southern portion of this divide has less of an influence on flow directions. Groundwater on the southern side of the divide flows west into the Laguna Seca Subarea and groundwater on the northern side of the divide flows northeast into the Northern Inland Subarea. This flow divide terminates at a second flow divide that surrounds a pumping depression outside the Basin.

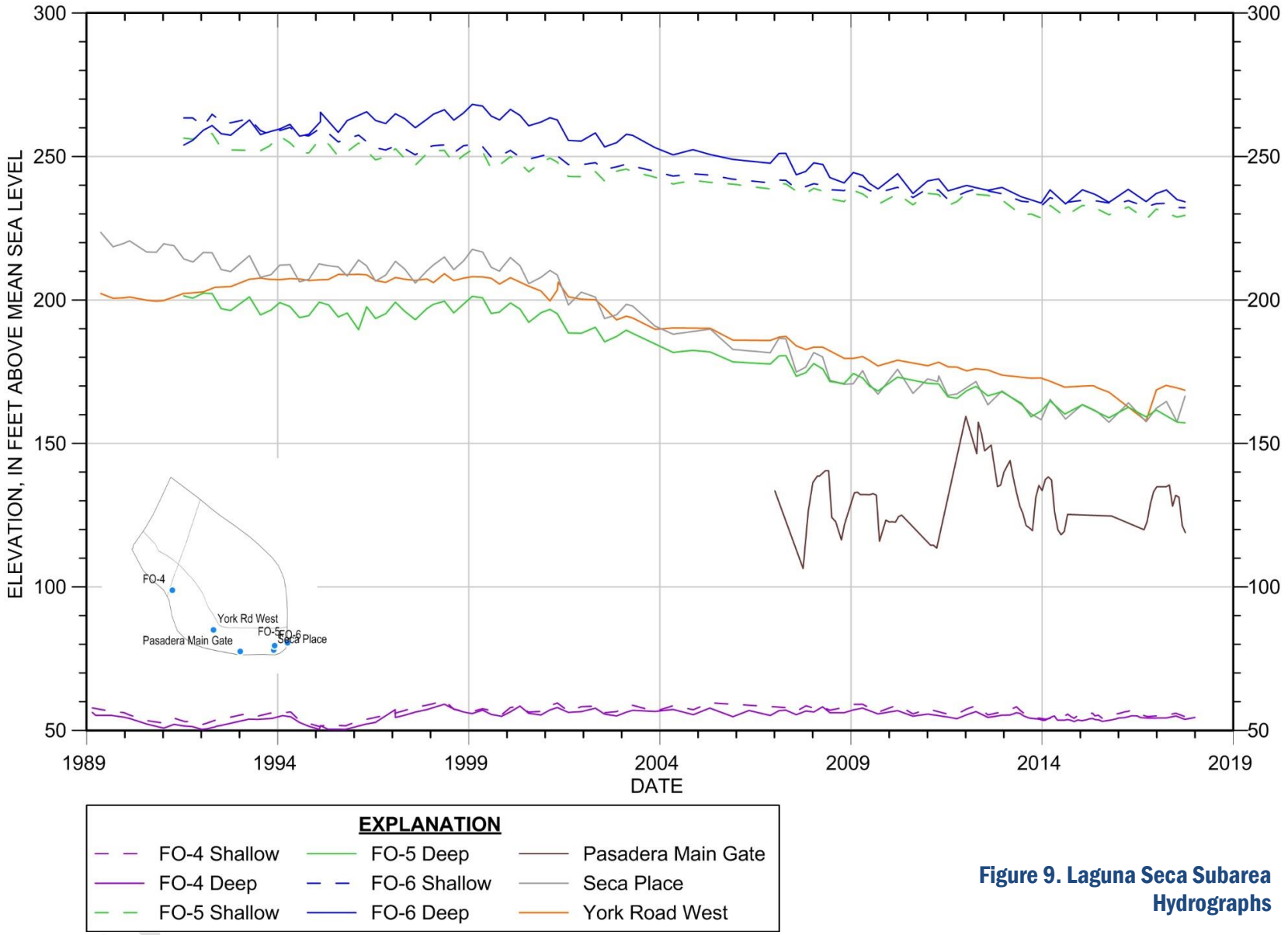


Figure 9. Laguna Seca Subarea Hydrographs

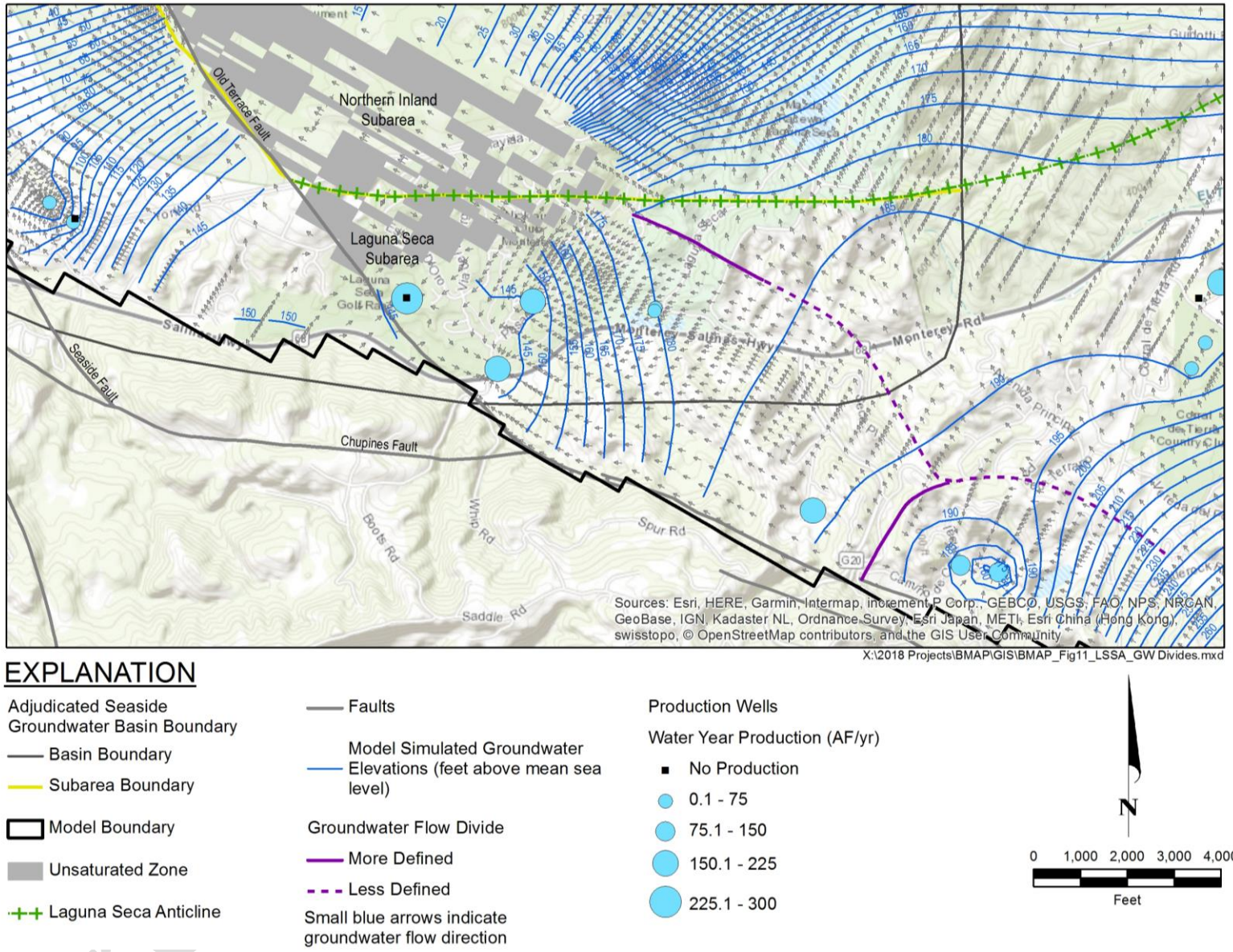


Figure 10. General Location of Groundwater Flow Divides in the Laguna Seca Subarea

3.3.4 Protective Groundwater Elevations

Protective groundwater elevations for selected coastal monitoring wells were established in 2009 using the Basin groundwater flow model and cross-sectional modeling (HydroMetrics LLC, 2009b). These protective elevations are designed to avoid and control seawater intrusion. Maintaining groundwater elevations at protective elevations will provide adequate pressure to prevent seawater intrusion. The 2009 protective elevations for both deep and shallow aquifers are summarized in **Table 5**. A subsequent study in 2013 to revisit and update the protective groundwater elevations concluded that protective elevations should not be lowered (HydroMetrics LLC, 2013).

Table 5. Summary of Protective Elevations for Coastal Monitoring Wells

Subarea	Well	Completion	Protective Elevation, feet above sea level
Northern Coastal	MSC	Deep	17
		Shallow	11
	PCA-W	Deep	17
		Shallow	2
	Sentinel Well 3	Deep	4
Southern Coastal	CDM-MW4	Shallow	2

Hydrographs for shallow monitoring wells for which protective elevations were established are shown on **Figure 11** through **Figure 13**. The only shallow protective elevation monitoring well with groundwater elevations below protective elevations is MSC shallow, which has levels 7 feet below protective elevations.

Hydrographs for deep monitoring wells for which protective elevations were established are shown on **Figure 14** through **Figure 16**. None of these deep monitoring wells have achieved protective groundwater level elevations.

