FINAL REPORT | May 2014

Amended Estuary Special Studies Phase 2:

Facilities Planning Study for Expanding Recycled Water Delivery

In fulfillment of the State Water Resources Control Board and U.S. Bureau of Reclamation grant funding requirements

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PREAMBLE

Introduction
The Estuary Special Studies Phase 2 Facilities Planning Study for Expanding Recycled Water Delivery - Final Report" (March 2013) (Final Report) was submitted to the Los Angeles Regional Water Quality Control Board per the requirements of the City of Ventura's Waste Discharge Requirements for the Ventura Water Reclamation Facility (Order No. R4-2008-0011, NPDES No. CA0053651). As described in Chapter 8 of the report, the development of this report was financially supported by grants from the State Water Resources Control Board (SWRCB) Water Recycling Funding Program and the U.S. Bureau of Reclamation (USBR) Title XVI Water Reclamation and Reuse Program. The Final Report also states that the SWRCB and USBR grant funding agreements were provided subject to stipulations on the content of the report, and explains that a subsequent version of the Final Report would be prepared to satisfy the funding agreement conditions by addressing a concept for a recommended project.

The "Amended Estuary Special Studies Phase 2 Facilities Planning Study for Expanding Recycled Water Delivery - Final Report" (May 2014) (Amended Final Report) was prepared in compliance with the grant funding requirements of the SWRCB and USBR. The Amended Final Report, in comparison with the Final Report includes the following changes and additions:

- Chapter 7 – Minor edits (format, units, and additional detail) to Tables 7.14, 7.15 and 7.16. Note that the Table ES.3 was revised since the content is the same as Table 7.14.
- Chapter 8 – Stakeholder Input and Recommendations: This version of Chapter 8 has been revised and expanded to include a recommended project concept and additional research needs.
- Chapter 9 – Project Financing and Revenue Program. Chapter 9 includes discussion of a conceptual funding and revenue program that might be used to support development of the recommended project concept.

Consistency with the Settlement Agreement

The City of Ventura (City) entered into a Tertiary Treated flows Consent Decree and Stipulated Dismissal with Heal the Bay and Ventura Coastkeeper, effective March 30, 2012. The settlement sets a goal to identify, select, plan, design engineer, environmentally review, permit and construct infrastructure projects that have the capacity to reduce, by 2025, the amount of water entering the Santa Clara River Estuary (SCRE) by up to 100 percent (subject to regulatory, technical and financial infeasibility) by diverting it to other recycled and reclaimed water uses, including uses that improve local supply and enhance conservation. At the same time, however, the Consent Decree obligates and allows the City to reduce discharges to the SCRE only by that amount approved and permitted by state and federal regulatory agencies with jurisdiction over discharges, the SCRE, and the endangered and threatened species and habitats it provides. The parties to the settlement have agreed to, among other points, to "use the best available science to determine the appropriate discharge reduction and diversion volumes," or the maximum ecologically protective diversion volume (MEPDV).

While the findings of the Final Report suggested that an average annual volume of 4 to 5 mgd of Ventura Water Reclamation Facility (VWRF) effluent should remain as discharge, via a treatment wetlands, to SCRE to protect beneficial uses, several stakeholders, including Heal the Bay and Ventura Coastkeeper, raised concerns about data gaps and the study findings. Consequently, Ventura Water Reclamation Facility Order No. R4-2013-0174 (VWRF's NPDES Permit and Waste Discharge Requirements governing discharge of tertiary treated flows to the estuary) (Permit) requires Phase 3 special studies to provide sufficient information to allow the Regional Water Quality Control Board to determine whether or not the continued discharge of effluent enhances the SCRE. The Permit indicates that the special studies described in this Permit may also provide the scientific analysis used to define the MEPDV.

On May 6, 2014, the City submitted a Workplan for the Phase 3 Special Studies per the requirements of the Permit. The Phase 3 Workplan commits the City to additional monitoring and analyses that will provide the technical basis for determining the MEPDV, and whether the continued discharge of effluent enhances the beneficial uses of the SCRE. .