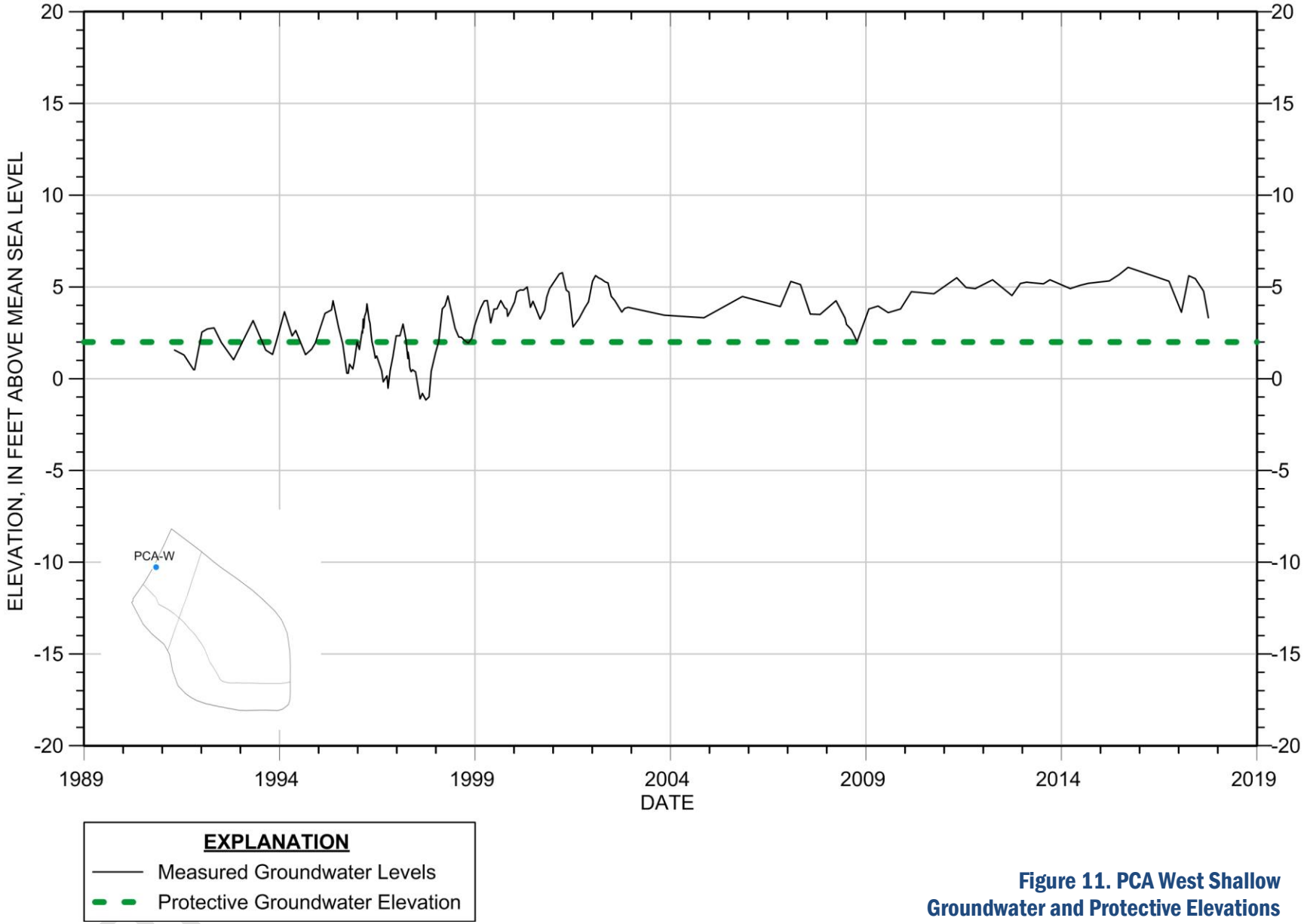


Figure 11. PCA West Shallow Groundwater and Protective Elevations

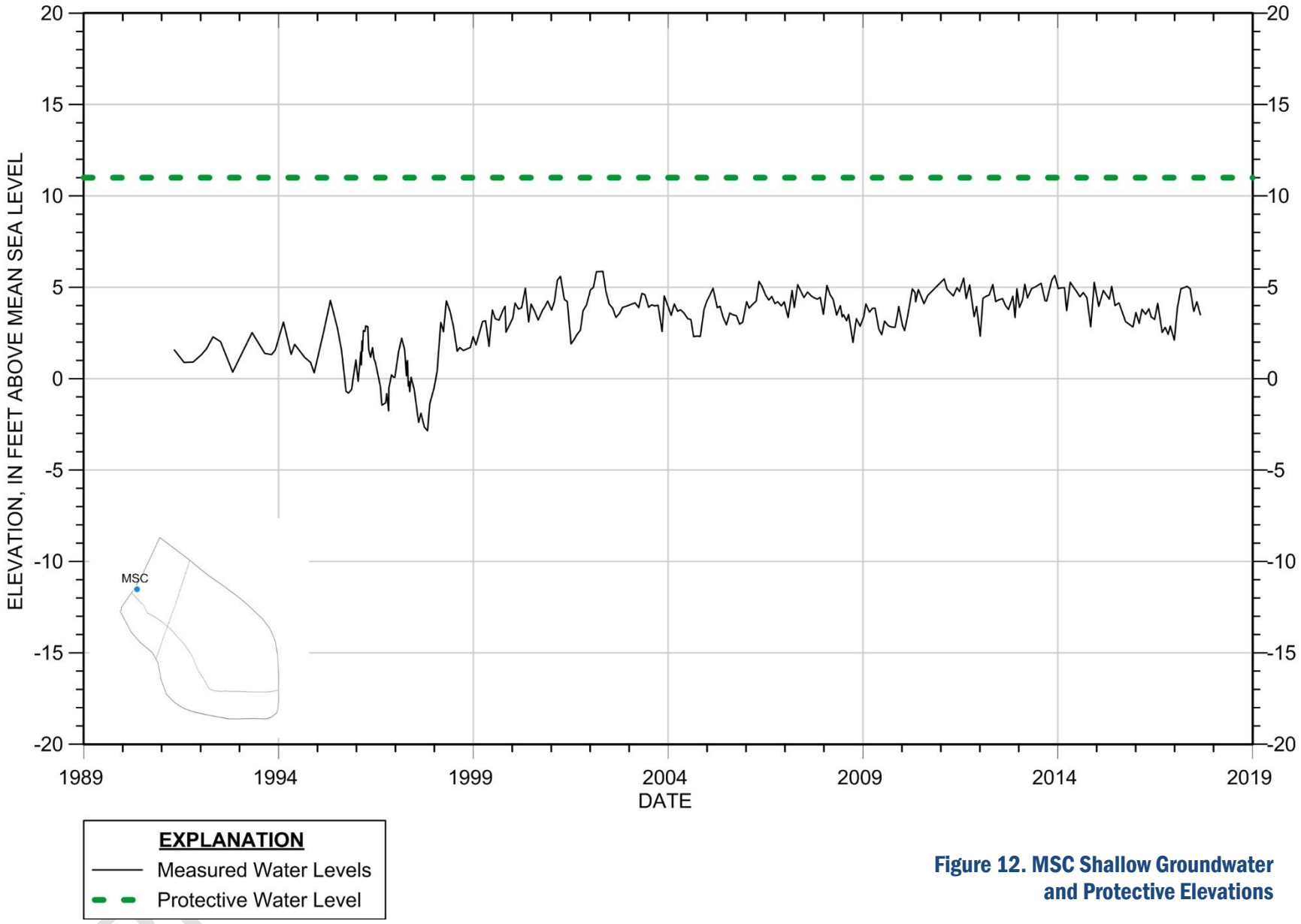


Figure 12. MSC Shallow Groundwater and Protective Elevations

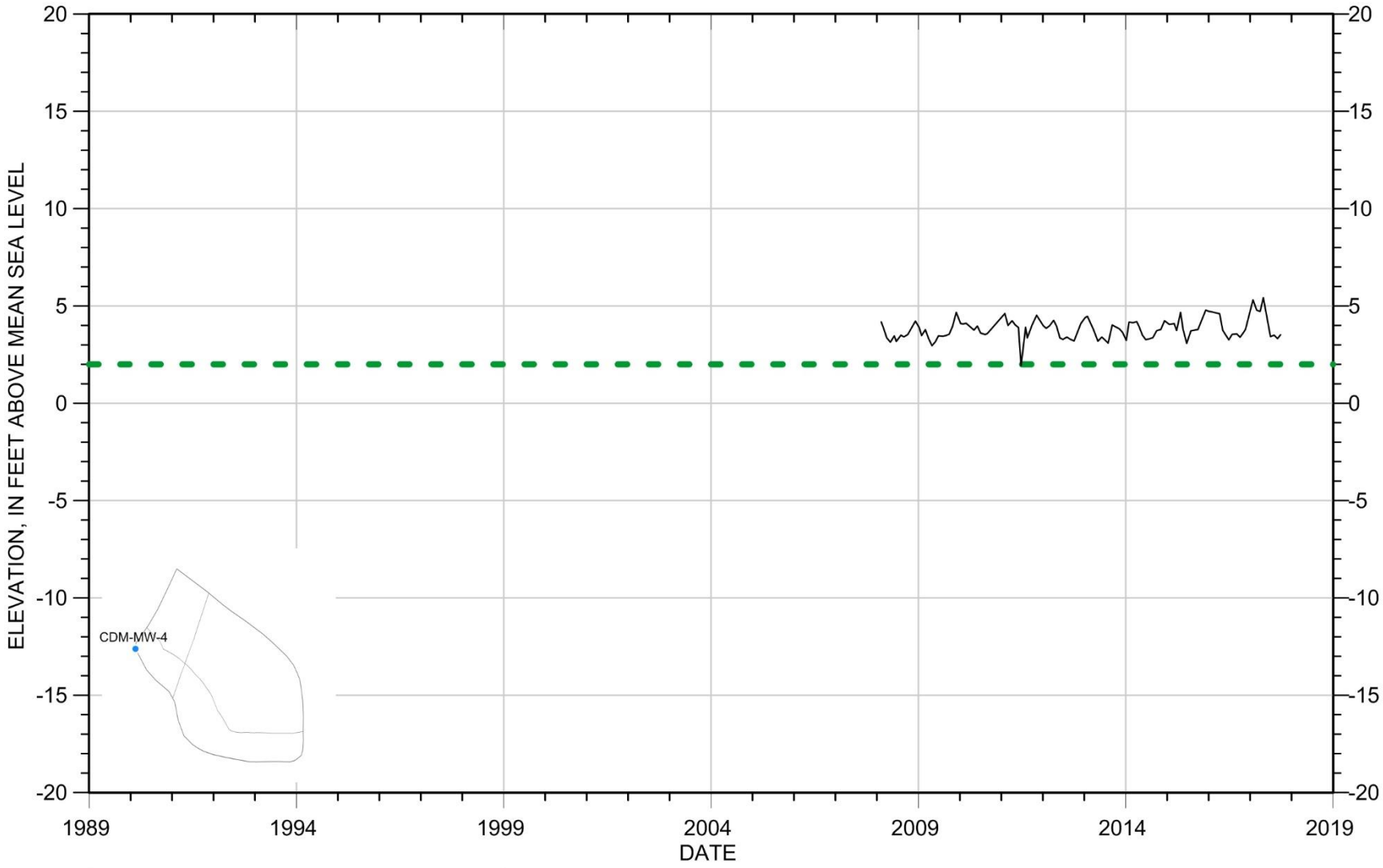


Figure 13. CDM-MW-4 Shallow Groundwater and Protective Elevations

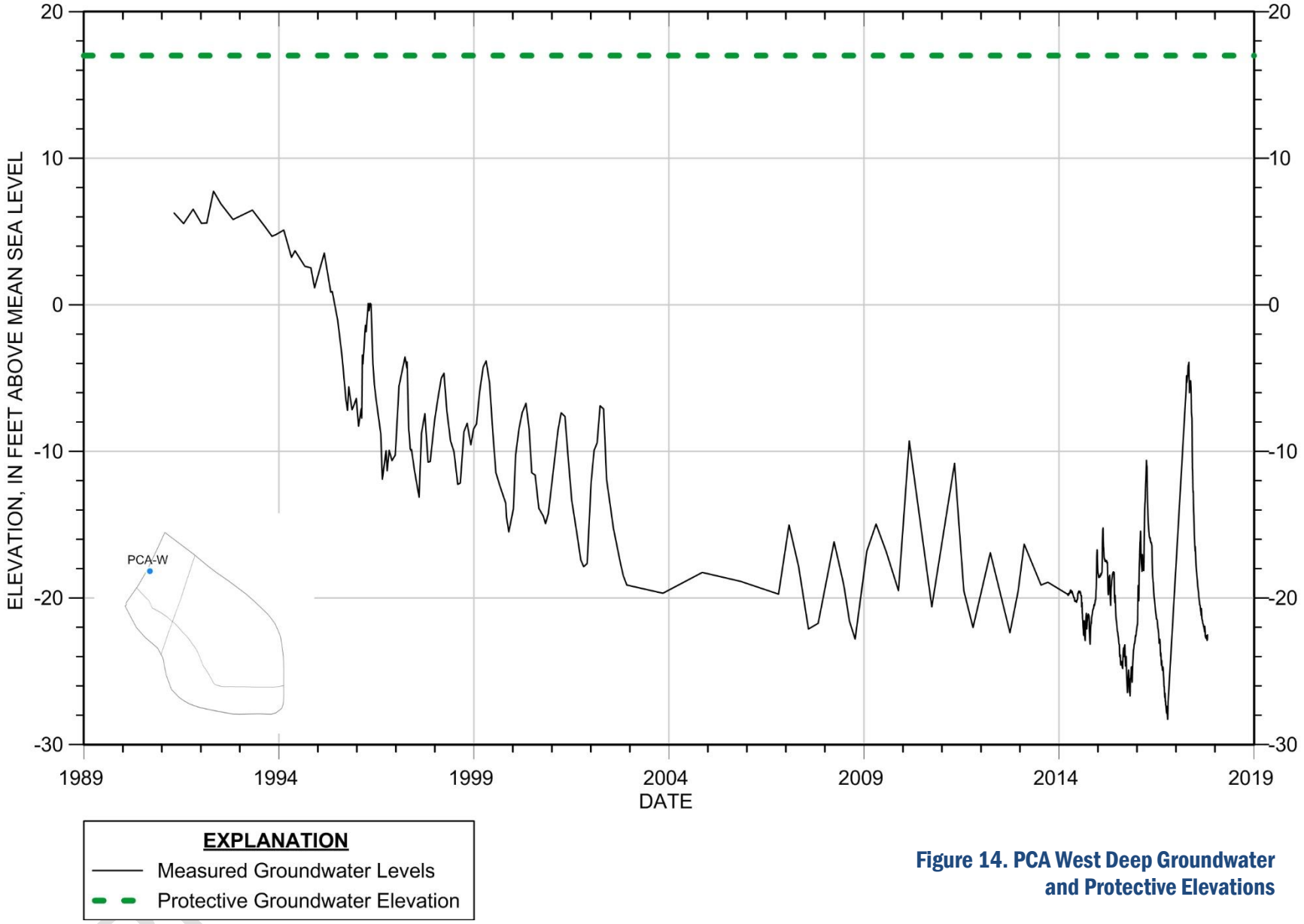


Figure 14. PCA West Deep Groundwater and Protective Elevations

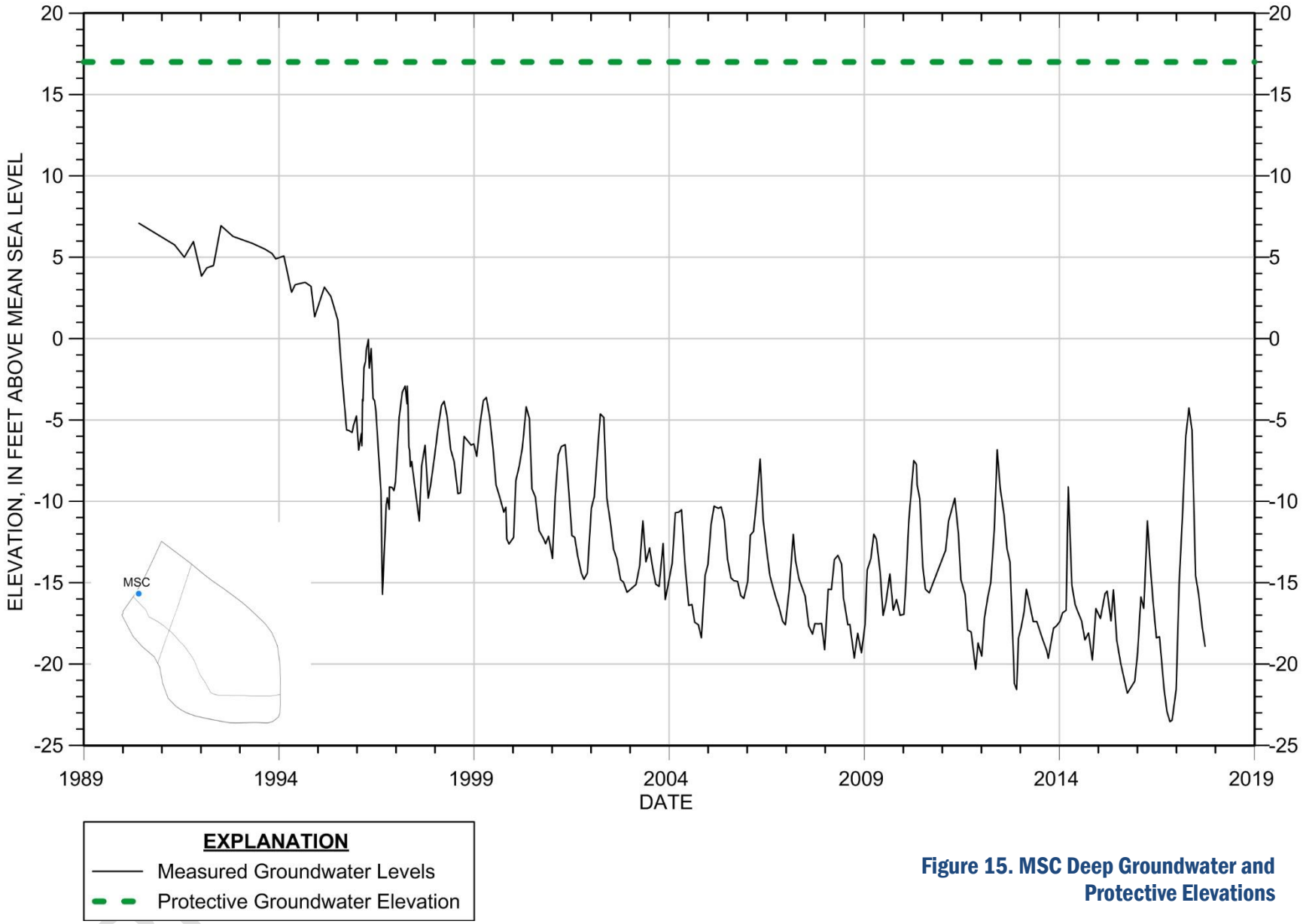


Figure 15. MSC Deep Groundwater and Protective Elevations

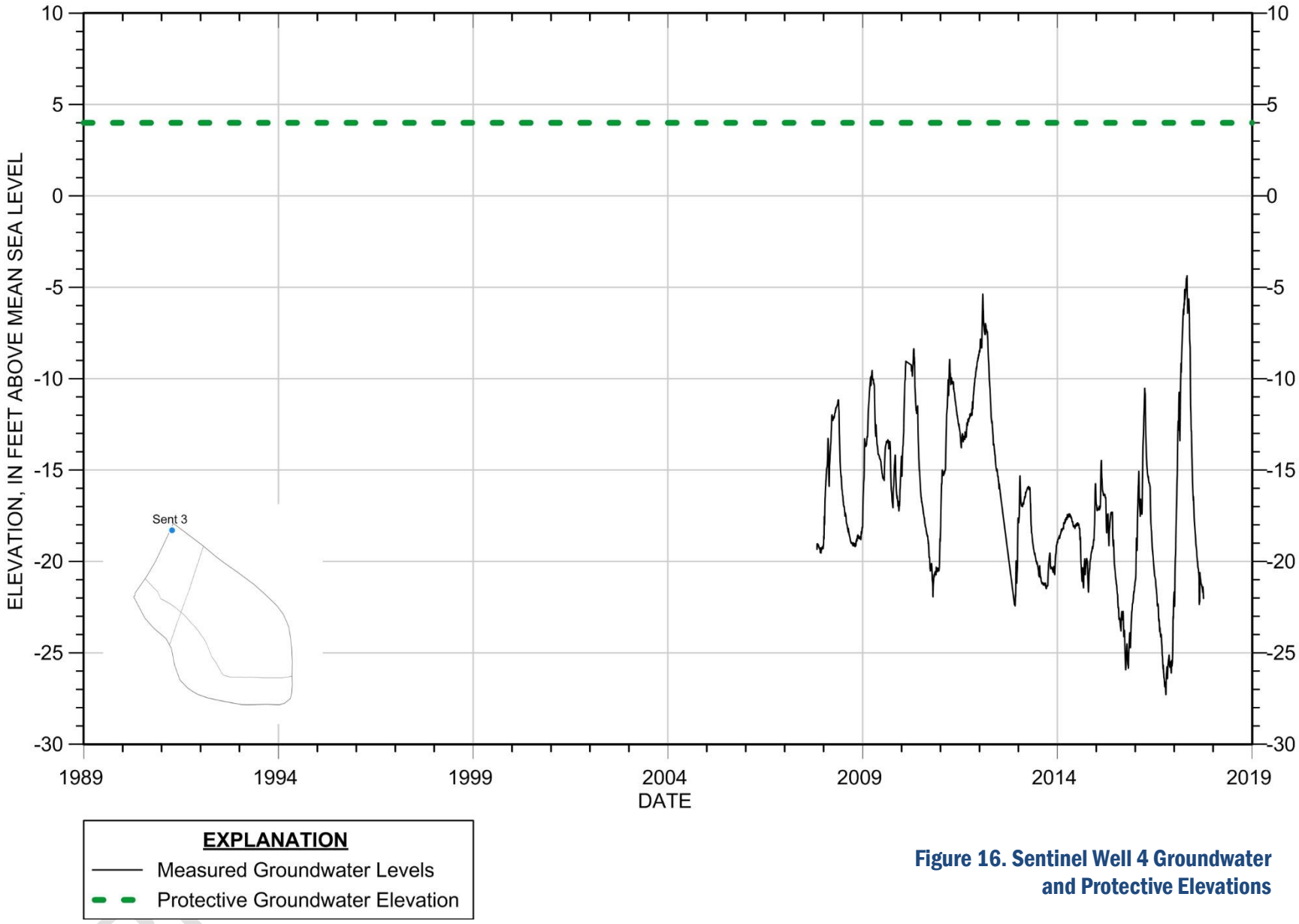


Figure 16. Sentinel Well 4 Groundwater and Protective Elevations

3.4 Groundwater Level Conclusion

A number of observations and conclusions relevant to the storage analysis can be drawn from the groundwater level data:

- The deep Santa Margarita aquifer is highly confined. High confinement means there is very little leakage into the aquifer from above. It is apparent that vertical leakage within the aquifer system is low near the coast, which retards the downward movement of seawater. Supporting this statement are:
    - Drawdown of groundwater levels in the Sentinel Wells correlates closely with pumping cycles in the Ord Grove and Paralta production wells and injection at the ASR wells, despite being relatively distant from these wells. Responses to pumping at long distances is indicative of confined conditions.
    - The prominent tidal fluctuations observed in Sentinel Well groundwater levels is a common occurrence in confined aquifers even if they are not directly connected to the ocean.
- There is still a flow divide between the Basin and the Salinas Valley, with the flow divide occurring below sea level. The deep aquifer groundwater contours in the Northern Coastal Subarea reveal a relatively flat groundwater surface extending northwards along the coast, at an elevation of about 20 feet below sea level.
- The persistence of groundwater levels below most coastal protective groundwater elevations implies that seawater will likely eventually intrude into the Basin. Although intrusion may take many years or decades to occur, groundwater levels need to rise above protective elevations to ensure protection of the aquifers.
- The continued steady long-term decline of groundwater levels over the last 25 years at monitoring well FO-3 indicates that coastal pumping influences groundwater levels in the Northern Inland Subarea at a distance of over 4 miles inland (**Figure 7**).
- Groundwater levels have continued to decline in all parts of the Basin, except in the Southern Coastal Subarea and in shallow wells near the coast in the Northern Coastal Subarea. In those locations, groundwater levels remain stable.

- Modeling to re-evaluate the Laguna Seca Subarea Natural Safe Yield and to examine groundwater elevations under anticipated future pumping conditions indicates that groundwater levels will continue to decline even when all pumping in the subarea is stopped (HydroMetrics WRI, 2013). The eastern portion of the Laguna Seca subarea suffers the greatest and most persistent declines. These declining groundwater elevations appear to result from the presence of nearby pumping wells east of the subarea.