The Amended Final Report recognizes that the determination of enhancement and the MEPDV will occur in the future. However, to meet funding agency requirements, which mandate inclusion of a recommended project and associated cost estimates, it was necessary to select a project capacity. This capacity for the recommended project is based on the findings of the Final Report (i.e. 4 to 5 mgd of VWRF effluent should be discharged, via a treatment wetlands, to the SCRE in the critical summer period, June through September), while recognizing that future determination of the MEPDV may require the project capacity to be changed. The project capacity of the recommended alternative is 3.6 mgd of Indirect Potable Reuse (IPR) or Direct Potable Reuse (DPR), which provides for continued VWRF discharge during the critical summer period that ranges between 2 mgd and 5 mgd. This range is based on the range of estimated VWRF critical summer period effluent flows for existing conditions (approximately 7 mgd) and future conditions (approximately 11 mgd).The range of 2 to 5 mgd of continued discharge to the SCRE captures the range of 4 to 5 mgd that was identified in the Final Report. Therefore, the recommended project capacity of 3.6 mgd is a reasonable capacity increment. The recommended project includes construction of additional treatment wetlands for the remaining discharge to the SCRE to be consistent with the intent of the settlement agreement. The City anticipates, however, that depending on the MEPDV determination, the 3.6 mgd IPR/DPR recommended project may be modified in the future to a greater capacity, or it may be combined with other projects to achieve a greater MEPDV that allows less continued discharge to the SCRE.

The City also intends to commence a study of additional Diversion Infrastructure Project(s) that cumulatively have the capacity for diverting 100% of the average annual volume or flow of discharge, and divert between 50% and up to 100% of the average annual volume or flow of effluent to reuse. By December 31, 2015, the City will develop a preliminary study of the Diversion Infrastructure Project(s), which will yield preferred alternative(s) for diversion of up to 100% of VWRF discharge. At a minimum, the recommended 3.6 mgd IPR/DPR alternative in the Amended Final Report will be included in this future analysis of Diversion Infrastructure Projects, or the future analysis may call for increasing the capacity of the currently described IPR/DPR project.

CITY OF VENTURA

VENTURA WATER

AMENDED ESTUARY SPECIAL STUDIES PHASE 2: FACILITIES PLANNING STUDY FOR EXPANDING RECYCLED WATER DELIVERY

In fulfillment of the State Water Resources Control Board and U.S. Bureau of Reclamation grant funding requirements

FINAL

MAY 2014

REGISTERED PROFESSIONAL ENGINEER
LYDIA A. HOLMES
No. 56616
CIVIL
STATE OF CALIFORNIA

01/02/2014

REGISTERED PROFESSIONAL ENGINEER
ELISA A. GARVEY
No. 71690
CIVIL
STATE OF CALIFORNIA

01/02/2014

PREAMBLE

The Revised Final Report (May 2014) provides an update to the Final Report (January 2014) to reflect changes requested by the Bureau of Reclamation. The Revised Final Report (May 2014) includes changes to the following pages:

Table of Contents: p. vi through vii
Executive Summary: p. ES-9
Chapter 7: p. 7-42 through 7-48
Chapter 8: p. 8-21
Appendices: New Appendix G

City of Ventura

PHASE 2 RECYCLED WATER STUDY

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GLOSSARY OF TERMS

ADWF	Average dry weather flow
AFY	Acre feet per year
AF	Acre feet
AOP	Advanced oxidation process
AWPF	Advanced Water Purification Facility
BOD	Biochemical oxygen demand
CDPH	California Department of Public Health
CEC	Constituents of emerging concern
CMWD	Casitas Municipal Water District
CWA	Clean Water Act
DAF	Dissolved air flotation
DPR	Direct potable reuse
ETS	Effluent transfer station
FAT	Full advanced treatment
FCGMA	Fox Canyon Groundwater Management Agency
GREAT	Groundwater Recovery Enhancement and Treatment
gpm	Gallons per minute
HCF	Hundred cubic feet
IPR	Indirect potable reuse
LAFCo	Local Agency Formation Commission
LARWQCB	Los Angeles Regional Water Quality Control Board
LAS	Lower Aquifer System
LPHO	Low-pressure high output
MBAS	Methylene blue active substances
MBR	Membrane bioreactor
MEPDV	Maximum environmentally protective diversion volume
MF	Microfiltration
MG	Million gallons
mgd	Million gallons per day
MP	Medium pressure
NPDES	National Pollutant Discharge Elimination System

OJS	Outfall junction structure
RO	Reverse osmosis
RWC	Recycled water contribution
SAR	Sodium adsorption ratio
SDWA	Safe Drinking Water Act
SCR	Santa Clara River
SCRE	Santa Clara River Estuary
SMCL	Secondary maximum contaminant level
SNMP	Salt and nutrient management plan
SRF	State Revolving Fund
SWP	State Water Project
SWRCB	State Water Resources Control Board
TIN	Total inorganic nitrogen
TDS	Total dissolved solids
TMDL	Total maximum daily load
TNC	The Nature Conservancy
UF	Ultrafiltration
UV	Ultraviolet
UWCD	United Water Conservation District
VWRF	Ventura Wastewater Reclamation Facility

EXECUTIVE SUMMARY

BACKGROUND

The City of San Buenaventura (City or Ventura) is located 62 miles north of Los Angeles and 30 miles south of Santa Barbara along the California coastline. The City currently occupies about 21 square miles being bound by the City of Oxnard to the south, by unincorporated Ventura County to the east and north, and by the Pacific Ocean to the west.

The City provides water and wastewater services through the City's water utility, Ventura Water, which operates the Ventura Water Reclamation Facility (VWRF). The "City of Ventura Estuary Special Studies Phase 2: Facilities Planning Study for Expanding Recycled Water Delivery" (Phase 2 Recycled Water Study) is sponsored by the City of Ventura and the City contracted with Carollo Engineers to provide engineering services for the study. The two key objectives of the Phase 2 Recycled Water Study are:

- To better define projects for expanding recycled water for the purpose of offsetting potable uses, recharging groundwater basins, offsetting agricultural use and creating wetlands that would serve as a public amenity and environmental enhancement to the community; and
- To determine the effects of any remaining discharge levels on the receiving water body, the Santa Clara River Estuary (SCRE), in terms of beneficial uses and nutrients, the key constituents for evaluation of the physical water quality conditions of the SCRE.

Previous Studies (Phase 1)

The VWRF has been granted a NPDES permit to discharge tertiary treated wastewater to the Estuary through the Los Angeles Regional Water Quality Control Board (LARWQCB). However, under the Water Quality Control Policy for the Enclosed Bays and Estuaries of California, discharges of municipal wastewater to enclosed bays and estuaries are to be phased out except in circumstances where the discharge is shown to enhance the quality of receiving waters. To address this issue regarding a finding of enhancement, the LARWQCB required the City to complete the "Special Studies for the Santa Clara River Estuary" as a condition of the City's NPDES discharge permit (CA0053651).

The Special Studies (termed Phase 1 studies) have been completed and submitted to the LARWQCB, and a series of six stakeholder workshops were held from 2009 to August 2011 to evaluate study methods and the results. The major findings of the three studies were:

1. Existing VWRF discharges to the SCRE provide a fuller realization of beneficial uses as compared to a zero discharge scenario, however, modification to VWRF flow volume and nutrients input to the SCRE during the dry season (Alternative 5 in the

assessment) would improve overall habitat conditions and further improve beneficial uses in the SCRE. Additional detail on this conclusion, and the data and analyses used to support this conclusion, are provided in the Recommendations Memorandum (Carollo Engineers and Stillwater Sciences, 2011).