3.5 Groundwater Storage

This updated BMAP uses the same storage concepts and conceptual framework for implementing the provisions of the Decision that were used in the first BMAP (HydroMetrics LLC, 2009a). The concepts were applied to obtain quantitative estimates of groundwater storage under current and historical conditions. Estimates of storage changes between 2013 and 2017 were used to refine the groundwater budget and review the Natural Safe Yield of the Basin.

3.5.1 Storage Concepts

Three key storage terms used in this section are total stored groundwater, usable stored groundwater, and *Total Usable Storage Space*.

- *Total Stored Groundwater* in a basin is the total volume of groundwater below the water table and above the impermeable geologic materials that forms the bottom of the basin.

- *Usable Stored Groundwater* is a portion of the total stored groundwater that reflects limitations imposed by well depths, well locations, seawater intrusion threats, aquifer layering, etc. Some of these limitations are fixed characteristics of the natural system that are difficult to change. Others are man-made characteristics such as well locations and land use that could be changed to optimize the amount of usable storage space.

- *Total Usable Storage Space* refers to the usable portion of the aquifer above the water table that is currently unsaturated and could be used for artificial recharge and groundwater storage. It can be thought of as the volume of storage that is currently unused, and therefore available for storage of replenishment water. It is defined in the Decision (Section III.A.41) as:

> "Total Useable Storage Space means the maximum amount of space available in the Seaside Groundwater Basin that can prudently be used for Storage as shall be determined and modified by Watermaster… less Storage space which may be reserved by the Watermaster for its use in recharging the Basin."

In practice, the majority of *Total Useable Storage Space* is in the shallowest portion of the Basin. This is because the shallowest aquifer is an unconfined aquifer that has drainable pore space for storage. Pumping a confined aquifer depressurizes it and groundwater in storage is released by changes in the pressure, not dewatering pore spaces. This translates to confined aquifers having less storage capacity than unconfined aquifers.

Additionally, the majority of the *Usable Stored Groundwater* is in the shallowest portions of most basins. Groundwater deep within a basin cannot be completely withdrawn without risking seawater intrusion, lowering groundwater levels at nearby wells, inducing subsidence, or causing other undesirable results.

The simplest approach is to consider all groundwater and all storage space below sea level as unusable regardless of distance from the coast. A more realistic approach considers the difference in density between seawater and freshwater. Because protective elevations along the Basin's coastline have been calculated that reflect these density differences, it is assumed *Usable Stored Groundwater* is all groundwater occurring above protective elevations at the coast and continuing inland as a groundwater surface that results from protective elevations being met at the coast. A description of the protective elevation surface is provided after **Figure 17**.

The ability to use storage space is further limited by the locations of wells. The distribution of wells in the Basin is very uneven, with the majority of groundwater production taking place in one subarea (Northern Coastal Subarea). Moving production wells inland could even out and redistribute the coastal cone of depression, resulting in less associated risk of seawater intrusion and allow more efficient access to usable stored groundwater in the Northern Inland Subarea.

3.5.2 Quantitative Estimates of Groundwater Storage

Total Stored Groundwater

The total stored groundwater in the Basin has been estimated in several previous technical studies and by MPWMD as part of their basin monitoring program. These estimates relied on various assumptions and covered different areas, so the values are not

strictly comparable to each other. However, the method employed by all storage estimates is similar: storage is calculated as the product of a geographic area, a vertical distance between two groundwater level surfaces, and a storage coefficient.

Previous estimates of total stored groundwater were summarized in the 2009 BMAP (HydroMetrics LLC, 2009a). Those estimates that included the whole Basin resulted in a range of groundwater in storage of between 439,000 and 730,200 acre-feet. The greatest source of discrepancy among previous estimates stems from the use of different geographic areas for the analysis.

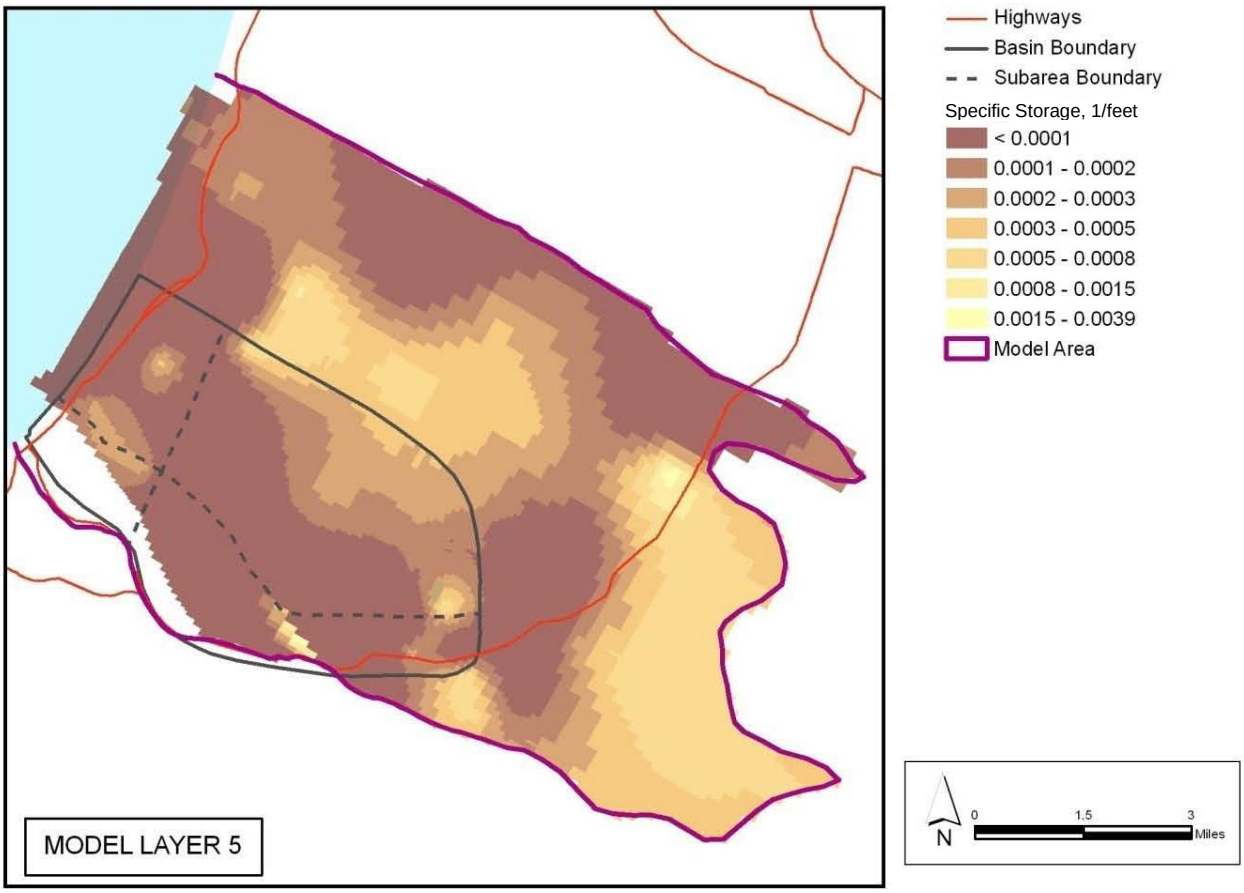
Neither the BMAP nor the SGMA requirement for annual reporting of change in storage for adjudicated basins require an estimate of total stored groundwater. Thus, the estimate is not updated from that included in the 2009 BMAP.

Usable Stored Groundwater

Current estimates of usable stored groundwater were developed for this report using an approach similar to those used in previous investigations. As mentioned previously, storage is calculated as the product of a geographic area, a vertical distance between two groundwater surfaces, and a storage coefficient. Two types of storage coefficients were used: specific yields and storativities. Specific yield, or drainable porosity, is the volume of water an unconfined aquifer will yield when water is allowed to drain out of it under the forces of gravity. Storativity is a measure of the volume of water a confined aquifer releases per unit surface area of the aquifer per unit change in head. Both specific yields and storativities are measured as percentages of the total aquifer volume. Storativities are smaller than specific yields, usually by a few orders of magnitude.

A specific yield of 0.12 from model layer 2 representing the shallow aquifer and a variable specific storage ranging from less than 0.0001 to 0.0039 per unit decline in head (1/feet) for model layer 5 representing the deep aquifer (**Figure 17**) are used in the storage calculations. In this context specific storage means the volume of water that an aquifer releases from storage, per volume of aquifer, per unit decline in hydraulic head. The specific storage is multiplied by layer thickness to derive Storativity. These specific storage values were obtained by calibrating the Seaside Basin groundwater model to long-term groundwater level changes (HydroMetrics LLC, 2009b).

Specific storage values were used to calculate useable stored groundwater for the confined deep aquifer; and a specific yield is used to calculate useable stored groundwater for the shallow unconfined aquifer. The storage coefficients are the same coefficients used to estimate annual changes in groundwater in storage for annual



reporting to the California Department of Water Resources (DWR) since Water Year 2015, under the Sustainable Groundwater Management Act (SGMA).

Figure 17. Model Calibrated Storage Coefficient for Model Layer 5 (Deep Aquifer)

Several elevation surfaces were used to calculate the different components of storage:

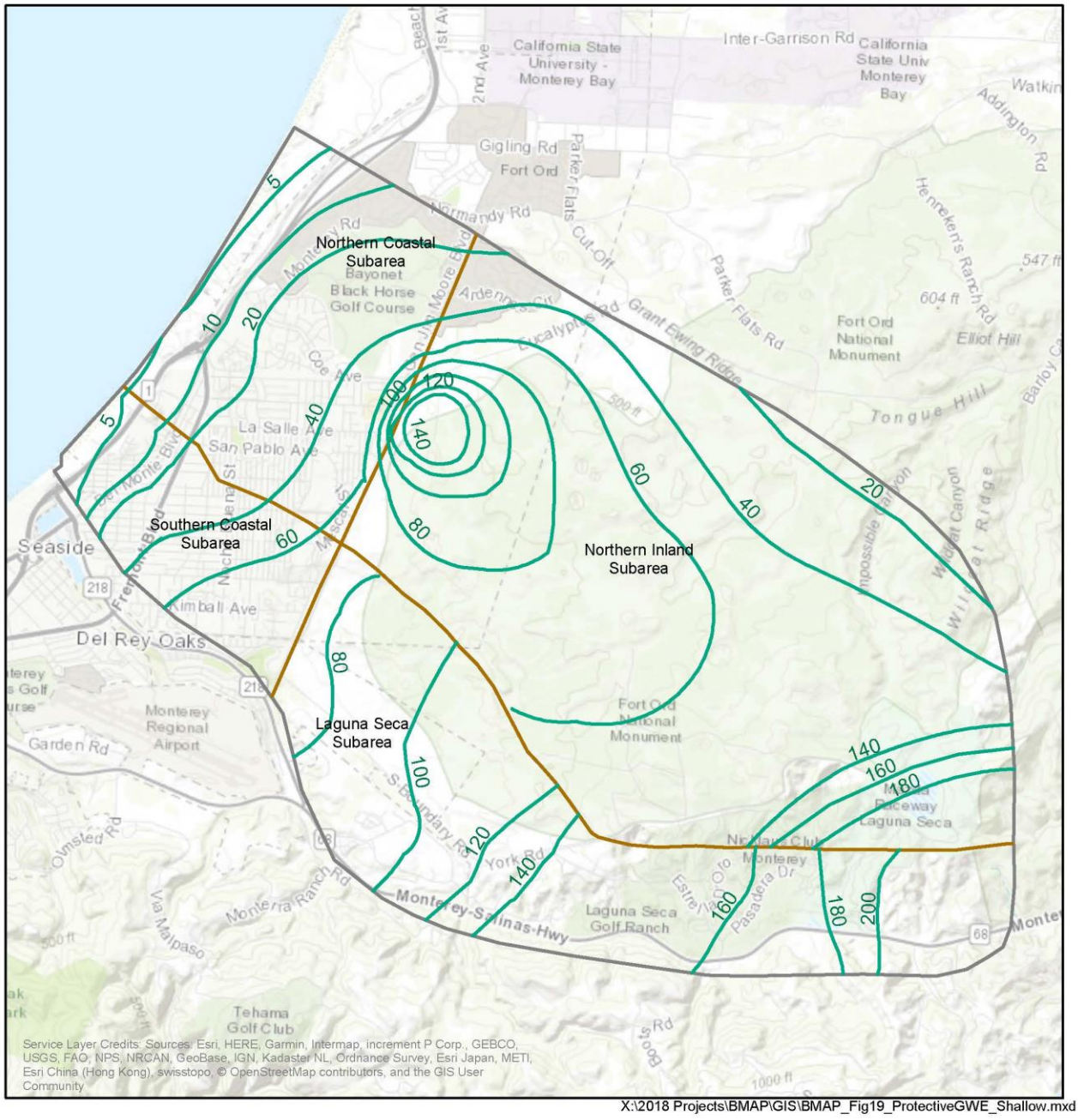
- Protective groundwater elevations. The 2009 BMAP used the Ghyben-Herzberg surface as the protective elevations (HydroMetrics LLC, 2009a). Since that report, groundwater elevations at several coastal monitoring wells have been developed with the aid of the groundwater model. The protective groundwater elevations at these wells range from 2 to 11 feet above mean sea level for the shallow aquifer and from 4 to 17 feet above mean sea level for the deep aquifer. Because protective groundwater elevations are available at the coast, improved protective level surfaces were developed for this report (**Figure 18** and **Figure 19**). Surfaces for both shallow and deep aquifers were generated using the groundwater model that was updated in early 2018 to determine what the groundwater elevations

would look like if groundwater pumping was reduced to the point that protective groundwater elevations were met. CAWC's Ord Grove 2 and Paralta production wells, which are screened mostly in the deep aquifer, were used to reduce pumping. Their adjusted annual pumping was reduced by 50% and 83% of projected pumping, respectively, which resulted in an average annual reduction of 1,800 acre-feet per year. The predictive runs also used projected injections and extractions simulated for the Pure Water Monterey project (described in Section 4.2.1) EIR. This surface would look very different if other projects were included. Note that this revised contour surface is less of a hypothetical surface than the Ghyben-Herzberg surface because it represents a surface that can actually be achieved and results from predicted pumping and injection, whereas the previous protective level surface did not. If new production wells are constructed and pumped, they may impact coastal groundwater elevations and require redistribution or reduction in pumping so that protective groundwater elevations can be met. The purpose of the contours is to produce a groundwater surface that could be used to estimate useable stored groundwater.

- Pre-development groundwater elevations. This groundwater surface is intended to represent the highest groundwater levels that would occur under conditions of natural recharge and no groundwater pumping. This surface was estimated by constructing a simple groundwater model (HydroMetrics LLC, 2009a). Contours of the resulting simulated groundwater surface are shown on **Figure 20**.
- Fall 2017 groundwater elevations. These are contours of the Fall 2017 groundwater elevations described in Section 3.3.1, and depicted in **Figure 3** and **Figure 4**. These groundwater elevations approximate current conditions.

A graphical representation of the relationship between the various surfaces is shown on **Figure 21**. For illustration purposes, **Figure 21** shows the current groundwater level above the protective groundwater level in all areas except near the pumping well. This is not actually the case in some areas of the Basin.

Useable Stored Groundwater is calculated for both pre-development and current conditions by subtracting each of those two surfaces from the protective elevations surface, and multiplying the resulting gross volumes by the relevant storage coefficients. **Table 6** lists the amount of *Usable Stored Groundwater* under pre-development and Fall 2017 conditions, subtotaled by aquifer and grouped subareas.