2. Treatment wetlands could provide additional nutrient reduction for the VWRF discharge thus improving the quality of the water that is discharged to the SCRE. In addition, wetlands could provide beneficial use through creation of wetland habitat.

3. Additional recycled water markets exist such that additional flows could be diverted from the estuary to be used for recycled water. However, more study was required to assess feasibility and further define water quality targets, treatment requirements, and infrastructure needs.

Current Study (Phase 2)

Directly following Phase 1, Phase 2 of the special studies was initiated to: (1) develop additional information (more hydrologic and water quality data) to improve the understanding of SCRE functioning and help assure protection of the sensitive wildlife and aquatic resources and habitats within the SCRE; and (2) integrate the conclusions of all three of the Phase 1 Studies into a process for selection, environmental review, and design of a preferred VWRF discharge/diversion alternative or combination of alternatives to create a discharge regime that further optimizes beneficial uses of the SCRE.

Key recommendations for Phase 2 studies identified at the end of Phase 1 included developing a suite of feasible VWRF effluent discharge reduction and/or improvement alternatives that utilize treatment wetland and recycled water approaches (i.e., variations of the Phase 1 Alternative 5) and assessing the impact of these alternatives on beneficial uses of the SCRE by assessing their impacts on SCRE habitat conditions and ecosystem functions using the developed predictive tools and SCRE stage-habitat area relationships (see Carollo Engineers and Stillwater Sciences 2011). Through close collaboration with the City, project Stakeholders, and other local entities, effluent discharge reduction and/or improvement alternatives were identified and evaluated as summarized in this report.

The development of this Phase 2 Report was financially supported by the City as well as grants from the State Water Resources Control Board Water Recycling Funding Program and the US Bureau of Reclamation Title XVI Water Reclamation and Reuse Program. Each of these grant funding agreements comes with stipulations for what shall be included in the development of a facilities plan. Therefore, this report contains sections and descriptions that are required by these grants.

Legal Actions

Coincident with Regional Board’s approval of the most recent VWRF NPDES permit, Heal the Bay and Wishtoyo Foundation's Ventura Coastkeeper Program pursued administrative challenges and legal actions to compel the City to discontinue releasing water to the SCRE. To resolve these challenges and actions, the City entered into a Tertiary Treated Flows Consent Decree and Stipulated Dismissal with Heal the Bay and Ventura Coastkeeper, effective March 30, 2012. The settlement sets a goal to identify, select, plan, design engineer, environmental review, permit and construct infrastructure projects that have the capacity to reduce, by 2025, the amount of water entering the SCRE by 50 percent to 100 percent by diverting it to other recycled and reclaimed water uses, including uses that improve local supply and enhance conservation. The parties to the settlement have agreed to, among other points, to "use the best available science to determine the appropriate discharge reduction and diversion volumes,." or the maximum ecologically protective diversion volume (MEPDV). The scientific analysis, or the best available science, will be provided by the Phase 1 and Phase 2 Special Studies, as well as future additional phases of these Special Studies. The appropriate discharge reduction and diversion volume must be approved and permitted by state and federal regulatory agencies with jurisdiction over discharges, the SCRE, and the endangered and threatened species and habitats it provides.

MAJOR FINDINGS OF PHASE 2 STUDY

The preliminary screening analysis conducted as part of this study, detailed in Chapter 6, led to a number of alternatives that were identified for further consideration, including:

- Northern Decentralized Treatment Plant with Urban and Agricultural Irrigation
- Direct Potable Reuse (DPR)
- Conveyance to the Oxnard WWTP/AWPF
- Groundwater Recharge of the Mound Basin (Indirect Potable Reuse or IPR)
- Groundwater Recharge/Irrigation at United Water Conservation District (UWCD) Facilities
- Treatment Wetlands Onsite and at City Owned Property

In addition, urban irrigation and agricultural irrigation are selected as alternatives that could be combined with other alternatives. Chapter 7 provides additional information, analysis, and evaluation of these alternatives.

Each alternative was evaluated as to the amount of flow that could be diverted for reuse, the cost for the alternative and the resulting effect of the remaining effluent discharged to the estuary. Based on stakeholder feedback at the Oct 31, 2012 meeting, treatment wetlands were added to each recycled water alternative for any flow that would still be discharged to the estuary with the goal of further improving the beneficial uses of the SCRE, taking into account physical water quality and habitat conditions for endangered and threatened species within the SCRE.

Impacts of Alternatives on SCRE Beneficial Uses Related to Habitat and Ecosystem Function

The Phase 1 Estuary Study assessed habitat/ecosystem function affected by each alternative during the dry season (June through September) by using the SCRE water balance, nutrient balance, and SCRE stage modeling tools. These tools developed during Phase 1 predicted future SCRE focal species habitat conditions while accounting for climate change and various alternatives for modifications to VWRF effluent discharges. Habitat conditions were assessed as a function of modeled SCRE stage, water depth, and associated mouth breaching timing, modeled average nitrogen levels, and habitat areas (as a function of SCRE stage) and habitat needs of for each listed focal species (Steelhead, Tidewater goby, California least tern, and Western snowy plover) associated with each VWRF discharge alternative. The Phase 1 studies (Stillwater Sciences, 2011) include a comprehensive analysis of the habitat/area relationship and water quality conditions to support the focal species. In the Phase 2 studies, these established conditions were used as the basis for evaluating the impacts of alternatives on SCRE beneficial uses related to habitat and ecosystem function.

Based on Stakeholder feedback received following the Phase 1 alternatives assessment, additional data was collected for Phase 2 and used to update both the water balance and nutrient balance tools. The additional data collected for Phase 2 led to several modifications to the water and nutrient balances, as described in Stillwater Sciences (2013) (provided in Appendix B) Key changes to the water and nutrient balances include:

- A SCRE mouth breaching elevation of 12.5 feet (NAVD88).
- Total inorganic nitrogen (TIN) concentration of 8 mg-N/L in the VWRF effluent
- Groundwater data from new wells on the north side of the SCRE provided groundwater quality information (TIN concentrations as high as 15 mg-N-L).

The Phase 2 alternatives assessment included developing SCRE stage/depth estimates for both dry and wet water year types. The Stillwater Sciences (2013) technical memo describes the analysis of the effects of the remaining discharge for each alternative on SCRE beneficial uses based upon impacts to the focal species' habitat and ecosystem function for both the existing and future VWRF flow conditions. The discharge to the SCRE under current and future conditions was calculated based on a water balance for the treatment plant and existing Wildlife Ponds. The loss of water through evaporation and percolation through the wetlands was estimated based on the observed losses from the existing Wildlife Ponds.

Based on the influent flow to the treatment wetlands, the wetland effluent (discharge from the treatment wetlands to the SCRE) nitrate concentrations were estimated based on estimates of hydraulic residence time, water temperature, and denitrification rate constants, as well as other inputs and parameters. The removal of nitrate in a wetland is variable, and is dependent on temperature and vegetation conditions. A range of nitrate concentrations was estimated for each of the alternatives and the upper end of this range was used as input to the nutrient balance.

The flow and water quality conditions for the alternatives are summarized in Table ES.1. For each of the alternatives with remaining VWRF effluent flow, the effluent would be conveyed to a treatment wetland for further water quality improvement. Depending on the remaining VWRF effluent flow, the wetlands would be the “onsite” Wildlife Ponds with modifications and/or the modified Wildlife Ponds in combination with the offsite City-owned property. The “no action” alternative represents the discharge from the Wildlife Ponds and existing flows. Each of the existing and future conditions for the alternatives, dry and wet year hydrologic conditions were evaluated. The analysis is limited to the critical summer period, June through September, when the SCRE mouth is typically closed. Alternatives with the same discharge conditions have been grouped to simplify Table ES.1.