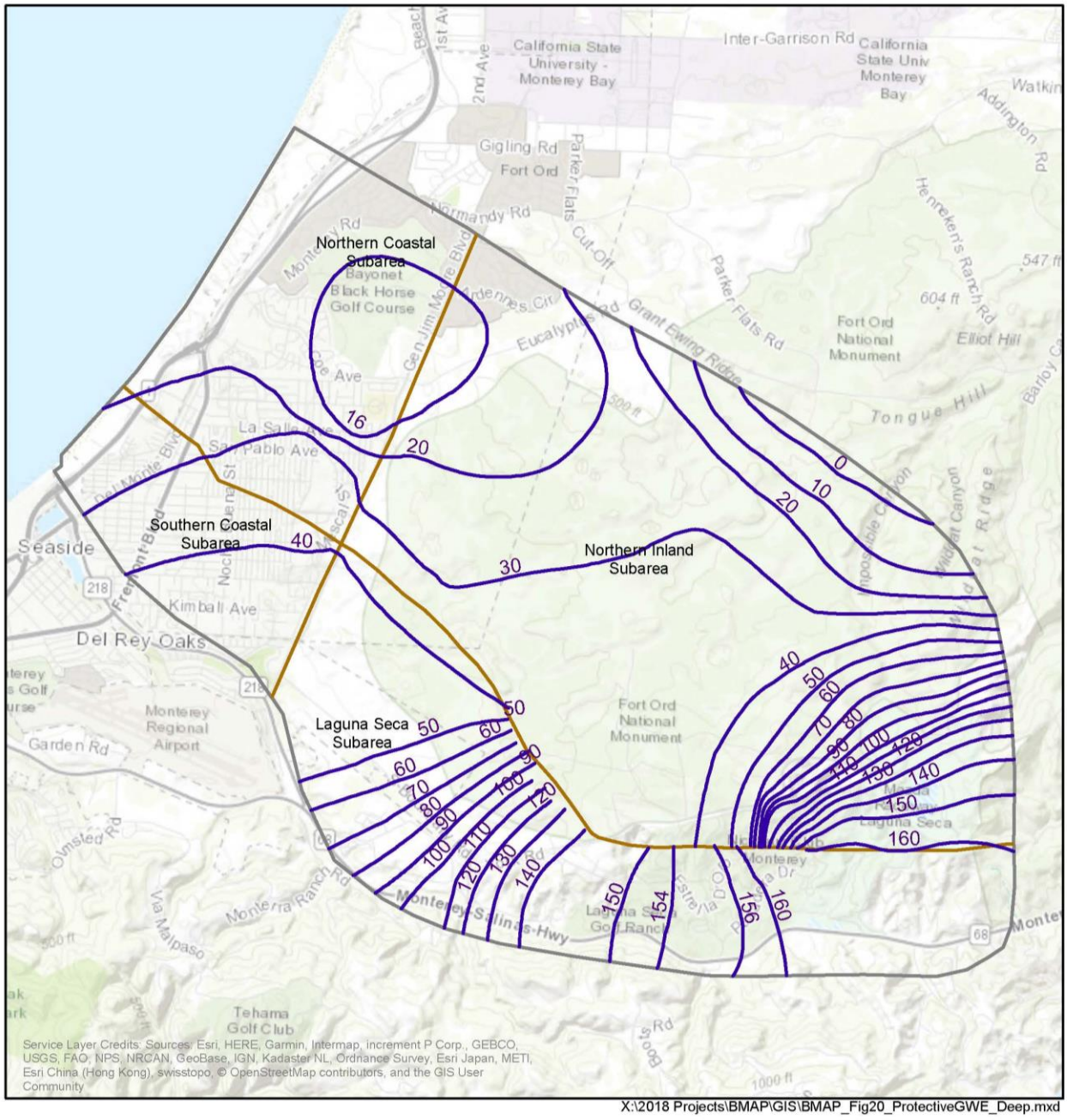
EXPLANATION

- Shallow Aquifer Protective Groundwater Elevations (ft MSL)
- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary

N

0 0.5 1 1.5 2
Miles

Figure 18. Shallow Protective Groundwater Elevations



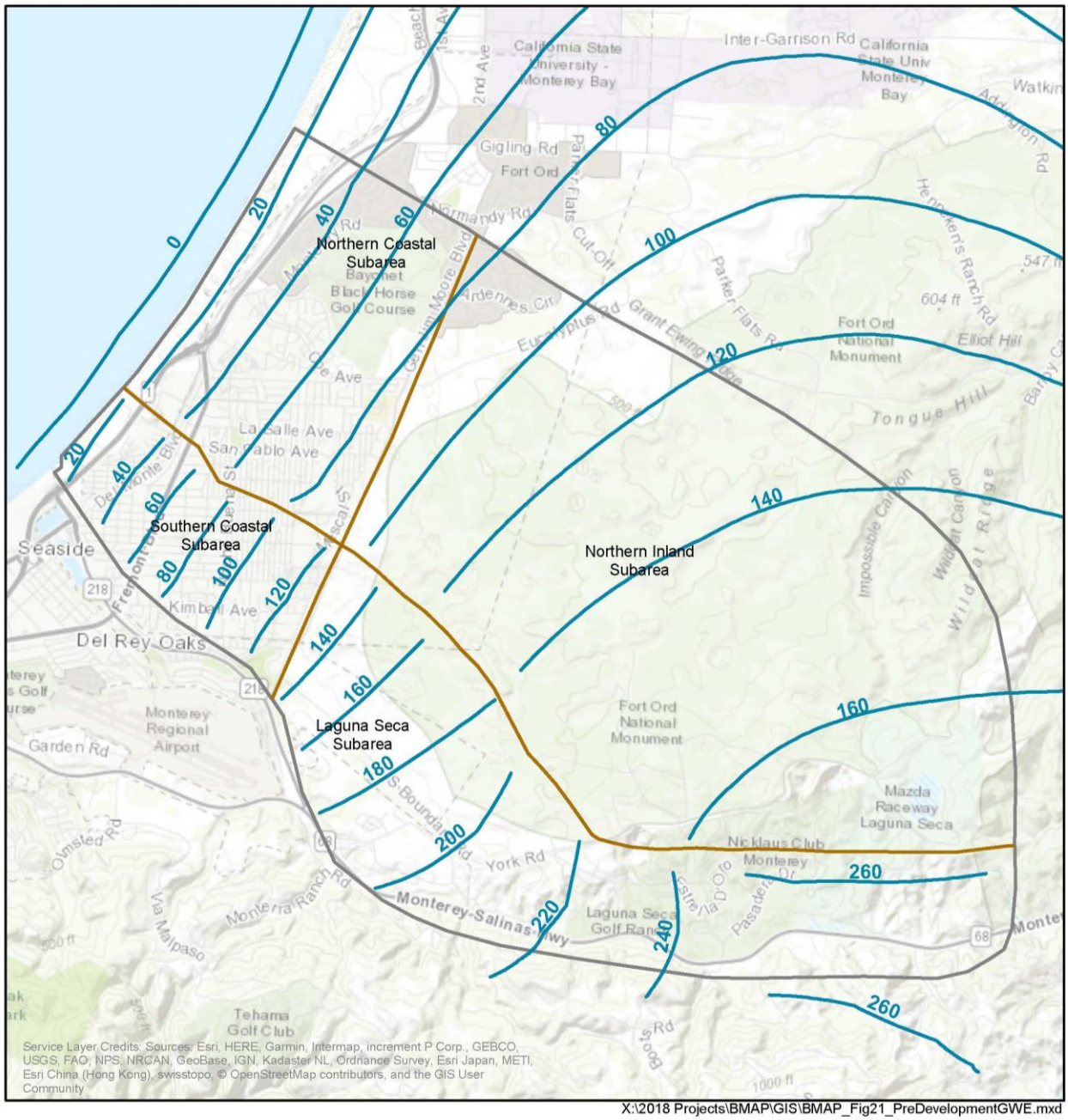
EXPLANATION

- Deep Aquifer Protective Groundwater Elevations (ft MSL)
- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary

N

0 0.5 1 1.5 2
Miles

Figure 19. Deep Protective Groundwater Elevations



EXPLANATION

- Pre-Development Groundwater Elevations (ft MSL)
- Adjudicated Seaside Groundwater Basin Boundary
- Basin Boundary
- Subarea Boundary

N

0 0.5 1 1.5 2
Miles

Figure 20. Pre-Development Groundwater Elevations

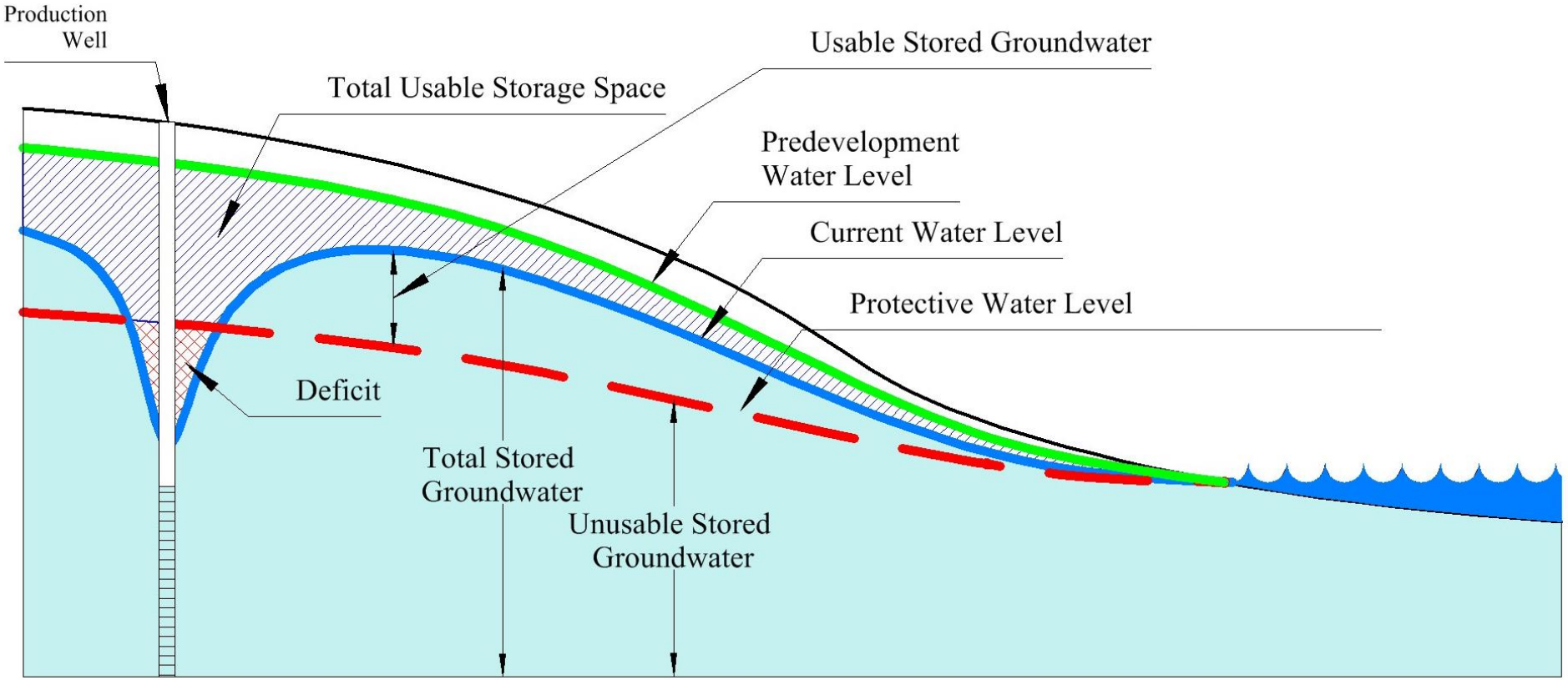


Figure 21. Definition of Total Usable Storage Space

Table 6. Useable Stored Groundwater under Pre-Development and Fall 2017 Conditions

Groundwater Surface	Coastal and Northern Inland Subareas			Laguna Seca Subarea			Total		
	Storage above Protective Level	Deficit below Protective Level	Net Useable Stored Groundwater	Storage above Protective Level	Deficit below Protective Level	Net Useable Stored Groundwater	Storage above Protective Level	Deficit below Protective Level	Net Useable Stored Groundwater
	(acre-feet)								
Shallow Aquifer									
Pre-development	64,126	0	64,126	32,665	0	32,665	96,791	0	96,791
Fall 2017	2,222	26,084	-23,862	4,123	3,631	492	6,345	29,715	-23,370
Deep Aquifer									
Pre-development	112	0	112	30	0	30	142	0	142
Fall 2017	4	28	-24	2	2	0	6	31	37
Total									
Pre-development	64,238	0	64,238	32,695	0	32,695	96,933	0	96,933
Fall 2017	2,226	26,112	-23,886	4,125	3,633	492	6,351	29,746	-23,395

The significant conclusions drawn from these data are:

- The shallow aquifer has greater storage potential because the specific yield value for an unconfined aquifer is many times larger than the confined storativity estimated for the deep aquifer.

- The amount of *Usable Stored Groundwater* in Fall 2017 is much less than the Fall 2007 volumes estimated in the 2009 BMAP. There are two reasons for this:

    1. Protective groundwater elevations for the entire Basin developed for this report are higher than those that were used in the 2009 BMAP. The amounts of *Usable Stored Groundwater* estimated in this report are more realistic because they are based on simulated groundwater levels that take into account Carmel River water ASR and the Pure Water Monterey replenishment project, which helps increase groundwater levels through replenishment of the Basin with 700 acre-feet per year to compensate for its over-pumping of the Basin since the Decision.
    2. Groundwater elevations in most parts of the Basin are lower than they were in 2009.

- The current deficit (2017 groundwater elevations below protective elevations) in the coastal and northern inland subareas is greater than the amount of stored groundwater above protective elevations in those subareas. Therefore, the net usable stored groundwater for these subareas is negative.

- The Laguna Seca Subarea currently has a storage deficit in some areas, but overall there is more groundwater in storage above protective groundwater elevations than below.

- The large deficit below protective groundwater elevations in the coastal and northern inland subareas results in an overall Basin net deficit of usable stored groundwater under current conditions.

Total Usable Storage Space

Similar to usable stored groundwater calculated above, the *Total Usable Storage Space* is calculated as the product of a geographic area, a vertical distance between two groundwater level surfaces, and a storage coefficient. The lower surface for calculating the *Total Usable Storage Space* is the 2017 groundwater level above protective elevations. The upper surface for calculating the *Total Usable Storage Space* is the estimated pre-development surface. **Figure 21** shows the *Total Usable Storage Space* in blue diagonal lines.

Based on the concepts presented above and illustrated in **Figure 21**, both groundwater storage space above and below protective groundwater elevations were estimated from the data in **Table 6**. The resultant volumes are presented in **Table 7**. Storage volumes are those above protective elevations and deficit volumes (in red) are those below.

Table 7. Total Usable Storage Space Estimates Using Protective Groundwater Elevations

		Pre-development	Fall 2017	Difference in Storage Space
		Acre-feet		
Coastal and Northern Inland Subareas	Storage	64,240	2,220	62,020
	Deficit	0	26,080	-26,080
Laguna Seca Subarea	Storage	32,700	4,120	28,580
	Deficit	0	3,630	-3,630
Total Basin	Storage	96,940	6,340	90,600
	Deficit	0	29,710	-29,710

Values obtained from Table 6 are rounded to the nearest 10

In the 2009 BMAP, *Total Usable Storage Space* was estimated by combining the storage and deficit numbers**.** However, in re-evaluating this approach, deficit storage space below protective groundwater elevations should not be allocated. Only the storage space between pre-development levels and 2017 groundwater levels above protective groundwater elevations should be allocated. Applying this approach results in a *Total Usable Storage Space* for the Coastal and Northern Inland Subareas of 62,020 acre-feet, Laguna Seca Subarea has 28,580 acre-feet, with a Basin total of 90,600 acre-feet.

The Basin's current *Total Usable Storage Space* is greater than the estimate of 52,030 acre-feet provided in the 2009 BMAP (HydroMetrics WRI, 2009a). This is partly because there was an error in the 2009 estimate as the deficit volume was subtracted, thereby resulting in a lower combined volume than it should have been; and partly because a different protective elevation contour map was used in this updated estimation.

For the purpose of allocating *Total Usable Storage Space*, the Watermaster has combined the *Total Usable Storage Space* of the Northern Inland Subarea with the *Total Usable Storage Space* of the Coastal Subareas, and allocated all of this space to the Coastal Subarea producers. This approach mirrors the way Natural Safe Yield is allocated in the Decision, which implicitly combines the Natural Safe Yield of the Northern Inland Subarea with the Natural Safe Yield estimate of the Northern and Southern Coastal Subareas.

Each producer's storage allocation is based on the amount of *Total Usable Storage Space* available in the subarea of the Basin in which the producer's well is located. An initial estimate of storage allocations is provided in **Table 8**. The first two columns on **Table 8** allocate groundwater production and *Total Usable Storage Space* in accordance with Sections III.B.2 and III.B.3 of the Decision. This means that the producers listed in Table 2 of the Decision that have elected to participate in an Alternative Production Allocation do not have storage rights in the Basin as per the Decision (Section III.B.3.b). Those producers are removed from the current allocation of storage space, and the remaining producers' allocation percentages are increased from the Standard Production Allocations (Table 1 of the Decision) on a pro-rata basis to equal 100%. The last two columns in **Table 8** allocate groundwater production and total usable storage space under the assumption that Alternative Producers exercise their option, subject to the provisions of the Decision, to convert to Standard Producers and thereby acquire storage rights.

Table 8. Allocation of Usable Storage Space

Producer	Current Allocation (Using Table 1 of the Decision and the Total Usable Storage Volumes developed in this report)		Allocation if all Alternative Production Allocations are Converted to Standard Production Allocations (Using Table 1 of the Decision and the updated Total Usable Storage Volumes developed in this report)	
	Allocation Percentage	Useable Storage Allocation (acre-feet)	Allocation Percentage	Useable Storage Allocation (acre-feet)
Coastal and Northern Inland Subareas				
California American Water	90.60%	56,181	77.55%	48,089
City of Seaside (Municipal)	7.43%	4,607	6.36%	3,944
City of Seaside (Golf Courses)*	0%	0	10.47%	6,492
City of Sand City*	0%	0	0.17%	105
Granite Rock Company	0.70%	434	0.60%	372
SNG*	0%	0	2.89%	1,792
DBO Development No. 27	1.27%	788	1.09%	676
Calabrese*	0%	0	0.27%	167
Mission Memorial Park*	0%	0	0.60%	372
TOTAL	**100%**	**62,010**	**100%**	**62,010**
Laguna Seca Subarea				
California American Water	100.00%	28,570	45.13%	12,894
Nicklaus Golf Course*	0%	0	22.65%	6,471
Bishop*	0%	0	28.88%	8,251
York School*	0%	0	2.89%	826
Laguna Seca County Park*	0%	0	0.45%	129
TOTAL	**100%**	**28,570**	**100%**	**28,570**

* Designates producer that is currently an Alternative Producer and therefore has no current storage allocation.