The alternatives result in five different combinations of SCRE discharge flow and nitrate concentration. The “no action” alternative, showing the current discharge, is also included in Table ES.2. Table ES.2 presents the results of the analysis for these conditions, and therefore brackets the range of results that would occur as a result of implementing the alternatives. The color gradations in Table ES.2 represent a relative comparison of the results with the lightest shades representing the lowest water quality/habitat and the darkest shades representing the highest quality and habitat. California least tern foraging habitat is not included because the results were constant across the discharge flow and nitrate concentrations. Table ES.2 suggests that a discharge flow into the SCRE of 4 to 5 mgd, with a nitrate concentration of 4 mg-N-L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide a the greatest (or near greatest) habitat for the four focal species.

As stated in the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011), because significant levels of TIN are present in local groundwater and the Santa Clara River, it should be noted that reductions in nitrate levels under one or more alternatives may not result in substantially reduced algal levels and continued algal bloom episodes are likely to occur under all alternatives. Historically measured dissolved oxygen levels in some locations within the SCRE were periodically found below Basin Plan objectives (Stillwater Sciences 2011). Nevertheless, it is expected that the frequency and duration of algal blooms and any related dissolved oxygen impacts should decrease with reduced TIN levels. As discussed in Stillwater Sciences (2011), however, measurable reductions of algal biomass in the SCRE may not occur until the TIN:PO4 ratio approaches 4.5:1 by mass, with TIN approximately below 1.5–4.5 mg-N/L under current conditions.

Table ES.1 Estimated Average Dry Season (June - September) Flows and Nitrate Concentration for each Alternative
Phase 2 Recycled Water Study
City of Ventura

Alternative	Treatment Wetland	Flow Components (mgd)					Discharge to SCRE (from Treatment Wetlands) Nitrate Concentration (mg-N/L)
		VWRF Effluent	Diverted Effluent Capacity	Influent to Treatment Wetland	Evaporation/ Percolation Estimate [(2)]	Approximate Discharge to SCRE from the Treatment Wetlands	
Existing Flows							
No Action	None	7.3	-	-	1	6.3 [(5)]	8
North decentralized plant (Irrigation or DPR)	Onsite + City-Owned	7.3	2.0[(4)]	5.3	1.3	4	4
Conveyance to Oxnard or Full Recharge/Ag supply for UWCD	Onsite	7.3	>7.3 [(1)]	0	-	0	0
Partial Recharge/Ag supply for UWCD	Onsite	7.3	>7.3 [(1)(3)]	0	-	0	0
Mound Basin IPR & DPR (3.6 mgd)[3]	Onsite	7.3	4.5	2.8	1	2	4
Mound Basin (6.3)	Onsite	7.3	>7.3 [(1)]	0	-	0	0
Future Flows							
North decentralized plant (Irrigation or DPR)	Onsite + City-Owned	11.2	2.0[(4)]	9.2	1.3	8	5
Conveyance to Oxnard or Full Recharge/Ag supply for UWCD	Onsite	11.2	>11.2	0	-	0	0
Partial Recharge/Ag supply for UWCD	Onsite + City-Owned	11.2	7.7[(3)]	3.2	1.3	2	4
Mound Basin IPR & DPR (3.6 mgd)[3]	Onsite + City-Owned	11.2	4.5	6.7	1.3	5	4
Mound Basin IPR (6.3 mgd)	Onsite + City-Owned	11.2	7.9	3.3	1.3	2	4

Notes:
(1) Capacity for the diverted flow is greater than the VWRF effluent flow. The VWRF effluent flow was used for the calculations.
(2) Estimated as 1 mgd for the onsite wetlands (modified Wildlife Ponds) and 1.3 mgd for the combination of the Modified Wildlife Ponds and the City-Owned Property Wetlands.
(3) There is significant variability in the diverted capacity since the diverted flow depends on the diverted SCR flow.
(4) The effluent flow diverted for Irrigation and DPR are 2 mgd and 2.5 mgd respectively. The lower value of 2 mgd was used.
(5) In this alternative treatment wetlands would not be constructed and therefore approximately 6.3 mgd would discharge from the Wildlife Ponds to the SCRE.