Total Usable Storage Space is a dynamic volume that changes with changing groundwater levels in the Basin. The Watermaster is required under the Decision to recalculate *Total Usable Storage Space* and adjust the allocation as needed. In particular, the estimates should be revised as improved tools for estimating storage space become available, such as the recently updated Seaside Basin groundwater model that is now used for simulating groundwater conditions in the Basin.

3.5.3 Recent Changes in Groundwater in Storage

The change in total stored groundwater from Fall 2013 to Fall 2017 was estimated in order to compare it with the groundwater budget presented in the next subsection. Storage change was estimated by subtracting the hand-contoured Fall (4th quarter) groundwater level contours developed for the annual SIARs, from the preceding water year's contours for both the shallow and deep aquifers; and multiplying the resulting volumes by their respective storage coefficients. **Table 9** summarizes the annual changes in total stored groundwater. Estimates since Water Year 2015 have been reported to the DWR, per SGMA requirements.

Table 9. Changes in Total Stored Groundwater Estimates from Groundwater Elevations

Water Year	Coastal Subareas & Northern Inland Subarea	Laguna Seca Subarea	Basin Total
	acre-feet per year		
2013	-1,030	-1,430	-2,460
2014	320	220	540
2015	-650	-930	-1,580
2016	-560	50	-510
2017	90	200	290
Average	**-370**	**-380**	**-750**

Values are rounded to the nearest 10

Average change in storage in the Laguna Seca subarea is similar to the average change in storage in the much larger Northern subarea over the past five years, despite the subareas' size differences. Declining groundwater elevations in the Laguna Seca Subarea corroborate this finding.

3.5.4 Storage Efficiency

Storage efficiency refers to the percentage of usable stored groundwater in the Basin that can be recovered at a later date, often a number of years after the water was stored. The Decision notes that storage may result from recharge of non-native water, a producer's carryover (i.e., allocated production that is not extracted during a particular water year), and in-lieu storage from non-native water purchased by the Watermaster and used to reduce over-production. Inefficiency arises when stored groundwater flows out of the Basin to adjacent basins, creeks or the ocean, or when groundwater is consumed by vegetation.

Presently, the outflows that reduce storage efficiency are along the ocean boundary and from the Northern Coastal and Inland Subareas to the Ord subarea of the Monterey Subbasin of the Salina Valley Basin. Based on the current hydrogeologic understanding, flows out to the ocean are relatively small. Outflow from the Southern Coastal Subarea is through alluvial deposits that are relatively thin at the coastline. Outflow from the Northern Coastal Subarea is only from a narrow coastal strip of the shallow aquifer. Modeling work associated with this BMAP indicates that in years when Carmel River water ASR takes place, there is outflow from the two northern subareas to the Ord subarea.

The storage efficiency of *Usable Stored Groundwater* in the Basin depends on location, method of storage, groundwater levels and flow direction, nearby pumping, and the amount of time before extraction of the stored water. For example, the updated Seaside Basin groundwater model has been used to understand storage efficiencies for the Pure Water Monterey groundwater replenishment project based on storage location and recharge mechanism (Denise Duffy & Associates, Inc., 2016). However, if hydraulic conditions such as pumping rates and locations change, stored water may flow towards the Salinas Valley Basin thereby reducing storage efficiency. Another example of storage efficiency change is when recharge is carried out by surface percolation. Some of the recharged water may remain unavailable to wells for several years as it slowly passes through the unsaturated zone, and some may leave the Basin as outflow through the shallow Aromas Sands.

The Decision states that due to the hydrogeologic characteristics of the Basin, naturally occurring losses of stored water may require the Watermaster to discount the percentage of stored water that may be extracted. The Watermaster is tasked to study the efficiencies of storage in the Seaside Basin and set a uniform percentage for withdrawals of stored water. For each project that stores water in the Basin, it is recommended that the

Watermaster evaluate the project specific storage efficiencies and include these in the producer's Storage and Recovery Agreement.

3.6 Groundwater Budget

A groundwater budget is an accounting of all the inflows and outflows to a groundwater basin. The 2009 BMAP included a water budget for Water Years 2003-2007. For this updated BMAP, the updated Seaside Basin groundwater model was used to estimate the long-term water budget components for Water Years 1988 through 2017. These long-term water budget components are shown in

Table 10. For Water Years 1988 - 2017, average rainfall at the Monterey Cooperative climate station was 19.69 inches per year, which is almost the same as the long-term annual average of 19.73 inches that has been calculated for Water Year 1907 through 2017. This indicates that the modeled water budget is representative of long-term average hydrologic conditions. The model update report (HydroMetrics WRI, 2018) and the original 2009 model document (HydroMetrics WRI, 2009b) provide detail on the sources of model input data.

Table 10. Modeled Water Budget, Average over Water Years 1988 - 2017

Recharge Source	Northern Coastal Subarea	Northern Inland Subarea	Southern Coastal Subarea	Laguna Seca Subarea	Total
	Acre-feet per Year				
Basin Inflows					
Percolation from streams	0	0	0	0	0
Deep Percolation					
Rainfall	510	1,670	130	900	3,210
Irrigation & System Losses	150	20	100	10	280
Injection wells	260	0	0	0	260
Groundwater inflow					
From adjacent subareas	2,900	1,520	520	360	5,300
From adjacent basins	130	400	50	770	1,350
From offshore area	490	0	10	0	500
Total inflows	**4,440**	**3,610**	**810**	**2,040**	**10,900**
Basin Outflows					
Wells	3,660	70	170	680	4,580
Groundwater outflow					
To adjacent subareas of the Basin	290	2,710	550	1,750	5,300
To adjacent basins	280	1,310	70	490	2,150
To offshore area	260	0	60	0	320
Total outflows	**4,490**	**4,090**	**850**	**2,920**	**12,350**
Storage Change					
Based on Inflows-Outflows	-50	-480	-40	-880	-1,450

Note: values are rounded to nearest 10.

3.6.1 Groundwater Inflows

Average groundwater recharge from precipitation is 3,210 acre-feet per year. Secondary recharge components include irrigation return flows, losses from water pipes and sewer pipes. Estimated groundwater recharge from these components averages 280 acre-feet per year. The Seaside Basin model report (HydroMetrics WRI, 2009) provides details on how these groundwater inflows are determined. Inflow assumptions are briefly bulleted below:

- Irrigation return flows are estimated as a percentage of delivered water based on the distribution of land use type; and

- Losses from water pipes and sewer pipes are estimated at 8.5% of delivered water.

Injection of Carmel River water by MPWMD is an additional source of inflow to the Basin. Average groundwater injection between Water Year 2013 and 2017 was 690 acre-feet per year, which is three times the average injection included in the 2009 BMAP. This increase in average groundwater injection is largely because Water Year 2017 had well-above average rainfall and therefore significant Carmel River water recharge,

There are substantial groundwater flows between subareas of the Basin (**Table 11**). The largest net inflows between Basin subareas are from the Northern Inland Subarea to the Northern Coastal Subarea (2,130 acre-feet per year) and from the Laguna Seca Subarea into the Northern Inland Subarea (940 acre-feet per year). Net Basin inflows from neighboring groundwater basins only occur at the eastern boundary of the Laguna Seca Subarea where it is adjacent to the Corral de Tierra Subarea of the Monterey Basin. At this location flows are both into and out of the Laguna Seca Subarea, however, net inflows across the Basin's eastern boundary are 280 acre-feet per year.

Table 11. Modeled Net Flows between Subareas, Adjacent Basins and the Ocean, Average over Water Years 1988 - 2017

Area	Northern Coastal Subarea	Northern Inland Subarea	Southern Coastal Subarea	Laguna Seca Subarea	Total
	Acre-feet per Year				
Northern Coastal Subarea	0	-2,130	-480	0	-2,610
Northern Inland Subarea	2,130	0	0	-940	1,190
Southern Coastal Subarea	480	0	0	-450	30
Laguna Seca Subarea	0	940	450	0	1,390
Adjacent Basins	-150	-910	20	280	-800
Ocean	230	0	-50	0	180

Notes: values are rounded to nearest 10; a negative number reflects net outflow and a positive number reflects net inflow.

There is both an average inflow of 500 acre-feet per year and an average outflow of 320 acre-feet per year from the ocean. The flow from or to the ocean depends on hydrologic conditions; however over the 30 years of the water budget, there was an average net flow from the ocean into the Basin of 180 acre-feet per year (500-320=180) (**Table 10**).

Onshore flow within the deep aquifer does not necessarily represent seawater intrusion. This is because fresh water may be stored offshore in the deep aquifer, and onshore flow is pulling this stored fresh water into the Basin. If the deep aquifer is truly not connected to the ocean, this fresh water will not be replaced by saline water, although unsustainably extracting this groundwater may induce vertical leakage from overlying sediments that are in contact with the ocean. If there is some connection to the ocean, the fresh water stored offshore will be replaced offshore by saline water, and continued onshore flows will eventually lead to saltwater intrusion. The Northern Coastal Subarea has net onshore flow and the Southern Coastal Subarea has net offshore flow (**Table 11**). This is a result of groundwater elevations which are well below sea level in the Northern Coastal Subarea and above sea level in the Southern Coastal Subarea.

3.6.2 Groundwater Outflows

Groundwater pumping constitutes the largest outflow of groundwater from the Basin; on average 5,480 acre-feet per year were pumped from the Basin between Water Year 1988 and Water Year 2017 (**Table 10**). For the past five years, groundwater pumping is much less because of Decision-mandated reductions in pumping and averaged 3,840 acre-feet per year. Annual pumping volumes for Water Year 2006 through 2017 are shown on **Figure 22**. This chart also compares annual pumping (blue bars) with the Decision-mandated Operating Yield (black line), and estimated Natural Safe Yield values included in the Decision (dashed black line). The green bars indicate groundwater pumping to

recover stored Carmel River water in the Basin which is not counted against the pumping of the Natural Safe Yield.

The Decision-established Operating Yield started at 5,600 acre-feet per year, with the Decision calling for the Operating Yield to be reduced to 5,180 acre-feet per year on January 1 2009, to 5,040 acre-feet per year on October 1 2009 and by 10 percent every October 1 triennially thereafter until the Operating Yield reaches the Decision-established Natural Safe Yield of 3,000 acre-feet per year (**Figure 22**).

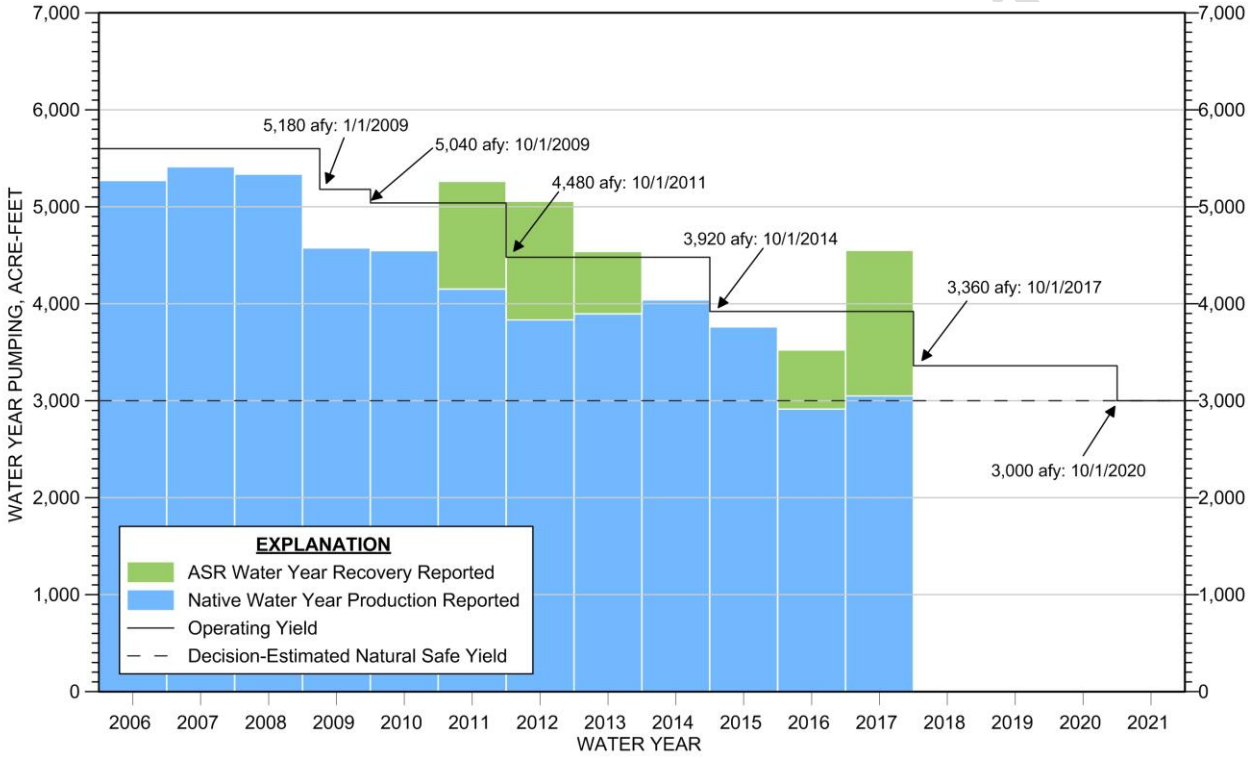


Figure 22. Annual Reported Groundwater Production and Operating Yield for Watermaster Producers

The Decision allowed the triennial pumping reductions to cease under certain conditions. Thus far, none of the four actions listed below from the Decision have occurred which would allow the triennial reduction in pumping to cease for the duration of the described action:

- The Watermaster has secured and is adding an equivalent amount of non-native water to the Basin on an annual basis; or
- The Watermaster has secured reclaimed water in an equivalent amount and has contracted with one or more of the Producers to utilize said water in-lieu of their

Production Allocation, with the Producer agreeing to forego their right to claim a Stored Water Credit for such forbearance; or

- Any combination of these which results in the decrease in production of Native Water required by the Decision; or
- The Watermaster has determined that groundwater levels within the Santa Margarita (deep) and Paso Robles (shallow) aquifers are at sufficient levels to ensure a positive offshore gradient to prevent seawater intrusion.

Although there are some subsurface inflows into the Basin from adjacent basins, overall there is more subsurface flows out of the Basin than into the Basin. The largest subsurface outflow from the Basin to an adjacent basin are from the Northern Inland Subarea to the Ord subarea of the Monterey subbasin of the Salinas Valley Basin. This outflow averages 910 acre-feet per year (**Table 11**). On average, 150 acre-feet per year flows from the Northern Coastal Subarea to the Ord Subarea of the Monterey Subbasin of the Salinas Valley Basin. Examination of modeled groundwater flow directions, reveals that in months when ASR recharge occurs, there are more outflows to the Ord subarea from the Coastal and Northern Inland Subareas.

3.6.3 Change in Groundwater in Storage

As shown in **Table 10**, the estimated annual groundwater inflows into the Basin between Water Years 1988 and 2017 averaged 5,600 acre-feet per year (10,900 acre-feet less 5,300 acre-feet of internal flows between subareas); and total Basin outflows averaged 7,050 acre-feet per year (12,350 acre-feet less 5,300 acre-feet of internal outflows between subareas). The net change in total stored groundwater basin-wide, calculated by adding all inflows and outflows, is an annual average net loss of 1,450 acre-feet per year for the 30 years between Water Years 1988 and 2017. As noted earlier, the Basin's change in groundwater storage is not equal to the over-production in the Basin.

As an independent check on the change in storage estimated from water budget inflows and outflows, the 2009 BMAP included estimates of storage changes calculated using mapped groundwater elevations and storage coefficients. As contour maps are not available for the entire model period, groundwater in storage changes for just the past five years are compared to the model estimated storage changes. For Water Years 2013 to 2017, a loss of groundwater in storage of 750 acre-feet per year was calculated using the groundwater elevations and storage coefficients approach used for annual reporting to the California Department of Water Resources. This value compares well with the water budget inflow less outflow estimate of 770 acre-feet per year lost for Water Years 2013

through 2017. **Table 10** shows that the subarea with the greatest loss in groundwater storage is the Laguna Sea Subarea. Its reduced groundwater in storage is due to groundwater pumping, and flows into the Corral de Tierra subarea of the Monterey subbasin of the Salinas Valley Basin.

3.7 Review of Natural Safe Yield

The Decision established the initial Natural Safe Yield for the Basin at 3,000 acre-feet per year. As shown in **Table 12**, the estimated Natural Safe Yield using data from Water Year 1988 through 2017 is 2,500 acre-feet per year for the Coastal and Northern Inland Subareas, and -190 acre-feet for the Laguna Seca Subarea, with an estimated 2,310 acre-feet per year for the entire Basin. In 2013, a Natural Safe Yield study of the Laguna Seca Subarea (HydroMetrics WRI, 2013) using hydrologic data from before the recent drought, determined the Laguna Seca Subarea Natural Safe Yield to be 240 acre-feet per year. However, predictive simulations with pumping limited to 240 acre-feet per year still result in declining groundwater levels, suggesting that pumping outside of the Basin was causing these declines. The negative Natural Safe Yield for the Laguna Seca Subarea in

Table 12 indicates that there is no pumping rate using existing wells that stabilize all groundwater elevations in the Laguna Seca subarea. Predictive modeling done in the 2013 study by HydroMetrics WRI indicates that continued pumping at current rates from the neighboring Corral de Tierra subarea of the Monterey subbasin will induce outflow from the Laguna Seca Subarea to the Corral de Tierra subarea.

Table 12. Estimated Water Year 1988-2017 Natural Safe Yield of the Seaside Groundwater Basin

Yield Components and Adjustments[1]	Coastal & Inland Subareas	Laguna Seca Subarea	Total
	acre-feet per year		
Current pumping (prescribed pumping plus recovery of injected water)	3,900	680	4,580
Storage change[2]	-640	-870	-1,510
Current ocean boundary inflow	500	0	500
Injected water	-260	0	-260
Yield (assuming no outflow to the ocean)	3,500	-190	3,310
Ocean boundary outflow needed to prevent seawater intrusion[3]	1,000	0	1,000
Natural Safe Yield	**2,500**	**-190**	**2,310**

Note: values are rounded to nearest 10.
[1] The values for pumping, storage change and ocean boundary flows are from the subarea groundwater budgets in

Table 10.
[2] The estimate of storage change equals the difference between inflows and outflows.
[3] Yates et al. (2005).

The total Basin Natural Safe Yield in

Table 12 is 2,310 acre-feet per year estimated over 30 years (Water Years 1988 – 2017). This estimate is less than the 2,850 acre-feet per year estimated in the 2009 BMAP, which was estimated over a six-year period between Water Years 2002 and 2007. The Natural Safe Yield estimate reflects the theoretical maximum amount of groundwater production that would have resulted in no decreases in groundwater in storage and no declining groundwater levels between Water Years 1988 to 2017. However, as noted earlier, pumping is unevenly distributed across the Basin. This results in areas of significant drawdown and other areas with limited or no drawdown. Therefore, the amount of pumping that can be sustained without ongoing localized groundwater level declines is likely lower than the Natural Safe Yield estimated here.

Climate change is expected to further impact groundwater recharge and thus the Natural Safe Yield in the future as there will be more extremes in rainfall, a shift in when the majority of rainfall occurs, longer drought periods, and hotter temperatures that increase evapotranspiration. The result of these changes is that there may be less water available for natural groundwater recharge than has been historically available and estimates used here based on historical rainfall may not be correct in the upcoming decades.

3.8 State of the Basin and Material Injury

Over the last five years, groundwater levels in the Basin continued the downward trends documented in previous studies and the 2009 BMAP. This is reflected in the recent estimated average loss of Total Stored Groundwater of 770 acre-feet per year. While no operational problems have been reported to the Watermaster as a result of these lowering groundwater levels, this trend is not sustainable.

Lower groundwater levels do not by themselves define material injury. Section III.A.15 of the Decision states:

> "Material Injury means a substantial adverse physical impact to the Seaside Groundwater Basin or any particular Producer(s), including but not limited to: seawater intrusion, land subsidence, excessive pump lifts, and water quality degradation. Pursuant to a request by any Producer, or on its own initiative, Watermaster shall determine whether a Material Injury has occurred, subject to a review by the Court as provided for in Section III.N."

No seawater intrusion has been detected in any monitoring or production wells completed in the shallow or deep aquifers in the Basin. Furthermore, land subsidence has not been

observed. Therefore, it could be concluded that the Basin has not suffered Material Injury.

However, individual producers may suffer Material Injury based on impacts to individual wells. The following conditions are examples of potential Material Injury to an individual well:

- Seawater intrusion.
- Pumping groundwater levels falling below the top of a well screen that was previously submerged during pumping. Note, this should be shown to result from a general lowering of the piezometric head, not loss of well efficiency.
- Pumping groundwater levels falling below the pump intake. Note, this should be shown to result from a general lowering of the piezometric head, not loss of well efficiency. Furthermore, it should be shown that the pump intake is at a reasonable depth, and lowering the pump intake is infeasible.

There are no reports that any of the above situations have occurred in the Basin. Therefore, it can be concluded that Material Injury to individual wells has not occurred.

A predictive modeling study conducted on declining groundwater levels in the Laguna Seca Subarea indicated that even if CAWC were to discontinue pumping in the Laguna Seca Subarea as they are projected to do, groundwater levels would continue to decline (HydroMetrics WRI, 2013). This is apparently largely due to pumping east of the Basin. The study predicted that groundwater elevations could fall below the top of well screens in the Bishop #3 and Ryan Ranch #7 production wells. These wells, however, are expected to be taken out of service by CAWC once the MPWSP is implemented.

4 SUPPLEMENTAL SUPPLIES

This section updates the corresponding section in the 2009 BMAP and summarizes the water supply projects currently being considered to meet long-term water needs in the Basin. These supplemental supply projects could help achieve the goals of the Decision by reducing pumping in the Basin to the Natural Safe Yield and providing additional water that could be used to help replenish the Basin. It also provides a historical listing of projects that were described in the 2009 BMAP, but which have since been deemed to be either overly costly or infeasible, and are therefore no longer being considered.

The supplemental supplies described below have utility beyond offsetting pumping or providing supplemental recharge in the Basin. Many of the supplemental supplies provide water to satisfy SWRCB Order No. 95-10, which requires CAWC to reduce its withdrawal from the Carmel Valley aquifer and diversions from the Carmel River by approximately 8,500 acre-feet per year (AFY) (MPWMD, 2006). Three of these supplemental supplies were used to calculate the Watermaster's WY 2018 Replenishment Assessment Unit Cost including:

- Monterey Peninsula Water Supply Project
- Seaside Basin ASR Expansion, and
- Regional Urban Water Augmentation Project.

4.1 Regional Context

Carmel River requirements and the Decision are driving the need to bring in supplemental supplies to reduce pumping to the Natural Safe Yield. The protective elevations are not enforceable and there is no management action specifically designed to increase coastal groundwater levels to above protective elevations.

A number of supplemental supply projects are described below. They fall into four categories: (1) Projects or actions that are currently being actively pursued and which have the potential to directly benefit the Basin and, (2) Projects or actions that are currently in the early planning stage and which would have the potential to indirectly benefit the Basin, (3) Projects or actions that have already been implemented, and (4) Projects or actions that were considered in the past and were found to be infeasible or were too costly and are no longer being considered.

The first category of projects or actions were included in this updated BMAP to inform the Watermaster of the range and type of projects or actions that may provide supplemental water supplies. The second category of projects or actions is presented to identify potential additional sources of water that may be able to directly recharge the Basin. The third and fourth categories of projects or actions are presented to provide a historical record of projects or actions that have already been implemented, or which were previously considered and were ruled out.

The estimated costs, volumes of water available to the Basin, implementation schedules, and organizational implementation descriptions for each project or action presented were obtained from direct contact with the project sponsors, news reports, and/or websites.

4.2 Alternatives Currently Being Considered

Various long-term water supply alternatives are currently being considered by several project proponents and/or are in the process of being constructed. Brief descriptions of the projects are presented below.

4.2.1 Monterey Peninsula Water Supply Project (MPWSP)

Cease-and-Desist Order No. 95-10 from the State Water Resources Control Board (SWRCB) mandates that CAWC drastically cut back pumping of the Carmel River, which constitutes nearly 70 percent of Monterey Peninsula's historic water supply. The MPWSP is CAWC's proposed project to develop an alternative water supply that will replace the Carmel River water.

In March 2018, the California Public Utilities Commission (CPUC) issued the Final EIR/EIS for the MPWSP proposed by CAWC to satisfy its obligations under SWRCB Order No. 95-10 and its obligations under the Seaside Basin Decision. The EIR/EIS evaluated a number of projects, including the originally-proposed 9.6 million gallons per day (mgd) desalination plant and several alternative projects. The EIR/EIS concluded that the environmentally superior/environmentally preferred project would be a combination of a 6.4 mgd desalination plant with ASR wells for storage of some of the desalinated water in the Basin, combined with at 3,500 AFY groundwater replenishment project referred to as the Pure Water Monterey [PWM] project. These project components are further described below.

The MPWSP would enable CAWC to reduce its pumping from the Basin down to its Decision-allowed 1,474 AFY, and also to return to the Basin the volume of water that it has annually pumped over this amount since the date of the Decision through in-lieu

recharge. This would be done over a period of approximately 25 years, at a rate of 700 AFY, until the full volume of its over-pumping has been returned to the Basin. The project is projected to become fully operational by the end of 2021.

When it prepared its Replenishment Assessment Unit Cost calculations in 2017, the Watermaster estimated the cost of water from this project as follows:

- Desalination Water - $6,147/AF
- Pure Water Monterey Project Water - $1,811/AF
- Combined Cost of Water from the Project (desalinated and reclaimed water combined) = $4,591/AF

These unit costs are likely out-of-date and too low. M1W's current website contains a report on its proposed PWM expansion project and that report cites a projected unit cost for the reclaimed water from the expanded project to be $2,472/AF. This is considerably higher than the $1,811/AF cited above, which was the projected cost in 2017 when the Watermaster last prepared its Unit Cost calculations.

Desalination Plant

The 6.4 mgd desalination plant and its associated facilities would consist of the following:

1. A source water intake system consisting of seven subsurface slant wells (up to five active and two on standby) extending into submerged lands of the Monterey Bay National Marine Sanctuary (MBNMS) offshore of the 180/400 ft Aquifer Subbasin of the Salinas Valley Groundwater Basin, and a Source Water Pipeline.

2. A 6.4 mgd desalination plant and related facilities, including pretreatment, reverse osmosis (RO), and post-treatment systems; backwash supply and filtered water equalization tanks; treated water storage tanks; chemical feed and storage facilities; brine storage and conveyance facilities; and other associated non-process facilities.

3. Desalinated water conveyance facilities including pipelines and a stand-alone pump station. The Castroville Pipeline would convey desalinated Salinas Valley return flows from the MPWSP Desalination Plant to the Castroville Seawater Intrusion Project distribution system and the

Castroville Community Services District's Well #3. If the Castroville Pipeline is not built, CAWC would pump the Salinas Valley return water from the MPWSP Desalination Plant through a pipeline to the existing Castroville Seawater Intrusion Project pond at the southern end of M1W's Regional Wastewater Treatment Plant. From the Castroville Seawater Intrusion Project pond, water would be delivered to agricultural users in the Salinas Valley through existing infrastructure. Additionally, this component of the project would include improvements to the interconnections between CAWC's main system and its Ryan Ranch and Bishop systems.

4. An expanded ASR system, including two additional injection/extraction wells and associated ASR facilities to store desalinated water when needed.

No groundwater modeling using the updated 2018 Seaside Basin groundwater model has been conducted on this portion of the MPWSP.

Pure Water Monterey Project

The PWM project is jointly sponsored by M1W and MPWMD. The City of Salinas, MCWD, and MCWRA are also participating. This project would provide up to 3,500 AFY of high quality purified water to recharge the Basin through a series of vadose zone wells and groundwater injection wells. As a result of this recharge, CAWC would be able to extract and distribute up to 3,500 AFY of additional water from the Basin and still be in compliance with its water rights as established by the Decision. M1W will sell purified water from the project to the MPWMD, which in turn will sell it to CAWC for extraction and distribution to customers in its Monterey District service area.

Portions of the PWM project are currently under construction, including the Advanced Water Purification Facility (AWPF), the transmission pipeline, and some of the injection wells.

Original Pure Water Monterey Project:

The PWM project and its associated facilities, as originally proposed in 2015, would consist of the following:

- A 4.0 mgd capacity AWPF for treatment and production of purified recycled water. This water would be conveyed to the Basin via a

transmission pipeline for injection into the Basin using a series of shallow and deep injection wells.

- Once injected, the purified recycled water would augment existing groundwater supplies and provide 3,500 AFY of water for extraction via existing CAWC wells. The extracted water would be delivered to CAWC customers to offset use of water from the Carmel River system.

- The project would also provide additional recycled water for crop irrigation via the existing Castroville Seawater Intrusion Project.

Expanded Pure Water Monterey Project:

In October 2017, M1W approved modifications to the PWM project to increase the operational capacity of the approved AWPF from 4.0 mgd to 5.0 mgd. This expanded capacity would be achieved by using redundancies in the AWPF design. The purpose of the expansion would be to enable delivery of 600 AFY of purified recycled water to MCWD for urban landscape irrigation by MCWD customers. This additional recycled water delivery is a component of the Regional Urban Water Augmentation Project (RUWAP) which is described below. The source water for the expansion of the PWM project would be entirely from MCWD's rights to the return of its municipal wastewater.

The currently proposed schedule for the expansion calls for it to become operational in the first Quarter of 2021, if approvals and permits are received expeditiously.

The Seaside Basin model was used to estimate impacts from the PWM project (HydroMetrics WRI, 2017). Model results show that the PWM project increases groundwater elevations in the Basin. Simulated groundwater elevations under Project conditions are higher than those under No-Project conditions at several observation points, including in the pumping depression in the Northern Coastal Subarea where Project conditions indicate that long-term groundwater levels may increase above sea level. Long-term coastal groundwater elevations under Project conditions are also higher than those under No-Project conditions resulting in protective groundwater elevations being met or being close to being met in some of the protective elevation monitoring wells, but not in all. These

coastal groundwater level increases indicate the Project is likely to help avoid the potential for seawater intrusion.

4.2.2 Regional Urban Water Augmentation Project (RUWAP)

The RUWAP includes a recycled water distribution system that will provide recycled water from the existing M1W Reclamation Plant to urban users within the Cities of Marina, Seaside, Monterey, Del Rey Oaks, and the County of Monterey. Additional recycled water could be provided to the Monterey Peninsula under a joint cooperative effort with MCWD, M1W, and CAWC.

A project-level EIR was certified for the RUWAP in 2015 to provide up to 1,727 AFY of recycled water to the identified urban areas: 1,427 AFY within the former Fort Ord and 300 AFY to the Monterey Peninsula. Of the 1,427 AFY available to the former Fort Ord, approximately 450 AF would be available to two City of Seaside golf courses and approximately 250 AF would be available to a proposed golf course in Del Rey Oaks. Therefore, the amount of water benefiting the Basin could be on the order of 700 AFY. When combined with other projects, the RUWAP would both help provide water to offset over pumping of the Basin and to help satisfy Order No. 95-10.

MCWD received a Proposition 1 low-interest loan and grant for the RUWAP. The RUWAP will serve both MCWD's Water Augmentation Program and the PWM project, as the MCWD and M1W combine their projects for the construction of one transmission pipeline that will serve both of these projects.

MCWD has completed the engineering and design for the RUWAP and has started construction on several sections of the transmission pipeline. Along with building the pipeline, MCWD has approved plans to construct a storage reservoir and distribution pipes to deliver advanced treated water to existing and planned urban irrigation facilities.

Phase 1 of the RUWAP was under construction in 2018. Phase 2 will include an additional 827 AFY of recycled water for a total of 1,427 AFY. Phase 2 is planned for a future date after construction of recycled water lateral pipelines to the other irrigation sites that would use this additional recycled water has been completed.

4.2.3 Monterey Bay Regional Water Project (MBRWP or Deepwater Desal Project)

The Monterey Bay Regional Water Project (MBRWP or DeepWater Desal), is being proposed by DeepWater Desal, LLC (DWD). The MBRWP is to be evaluated in a

separate EIR/EIS to be prepared by the California State Lands Commission as the CEQA Lead Agency, and by MBNMS as the NEPA Lead Agency.

In June 2015, the California State Lands Commission and MBNMS issued a joint Notice of Preparation/Notice of Intent to prepare a Draft EIR/EIS for the MBRWP. The project would be developed to meet a regional need for water, and MPWMD would be one of several customers, or off-takers, of the supply. CAWC would purchase water from MPWMD to serve the needs of their customers in CAWC's Monterey District.

The MBRWP would be located adjacent to the existing Moss Landing Power Plant, and would consist of a seawater reverse osmosis (SWRO) desalination facility, a co-located data center, power substation, intake and outfall facilities, and a hydroacoustic monitoring system.

In the context of desalination projects, a subsurface intake is any type of intake that lies below the sea floor such as slant wells, beach wells or infiltration galleries. With a subsurface intake, surface water is pulled through the sand, trapping impurities and other material, with the sand basically acting as a filter. A surface water intake is one that directly intakes water from the sea without that water first passing through the sand.

This project is proposing to use a deep screened surface water intake. Project proponents have said that while the Ocean Plan states a preference for subsurface intakes of seawater, their studies of the hydrogeology of local sites have found no sites able to provide the total source water needed using the subsurface intake method. They have also commented that the sites they found that will allow some withdrawal of seawater using the subsurface intake method will also pull groundwater from the critically overdrafted Salinas Valley groundwater basin. They have voiced the opinion that this is in conflict with the Sustainable Groundwater Management Act. DWD submitted their subsurface intake study with their request for a Section 13142.5(b) Determination to the Central Coast RWQCB in June 2018.