Table ES. 2 Estimated Average Dry Season (June through September) Flows and Nitrate Concentration for each Alternative Phase 2 Recycled Water Study City of Ventura					
Discharge from the treatment wetlands to the SCRE – Flow and Water Quality		**Predicted SCRE Nitrate Concentration Range$^{(1)(3)}$ (mg-N/L)**	**Predicted Habitat (acres)**		
Flow (mgd)	**Nitrate Concentration (mg-N/L)**		**Steelhead**	**Tidewater Goby**	**CLT and WSP nesting$^{(2)(3)}$**
No Action (6.3)	8	6.2 – 7.7	148	101	167
0	0	9.6 – 12.5	58	107	183
2	4	4.5 - 8	78	110	183
4	4	3 – 5.2	115	111	182
5	4	2.8 – 4.7	132	110	177
8	5	3.5 – 4.9	157	85	160

Notes

(1) Concentration range is based on range of denitrification rates and wet and dry hydrologic conditions.

(2) CLT = California least tern; WSP = Western snowy plover

(3) Color gradations for SCRE nitrate concentrations and habitat area show lowest quality/habitat in the light shades and the highest quality/habitat in the darkest shades. For similar numbers the same color shading was applied.

As discussed in Stillwater Sciences (2011), unseasonal breaching of the SCRE mouth has potential adverse impacts on tidewater goby and steelhead. Estimated stages for a discharge into the SCRE of 4 mgd and 5 mgd are 9.5 feet NAVD88 and 10.5 feet NAVD88 respectively. Both of these stage estimates are below both the Phase 1 and Phase 2 estimates of breaching stage (11.0 ft NAVD88 and 12.5 feet NAVD88, respectively). The alternatives with discharges into the SCRE of 4 mgd to 5 mgd will result in increased breaching potential relative to alternatives with lower discharges in to the SCRE, but reduced breaching potential relative to alternatives with greater discharge into the SCRE.

It is important to understand that the alternatives do not need to be implemented at their full diversion capacity shown in this study. Several alternatives could be implemented at a capacity for diversion that would lead to increased water recycling, and local supply benefits, while continuing a discharge to the SCRE of between 4 to 5 mgd. At these flow levels, the combination of the modified Wildlife Ponds and the City-Owned Property would be used for treatment wetlands to achieve a nitrate concentration of approximately 4 mg-N/L (outflow from the treatment wetlands to the SCRE).

The findings, based on the additional data collected on Phase 2, are different than the results of the Phase 1 Estuary Subwatershed Study, which suggested that a lower VWRF discharge into the SCRE would provide better water quality conditions. The difference in these findings is in large part due to the north side groundwater data that were obtained during Phase 2. However, the estimated groundwater flow and quality from the north side is based on a limited data set. The results and evaluation of alternatives that follows is based on findings of the Phase 2 study, which suggests that a discharge flow into the SCRE of 4 to 5 mgd, and a nitrate concentration of 4 mg-N/L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide the greatest (or near greatest) habitat for the four focal species. However, as noted in Chapter 8, the City plans on conducting further groundwater studies to confirm the Phase 2 data and water quality analysis.

Cost Estimates

Common to all of the alternatives is the additional cost of treatment wetlands, as the approach is to combine each of the alternatives with treatment wetland for any remaining flow that the alternative does not provide the capacity to divert for reuse. Considering the additional cost of treatment wetlands as common to all alternatives also assures that additional water quality treatment and habitat benefits associated with the treatment wetlands are provided should it be determined appropriate to implement one or more alternatives at less than full diversion capacity for purposes of assuring some continued discharge to the SCRE to control TIN values. Costs are included to construct vegetated zones in the existing Wildlife Ponds as well as constructing new treatment wetlands at the City-Owned Property adjacent to the VWRF.