The project would be capable of producing up to 25,000 AF of high quality potable water annually, and is intended to make a new supply of potable water available north to Santa Cruz, east to Salinas, and south to the Monterey Peninsula. The MPWMD has helped fund some of the work on the MBWRP and holds an option to assume control of the desalination operation.

Construction of the project is planned to begin after receipt of a California coastal permit and is expected to take approximately 18 months. The project's proponents said they

hope to apply for a coastal permit in mid to late 2019, but as of the date of preparation of this updated BMAP their application had not been submitted.

The project's proponents have stated that the cost of water produced by the project is expected to be between $1,700 and $2,200 per acre foot at the project's fence line in Moss Landing. The full cost per acre foot to buyers of the water will include the cost of distributing the water from the desalination plant site to the buyer's location. Final costs had been expected to be determined in 2017, but those figures are still being developed. In 2017, DWD estimated the cost of water to be in the range of $2,000 - $2,500/AF. They are using $1,700 – $2,200 for the final price range, assuming some income from the data center for the use of the cooling water. DWD stated that the specific cost that will be used in offtake agreements expected to be negotiated in 2019 will fall within this range but be dialed in according to the construction and O&M contract costs at the time of signing.

4.2.4 People's Moss Landing Water Desalination Project (People's Project)

The People's Moss Landing Water Desalination Project (People's Project) is being proposed by Moss Landing Green Commercial Park, LLC.

The People's Project is to be evaluated in a separate EIR that is being prepared for the Moss Landing Harbor District as the CEQA Lead Agency. The Moss Landing Harbor District issued a Notice of Preparation for the People's Project in June 2015. The project proponent submitted permit application materials to MBNMS in October 2015 and that application was deemed incomplete. As of the date of preparation of this updated BMAP, a revised application had not been submitted. It is possible that a joint EIR/EIS will be prepared for the project, with MBNMS as lead federal agency, if a complete application is submitted to MBNMS. The Moss Landing Harbor District recently reported that the project is still moving forward and that the environmental analysis/preparation is ongoing, but there was no specific timeline provided for completion of that work.

According to a 2016 news report in the Monterey Herald, the project proponents said they expected to release their draft environmental documents that year and hoped to have them certified by the end of that year or early 2017. They also said they expected to be able to deliver water by some time in 2019. However, the environmental process has taken longer than expected, so this delivery time frame is no longer accurate. As of the date of preparation of this updated BMAP, the website for this project was not active.

The $230 million People's Project would include the construction and operation of an open ocean intake system, a 12 mgd desalination plant, brine discharge through an

existing/rehabilitated outfall pipeline and associated components to provide 13,400 AFY of water supply to meet the current and future needs of the Monterey Peninsula area.

The desalinated product water would be delivered from the desalination plant site to the Monterey Peninsula via a new 36-inch diameter pipeline. The components of this project would be located in the Moss Landing area of unincorporated Monterey County and offshore in the Monterey Bay. No per-acre foot cost data were available for this project as of the time this BMAP was written.

4.2.5 Projects in the Planning Stage having the Potential to Increase Source Water to the M1W Advanced Wastewater Purification Facility

M1W was the lead entity in the development of a Greater Monterey County Storm Water Resource Plan (SWRP) for the Monterey Peninsula, Carmel Bay, and South Monterey Bay Integrated Regional Water Management (IRWM) Planning Area.

The purpose of the SWRP is to identify storm water capture project opportunities that could be used as new water supply sources for the Monterey Peninsula and to provide additional water quality and environmental benefits. The purpose of the Monterey Peninsula Water Recovery Study, which was conducted as part of the development of the SWRP, was to examine the feasibility of establishing a Peninsula-wide water recovery and reclamation system, including identifying and evaluating potential projects that could capture sources of wet and dry weather runoff within the Monterey Peninsula IRWM Planning Area. The water recovery projects were specifically identified based on their potential to reduce the Peninsula's dependence on the Carmel River, Carmel Valley Alluvial Aquifer, and adjudicated Basin. The study considered how to store, treat, and transport potential sources of runoff prior to entering existing water and wastewater infrastructure for use, but did not identify projects that expand existing water distribution and wastewater storage, treatment, and conveyance system capacities, or determine if this will be needed.

Seven projects were selected for conceptual design in the SWRP. Four of these have the potential to augment wastewater flows to the M1W reclamation facilities, and could thus help the PWM project produce more water for use in recharging, or reducing pumping from the Basin. These four projects are described below:

1. **Hartnell Gulch Restoration and Stormwater Diversion**
   This project consists of a proposed diversion of stormwater to the sanitary sewer and creek restoration project located in the City of Monterey. The tributary drainage area for this project is approximately 1,100-acres. The project could

augment the influent flow to the PWM project by an estimated 20 to 100 AFY. The projected cost of water from this project is $1,800 to $2,100 per AF.

2. **Lake El Estero Diversion to Sanitary Sewer**
   The project would augment water supply by diverting stormwater to the sanitary sewer in the City of Monterey. The project could augment influent flow to the PWM project by an estimated 100 AFY from an approximately 3,670-acre tributary drainage area. The projected cost of water from this project is $620 to $750 per AF.

3. **Monterey Tunnel Stormwater Diversion**
   The project would divert flows from the City of Monterey's downtown Tunnel and Oliver Street storm drain gravity pipe to the sanitary sewer instead of discharging it into Monterey Bay. This project could augment the influent flow to the PWM project by an estimated 10 to 20 AFY from an approximately 150-acre tributary drainage area. The projected cost of water from this project is $20,000 to $44,000 per AF.

4. **Pacific Grove-Monterey ASBS Watershed – David Avenue Stormwater Storage and Diversion**
   The project, located in the City of Pacific Grove, would store wet weather and dry weather flows for diversion to the Pacific Grove sanitary sewer instead of discharging runoff into Monterey Bay and the Pacific Grove Area of Special Biological Significance (ASBS) region. This project could augment the influent flow to the PWM project by an estimated 10 to 20 AFY from its approximately 100-acre tributary drainage area. The projected cost of water from this project is $20,000 to $44,000 per AF.

Two of the projects in the SWRP propose to directly recharge the Basin by infiltrating urban runoff. These two projects are described in more detail below.

5. **Del Monte Manor Park Infiltration**
   Part of a regional infiltration project, this project includes open space park improvements and flood management to infiltrate runoff from the surrounding area. In the City of Seaside, it could provide indirect benefits of infiltrating 5 to 10 AFY of urban runoff above a potable water supply aquifer from its approximately 25-acre tributary drainage area. The projected cost of water from this project is $3,300 to $3,500 per AF.

6. **Drywell Aquifer Recharge Program**
   A recharge project in the City of Seaside would use drywells to recharge urban runoff into a primary water supply aquifer. The program would divert flows from surface ditches or within the storm drain network to a water quality pretreatment system that would discharge to a drywell above the domestic supply aquifers in the Basin. The project could provide indirect benefits of infiltrating between 20 to 100 AFY. The projected cost of water from this project is $4,600 to $6,200 per AF.

All of the projects described above are in the early planning stages and are not currently funded. Therefore, they are only considered to be potential sources of water that M1W could use to increase the capacity of its PWM project, or that could help directly recharge the Basin. Thus, no specific quantities of water that could be used for the benefit of the Basin can be identified for these projects.

4.3 2009 BMAP Implemented Supplemental Supplies

In the time that has elapsed since the 2009 BMAP was prepared, a few of the alternatives described therein have been implemented by their sponsors. These alternatives are briefly described below.

4.3.1 Sand City Water Supply Project

The Sand City Water Supply Project is owned by the City of Sand City, and is operated by CAWC through a contractual agreement. It consists of a desalination facility and a potable water system that serves City of Sand City customers. Brackish source water for the desalination plant is obtained from four intake wells in the shallow groundwater aquifer near Monterey Bay. Byproduct water is disposed of through a horizontal injection well beneath the Sand City beach.

The Sand City Desalination Plant is designed to provide approximately 300 AFY of desalinated water. The water produced by this project is not required to offset Order No. 95-10. It can therefore be used to help offset production in the Basin, subject to the best management practices of CAWC, but only on an interim basis until Sand City customers use the water for their own purposes. The facilities were completed and placed into operation in 2010.

4.3.2 Pacific Grove Wastewater Reuse Project

In 2017, the City of Pacific Grove completed construction of a $7.7 million Wastewater Reuse Project designed to produce and distribute 100 to 125 AFY of reclaimed water to irrigate the Pacific Grove Golf Links and the city's El Carmelo Cemetery. The treatment facilities for this project are located at the site of the City's former wastewater treatment plant off of Ocean View Boulevard. These facilities divert and treat raw wastewater and are expected to provide up to 125 AFY of non-potable water for irrigation of the City's golf course and the cemetery, and to provide toilet flushing at the City's Crespi Pond public restrooms.

One objective of this project is to provide an additional potable water allocation to the City in the form of water credits from the MPWMD in order for selected land use projects to be implemented. There is some uncertainty about how the water credits resulting from the potable water savings that will be achieved by this project will be applied. The SWRCB, which provided grant funding and low-interest loan financing for the project, required that the potable water saved by this project must first be used to help reduce CAWC's water deliveries from the Carmel River Basin in order to help satisfy Cease and Desist Order No. 95-10, until that Board agrees to allow its use elsewhere. The City expects that once Order No. 95-10 has been satisfied, the City will receive some water credits resulting from the water savings from this project.

The stormwater capture and reuse aspects of this project have been updated and are now incorporated into the Pacific Grove-Monterey ASBS Watershed – David Avenue Stormwater Storage and Diversion project that is described in Section 4.2.5.

4.3.3 Carmel River Water Aquifer Storage and Recovery Project – Phases 1 and 2

In 1996, MPWMD began investigating the feasibility of ASR and constructed a proof-of-concept demonstration project in 1997, followed by a pilot test well in 1998 in the shallower aquifer of the Seaside Basin. After several years of successful pilot-well testing, MPWMD acquired property and approvals to construct a full-scale, 700-foot deep test well in 2001 in the deeper aquifer

Based on the success of a feasibility testing program, MPWMD developed a permanent project at the site of the full-scale test well located east of General Jim Moore Boulevard near Eucalyptus Road on the former Fort Ord Military Base, also known as the Santa Margarita site. A second full-scale well was completed at this site in 2007, and MPWMD received the needed approvals to transition the site from a testing program to a permanent project in 2008.

The Phase 1 ASR project entailed MPWMD diverting excess winter flows from the Carmel River Basin during high flow periods using existing CAWC wells. The diverted water is treated to potable drinking water standards and pumped through the CAWC distribution system to the Basin, where the water is injected into MPWMD's ASR wells for recovery during dry periods.

Although the water supply available for this project depends on the availability of excess winter flows in the Carmel River, Phase 1 of the Seaside ASR project can potentially divert up to 2,400 AFY from the Carmel River, with an average yield of about 920 AFY.

MPWMD began Phase 2 ASR expansion planning in 2008 in cooperation with CAWC at a site that is adjacent to the Phase 1 site in the Seaside Basin. The Phase 2 ASR Project consists of two ASR wells, completed in 2011 and 2013. The two wells are designed to inject up to 2,900 AFY of excess Carmel River flows. The average yield of the Phase 2 ASR project is estimated at approximately 1,050 AFY.

There is limited benefit to the Basin as there is an agreement between the active parties that water needs to be recovered the following year if a minimum injection threshold is met.

4.4 Alternatives No Longer Being Pursued

In the time that has elapsed since the 2009 BMAP was prepared, a number of the alternatives described therein have either been found to be infeasible, too costly, too difficult to implement, or for other reasons are no longer being pursued by their sponsors. These alternatives are briefly described below.

4.4.1 MPWMD 95-10 Desalination Project

A desalination plant was proposed by MPWMD in 1995 in response to SWRCB Order No. 95-10. The MPWMD 95-10 Desalination Project would have provided up to 8,400 acre-feet of water per year. This water would have only offset the requirements of SWRCB Order No. 95-10, and therefore would not have offset over-pumping in the Basin. The proposal was not implemented. It was reevaluated by MPWMD in 2008, was again not selected for further study, and is no longer being pursued.

4.4.2 Seawater Conversion Vessel

Water Standard Company proposed a Seawater Conversion Vessel project, consisting of a seawater desalination vessel anchored in Monterey Bay with a pipeline to deliver the

desalinated water ashore. Although this alternative was never fully defined, it is assumed that, if developed, it would both provide sufficient water to offset the over-pumping in the Basin and to satisfy Order No. 95-10. This type of alternative has not been proven in any other applications. The ability of this project to receive the necessary regulatory permits or to reliably deliver water at an affordable cost compared to other alternatives were deemed to be very unlikely and this alternative is no longer being pursued.

4.4.3 Coastal Water Project (Moss Landing Desalination – Local Alternative)

The Coastal Water Project (also called the Moss Landing Desalination Project – Local Alternative) would have had a desalination plant located near the Moss Landing Power Plant (MLPP) similar to the DeepWater Desal project. The feedwater supply for the desalination plant would have been MLPP's existing seawater intake. Brine would have been disposed through the plant's existing outfall. This desalination plant would likely have been owned and operated by CAWC. It would have been sized to only supply existing water demands, with no supplemental supply to accommodate future growth. Because other more politically acceptable desalination alternatives were developed, this local desalination alternative was dropped from further consideration.

4.4.4 North Marina Desalination – Local Alternative

The North Marina seawater desalination facility would have been owned and operated by CAWC in the City of Marina's sphere of influence on Armstrong Ranch. This plant would either have included a pipeline to the MLPP to discharge the brine, or a pipeline to use M1W's existing outfall. The feedwater intake for this plant would have been a set of coastal slant wells extending under the sea floor. These slant wells and the desalination plant would have been constructed in North Marina.

Because other more politically acceptable desalination alternatives were developed, this local desalination alternative was dropped from further consideration.

4.4.5 Regional Alternative (Moss Landing Desalination – Regional Alternative)

A larger version of the Moss Landing Desalination Plant – Local Alternative was developed and was referred to as the Regional Project. This larger desalination plant was intended to serve many communities in Monterey County including Moss Landing, North Monterey County, and Castroville. The Regional Project would have been implemented jointly by CAWC, Marina Coast Water District (MCWD) and Monterey County Water Resources Agency (MCWRA). The desalination plant would likely have been located in North Marina (Armstrong Ranch) and owned and operated by CAWC.

The Regional Project was envisioned as being implemented in phases and would have included vertical seawater intake wells on coastal dunes located south of the Salinas River and north of Reservation Road. CAWC withdrew its support for the Regional Project because of potential conflicts among the regional partners, and subsequently submitted an application to the CPUC for the MPWSP. Therefore, this project was dropped from further consideration.

5 BASIN MANAGEMENT ACTIONS

Supplemental water supplies from the long-term water supply alternatives identified in Section 4 are not immediately available. Furthermore, after implementing the long-term water supply solutions, an additional amount of time will pass before a rise in groundwater levels will be observed in the Basin. To address this time lag, this section presents management actions that could be implemented before the supplemental supplies begin to restore groundwater levels. Although many of the actions discussed in this section are not under Watermaster's direct control, the Watermaster should consider providing support where needed.

The purpose of these management actions is threefold:

1. Raise groundwater levels in the Basin before supplemental supplies become available.

2. Optimize existing natural recharge and basin storage capacity.

3. Manage and reduce the near-term threat of seawater intrusion.

These actions are not intended to provide long-term solutions to restoring groundwater levels in the Basin. Rather, they assist with groundwater management and are intended to reduce the risk of seawater intrusion before long-term solutions raise groundwater levels to protective elevations. Some of the actions were also considered in the 2009 BMAP but with increased understanding of the Basin, they may not have the benefit initially thought.

Three types of actions are presented: increase groundwater recharge, decrease groundwater demand, and operational management options.

5.1 Increase Groundwater Recharge

5.1.1 Enhanced Storm Water Recharge within the City of Seaside

Although there are existing storm water percolation facilities within the City of Seaside, mostly associated with new developments, most of the storm water from the City of Seaside is collected and discharged to the ocean through outfalls to Monterey Bay. A portion of this storm water could potentially be captured and recharged into the Basin to supplement natural groundwater recharge. Examples of two similar projects in the

planning stages are included in Section 4.2.5: Del Monte Manor Park infiltration and the Drywell Aquifer Recharge Program.

Advantages:

- No water right is needed
- A storm water recharge system will likely not be abandoned as other supplemental supplies are developed, so the up-front investment would not become obsolete if other supplemental supplies come on-line.

Disadvantages:

- There is an unknown capital cost involved in designing, constructing, and managing storm water recharge facilities.
- Depending on recharge location and method, recharged water may not be available in the immediate future. The benefits of such projects might not be immediate.
- Depending on recharge location and method, recharged water may flow out to ocean.
- Urban runoff includes street runoff that contains contaminants. Water proposed for recharge will likely need to be treated before it can be recharged.
- Land is needed for recharge facilities.
- It may be difficult to quantify the volume of recharge enhancement due to the project.

5.1.2 Groundwater Injection Preferable to In-Lieu Recharge for Raising Coastal Groundwater Levels

The original model report (HydroMetrics LLC, 2009b) simulated five different future Basin management scenarios. Those scenarios which included significant direct injection into the deep aquifer as a recharge mechanism, as opposed to passive in-lieu recharge, are the most successful in raising groundwater levels to protective elevations. This is because the deep aquifer is highly confined beneath thick clay layers near the ocean which limits its natural recharge. It takes a long time for wells in the deep aquifer to reach protective elevations without direct injection into the aquifer.

To recover the Basin to protective elevations within a reasonable period of time, recharge by direct injection of water into the deep aquifer is the most effective. In this option,

injected water is not used for storage and recovery as a supplemental supply, but rather to stay in the Basin as a management measure to protect against seawater intrusion.

5.2 Decrease Groundwater Demand

5.2.1 Water Conservation

Water savings from conservation are not a new supply source, however, they reduce overall demand and the need for potable water. The MPWMD has partnered with both the City of Seaside and CAWC to develop conservation plan aimed, in part, in meeting requirements of the Decision.

Seaside Municipal Water System Water Conservation Plan

In 2009, the City of Seaside and MPWMD adopted the Seaside Municipal Water System Water Conservation Plan (City of Seaside, 2009). The conservation plan applies to areas served by the City of Seaside within the Northern Coastal and Southern Coastal Subareas. The purpose of this plan is to help reduce water demand so that the City of Seaside can meet its allocated annual water production per the Decision. Water conservation plan goals are to achieve a 5% reduction in water use through public outreach and support of new water efficient technologies through rebate incentives and give-away programs. No rationing measures like those described in the next paragraph are included in the Seaside Municipal Water System Water Conservation Plan.

Monterey Peninsula Water Conservation and Rationing Plan

In 2016, CAWC and MPWMD adopted the Monterey Peninsula Water Conservation and Rationing Plan (MPWMD, 2016). Water savings from conservation contribute to satisfying both SWRCB Order No. 95-10 and the Decision. The overall conservation measures are administered by CAWC and MPWMD within the MPWMD service area, including the Northern Coastal and Laguna Seca Subareas.

The measures are implemented in four stages to respond to (1) a physical shortage or water resource system storage, (2) regulatory or missed production targets, (3) a regulatory order, and (4) an emergency. **Table 13** provides a summary the stages. A full version of the rules is available on MPWMD's website at http://www.mpwmd.net/wp-content/uploads/2016-Conservation-and-Rationing-Plan-1.pdf. The provisions of each preceding stage are continued when the additional measures of a succeeding stage are implemented. The amount of water that is saved and the long-term reliability of

conservation measures is linked to the success of the local authority and the public's participation in conservation measures.

Table 13. Summary of Monterey Peninsula Water Conservation and Rationing Plan Stages

	Stage 1 Physical Shortage	Stage 2 Regulatory	Stage 3 Regulatory Order	Stage 4 Emergency
Measure	Prohibition on water waste	Voluntary conservation	Conservation rates	Rationing
Effect	Contains definition of water waste, enforcement process, and water waste fines	Call for action and increased water waste enforcement and outreach	25% Level 1 surcharge	Residential and non-essential commercial rationing first
			40% Level 2 surcharge	Moratorium

Through water conservation measures, water demand in CAWC systems within the Seaside Basin was reduced by approximately 19% from the start of the recent drought in 2012 to the end of the drought in 2016. However, there typically tends to be bounce-back in water use after a drought, so usage may not remain below the 2012 level.

5.2.2 Recycled Water for Laguna Seca Golf Courses

Currently, the Nicklaus Golf Course is the only golf course in the Laguna Seca Subarea that uses recycled water. The source of recycled water is from the Pasadera development and its use only covers a very small portion of the golf course's total demand.

There are no other known plans to use recycled water in the Laguna Seca Subarea. However, golf course irrigation is the largest user of groundwater in the Laguna Seca Subarea and increased use of recycled water would alleviate declining groundwater levels in the subarea. West of the Nicklaus Golf Course is the Laguna Seca Golf Resort which does not have access to recycled water. There may be a possibility in the future to receive recycled water from an extension of the RUWAP (see Section 4.2.2). Approximately 2.7 miles of pipeline would need to be constructed. There would also be land transfer issues with FORA to contend with.

5.3 Operational Management

5.3.1 Redistribute Pumping Among Existing Wells

Groundwater extractions from the Northern Coastal Subarea are concentrated at two wells: CAWC's Ord Grove and Paralta wells. Between Water Years 2011 and 2017, an average of close to 2,500 acre-feet was pumped from these two wells. Since Water Year 2011, pumping from these two wells constituted 50 – 60% of the total basin pumping and 65 – 83% of Northern Coastal Subarea pumping. Spreading the pumping among multiple wells in the subarea could result in a broader, shallower cone of depression. The shallower cone of depression would slow the potential rate of advance of seawater intrusion.

Advantages:

- This action potentially reduces the rate of potential seawater intrusion.
- Because redistribution would be amongst existing wells, this action is easily reversible.

Disadvantages:

- Most of the underused wells are in the shallower Paso Robles Formation. Additional pumping in the Paso Robles Formation may be more likely to induce seawater intrusion because that aquifer appears to have a better connection to the ocean than the Santa Margarita Sandstone.
- CAWC has few wells in the Paso Robles Formation, and the wells they do have, have limited production capacity.
- Additional distribution piping would likely be required to get water to existing infrastructure.

5.3.2 Install New Southern Coastal Subarea Wells

As noted in Section 5.3.1, extraction in the Northern Coastal Subarea is concentrated at two CAWC production wells. Pumping could be distributed more evenly across the Coastal Subareas by installing new production wells in the Southern Coastal Subareas. The Southern Coastal Subarea would be particularly advantageous, because it appears to have more water stored above sea level than the Northern Coastal Subarea. Installing new wells in this subarea could result in a broader, shallower cone of depression across

the coastal portion of the Basin. The shallower cone of depression would slow the potential rate of advance of seawater intrusion.

Advantages:

- This action potentially reduces the rate of potential seawater intrusion.
- There is an opportunity to transfer pumping to the Paso Robles aquifer if it does not result in an increase in the overall drawdown near the coast.

Disadvantages:

- Potential well sites would likely be located in urban areas with limited available land, leading to possibly difficult well installations.
- Increasing pumping in the Southern Coastal Subarea would increase the risk of seawater intrusion in this subarea, if it led to lowering groundwater levels to below protective levels.
- These actions would require funding approval from the CPUC.
- Additional distribution piping would likely be required to get water to existing infrastructure.

5.3.3 Install New Inland Wells

The original model report (HydroMetrics LLC, 2009b) simulated Basin effects of moving the largest capacity production wells, Ord Grove and Paralta wells, from the Northern Coastal Subarea to the Northern Inland Subarea in an effort to reduce stress on coastal groundwater levels. Model results showed that moving pumping inland would have limited benefit to groundwater levels, and that it is doubtful the cost of moving wells is justified.

5.3.4 Coordination with Neighboring Sustainability Management Planning Agencies

Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA)

Groundwater modeling work carried out by the Watermaster in 2016 to identify groundwater flow divides within and to the east of the Laguna Seca Subarea, demonstrated that the eastern portion of the subarea is hydraulically linked to the Corral de Tierra subarea of the Monterey Basin (see **Figure 1**).

Although groundwater flow is currently east to west across the Basin boundary in this area, predictive modeling shows that this flow direction may switch by 2030

(HydroMetrics WRI, 2015). Groundwater pumping and any potential projects or management actions implemented as part of the Salinas Valley Groundwater Sustainability Plan (GSP) that are near the Seaside Basin may impact groundwater levels within the Basin. DWR will evaluate whether GSPs adversely affect the ability of an adjacent basin to implement their groundwater sustainability plan or impede achievement of sustainability goals in an adjacent basin. This would also apply to Adjudicated basins.

Seaside Basin Watermaster staff have been involved in lead up work to GSP development by attending meetings on the development of the Salinas Valley Integrated Hydrologic Model (SVIHM) and on development of the GSP.

Marina Coast Water District Groundwater Sustainability Agency (MCWDGSA)

The Seaside Basin's northern boundary is shared with the Ord subarea of the Monterey subbasin, which falls under the Marina Coast Water District Groundwater Sustainability Agency's (MCWDGSA) for GSP development (see **Figure 1**).

Groundwater levels on either side of the Seaside Basin's northern boundary control the location of the Basin's northern flow divide, which is not exactly at the Basin's northern boundary as shown in the Decision. Similar to GSP development by the SVBGSA, the Watermaster will need to be involved and coordinate with the MCWDGSA during their GSP development. Coordination is needed to ensure Ord subarea GSP projects and management actions do not adversely affect Seaside Basin projects and management actions that reduce native groundwater pumping and raise coastal groundwater levels to protect against seawater intrusion.

6 RECOMMENDED MANAGEMENT STRATEGIES

Many of the recommendations made in the 2009 BMAP have been implemented and have successfully contributed to producers adhering to triennial pumping reductions. Producers in the Basin have already demonstrated that they have the means to reduce pumping to close to 3,000 acre-feet per year. With the supplemental water supply projects currently under construction, basin producers are on track to achieving the Basin's Operating Yield at the Decision-Established Natural Safe Yield of 3,000 acre-feet per year by October 2020.

The modeling that developed the protective elevation groundwater surfaces for this report indicate that the MPWSP, in its current configuration, will not raise groundwater levels to protective groundwater elevations in all parts of the Basin. A further reduction of pumping in production wells screened in the deep aquifer of the Northern Coastal Subarea of approximately 1,800 acre-feet per year is needed for all protective groundwater elevations to be reached by the end of the predictive model period (2041). This will ensure that seawater intrusion will not impact the Basin and its production wells.

Recommendation 1: Encourage Implementation of Selected Management Actions

From the basin management actions outlined in Section 5, the following five are the most likely to be implemented cost-effectively and provide the greatest benefit to the Basin in the short-term. These recommended management strategies are focused on increasing recharge in the Basin and decreasing groundwater demand in the key areas of the Basin that are under stress: Northern Coastal and Laguna Seca Subareas. Any action that would assist in appropriate management of the Basin should be encouraged and supported by the Watermaster.

1. **Install New Southern Coastal Subarea Wells**

   This strategy further spreads pumping across the Basin. It could be implemented more quickly than the inland wells strategy if land is available to CAWC in the Southern Coastal Subarea. The Southern Coastal Subarea would be particularly advantageous, because it has more groundwater stored above sea level than the Northern Coastal Subarea. New well locations should be sited in coordination with the Watermaster to determine optimal locations that do not cause groundwater levels to fall below protective elevations.

2. **Recycled Water for Laguna Seca Golf Courses**
   The use of recycled water in the Laguna Seca Subarea for irrigation purposes should be encouraged by the Watermaster provided that no detrimental water quality impacts occur.

3. **Water Conservation**
   This is a management action without capital costs that results in a demand reduction. Water conservation should be given high priority with respect to the Watermaster's support of projects that reduce the amount of groundwater pumped from the Basin. Opportunities for additional water conservation, however, may be limited and therefore the benefit may be small.

4. **Coordination with the Salinas Valley Basin Groundwater Sustainability Agency**

   Over the next few years, the Salinas Valley Basin and MCWD Groundwater Sustainability Agencies will be developing sections of their GSPs related to sustainable management criteria and the projects and management actions that will be implemented to achieve their sustainability goals for the Corral de Tierra and Ord subareas of the Monterey Subbasin by 2042. Their GSPs are required to be submitted by January 31, 2022. Since pumping in the Corral de Tierra subarea east of the Laguna Seca Subarea influences groundwater levels in Laguna Seca Subarea, and pumping in the Ord subarea can influence groundwater levels in the Seaside Basin's Northern Coastal Subarea, it is vital that the Watermaster have technical representation at GSP coordination meetings required under SGMA with neighboring basins. Due to the extended timeline for GSP implementation, this management action is likely to have a longer-term impact on the Basin than the other recommendations.

5. **Enhanced Storm Water Recharge within the City of Seaside**
   Recharge project opportunities using storm water similar to the Del Monte Manor Park infiltration and the Drywell Aquifer Recharge Program should be supported by the Watermaster. The shallow aquifer will benefit from this type of recharge of stormwater that normally discharges to the ocean through outfalls to Monterey Bay.

Recommendation 2: Groundwater Modeling to Determine a Combination of Management Actions and Supplemental Supply Projects that Achieve to Protective Groundwater Elevations

A calibrated groundwater flow model was developed for the Basin based on recommendations in the 2009 BMAP. The groundwater model has been used regularly to evaluate Basin conditions that result from various management actions and supplemental water supply projects. The model was updated in early 2018 prior to the preparation of this updated BMAP.

Although individual projects have been modeled and compared against protective groundwater elevations, the combination of basin management actions and supplemental water supply projects that are able to raise groundwater levels to protective elevations has not been studied. This is understandable, since the focus over the past nine years has been on meeting triennial pumping reductions. Since it is only two years until the last triennial reduction takes effect, the Watermaster should focus on establishing a path forward to meet coastal protective elevations.

Recommendation 3: Continue Ongoing Groundwater Monitoring

Groundwater level and groundwater quality monitoring is currently being conducted in accordance with the Seaside Basin M&MP and Seawater Intrusion Response Plan (SIRP). The M&MP is a key component of basin management that is already being implemented by the Watermaster. Continued monitoring in accordance with the M&MP and SIRP will provide data necessary for making future management decisions.

Water quality and groundwater level data from monitoring wells associated with new supplemental projects should be reported to the Watermaster.

Recommendation 4: Continue Annual Analyses

The Decision requires that an Annual Report be prepared by the Watermaster. The Annual Report is to address the specific Watermaster functions set forth in Section III.L.3.x of the Decision. The Annual Reports include a section pertaining to Water Quality Monitoring, and also include summaries of the annual Seawater Intrusion Analysis Report (SIAR).

The annual reports are important documents that serve to 1) provide a spring and fall snapshot of groundwater quality and groundwater levels for each year, 2) allow for a year-by-year comparison of Basin conditions, and 3) document Basin management decisions and actions, and their resultant impacts on the Basin.

The analyses that are included in the SIARs should be continued.

Recommendation 5: Develop Long-Term Financing Plan for Replenishment Water

The Decision identifies three separate budgets that the Watermaster oversees: (1) the Monitoring and Management Plan budget, (2) an annual Administrative budget, and (3) a Replenishment budget. These budgets are set every year by the Watermaster.

The replenishment assessments are only intended to offset overproduction that has occurred after the Decision was issued. The current replenishment assessments are not sufficient to buy water that offsets over-pumping that occurred prior to the Decision. The over-pumping prior to the Decision added to the Basin's deficit. Offsetting only the over-production that occurred after the Decision may not be sufficient to raise groundwater levels in the Basin sufficiently to prevent seawater intrusion. The Watermaster should develop a plan to address this issue.

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8 ACRONYMS & ABBREVIATIONS

AF .....acre-foot
AFY.....acre-foot per year
ASBS.....Area of Special Biological Significance
ASR.....aquifer storage and recovery
AWPF .....Advanced Water Purification Facility
Basin .....Seaside Groundwater Basin
BMAP .....Basin Management Action Plan
CAWC.....California American Water Company
CDPH.....California Department of Public Health
CEQA.....California Environmental Quality Act
CPUC .....California Public Utilities Commission
CSIP .....Castroville Seawater Intrusion Project
CWP.....Coastal Water Project
Decision .....Monterey County Superior Court Decision filed February 9, 2007 under Case No. M66343 - California American Water v. City of Seaside et al.
DWD.....DeepWater Desal, LLC
DWR .....California Department of Water Resources
EIR .....Environmental Impact Report
EIS.....Environmental Impact Statement
FORA.....Fort Ord Reuse Authority
HDD.....horizontal directionally drilled
IRWM .....Integrated Regional Water Management
MBNMS.....Monterey Bay National Marine Sanctuary
MBRWP.....Monterey Bay Regional Water Project
MCWD.....Marina Coast Water District
MCWDGSA...Marina Coast Water District Groundwater Sustainability Agency
MCWRA.....Monterey County Water Resources Agency
mgd .....million gallons per day
MLPP .....Moss Landing Power Plant
M&MP .....Seaside Basin Monitoring and Management Plan
MPWMD.....Monterey Peninsula Water Management District
MPWSP.....Monterey Peninsula Water Supply Project
MRWPCA.....Monterey Regional Water Pollution Control Agency
msl.....mean sea level
NAVD 88.....North American Vertical Datum of 1988
NEPA .....National Environmental Policy Act

O&M .....operation and maintenance
PWM .....Pure Water Monterey
RO .....reverse osmosis
RUWAP .....Regional Urban Water Augmentation Project
RWQCB.....Regional Water Control Board
SBWM .....Seaside Basin Watermaster
SGMA .....Sustainable Groundwater Management Act
SIAR .....Seawater Intrusion Analysis Report
SIRP .....Seawater Intrusion Response Plan
SVBGSA.....Salinas Valley Basin Groundwater Sustainability Agency
SVIGSM .....Salinas Valley Integrated Ground and Surface Water Model
SVRP.....Salinas Valley Reclamation Plant
SWRCB.....State Water Resources Control Board
SWRO.....seawater reverse osmosis
SWRP.....Storm Water Resource Plan
TAC.....Technical Advisory Committee