Several of the alternatives require implementation of reverse osmosis, which will result in a brine that has to be disposed. There are a number of brine treatment and disposal alternatives that could be considered. Constructing pipeline to the Calleguas Salinity Management Pipeline (SMP) is one of the more promising alternatives since it is an existing pipeline. The estimated cost for the pipeline between the VWRF and the Calleguas SMP is approximately $22 million. The costs for the alternatives that require brine disposal include the cost ($22 million) of the pipeline to convey the brine from the VWRF to the Calleguas SMP.

The project cost estimates for the alternatives are presented in Table ES.3. The table shows a breakdown of the treatment costs and infrastructure associated with each alternative.

STAKEHOLDER INPUT AND RECOMMENDATIONS

Based on the findings of this Phase 2 study there are many opportunities for diverting water from the Estuary for the purposes of recycling the water and benefitting the local communities' water supply. However, there is a significant cost associated with these

Table ES.3 Alternatives Comparison Summary
Phase 2 Recycled Water Study
City of Ventura

Alternative	Effluent Diversion Capacity (AFY)	Water Supply Flow (AFY)	Treatment Processes	Project Cost Components ($M)					CEQA and Permitting ($M)	With Wetlands		Without Wetlands	
				Wastewater Treatment	Brine Disposal [(1)]	Conveyance/ Storage/Injection	Recycled Water Distribution System	Wetlands		Total Project Cost ($M)	O&M Cost ($M/yr)	Total Project Cost ($M)	O&M Cost ($M/yr)
North decentralized plant - Irrigation	2,240	270	MBR Plant	21			3.5	6.8	1.5	33	0.90	26	0.70
Conveyance to Oxnard[(2)]	14,560	None	Disinfection Improvements	5		41		6.8	2.0	54	16.20	48	16.00
Conveyance to Oxnard[(3)]	14,560	None	AWPF Expansion and Disinfection Improvements	45		41		6.8	2.0	95	5.20	88	5.00
Full Flow Recharge/Ag supply for UWCD	14,560	Possible [(4)]	MF/UF and RO	41	22	27		6.8	2.5	100	5.60	93	5.50
Partial Flow Recharge/Ag supply for UWCD	8,960	Possible [(4)]	MF/UF and RO	16	22	27		6.8	2.5	74	2.10	67	2.00
Mound Basin IPR (3.6 mgd)	5,040	4,030	MF/UF, RO, advanced oxidation	32	22	30		6.8	2.5	94	3.20	87	3.00
Mound Basin IPR (6.3 mgd)	8,870	7,100	MF/UF, RO, advanced oxidation	52	22	39		6.8	2.5	122	5.30	115	5.10
North decentralized plant - DPR	2,520	2,020	MBR, RO, advanced oxidation	38		4		6.8	3.0	52	2.10	45	1.00
DPR (3.6 mgd)	5,040	4,030	MF/UF, RO, advanced oxidation	32	22	16		6.8	3.0	80	3.00	74	2.90

Notes:
(1) For alternatives with brine treatment, the cost of disposal at the SMP is included.
(2) City of Oxnard pays for the AWPF expansion. Treatment and conveyance capital costs, and O&M costs are from Kennedy Jenks (2013).
(3) City of Ventura pays for the AWPF expansion. Treatment and conveyance capital costs, are from Kennedy Jenks (2013). O&M costs estimated as part of this study.
(4) Potential water supply flow undefined at this point as it would be based on negotiations with Fox Canyon GMA.

alternatives and the City must carefully consider the larger water supply and integrated water management benefits associated with any of these alternatives to maximize the benefits of any investment.

Based on the currently available data collected for the Phase 1 and Phase 2 studies, it appears that the Estuary water quality and habitat function is most benefited by some discharge remaining in the estuary. However, these findings are based in part on a limited data set for groundwater quality on the north side of the Santa Clara River.

The draft version of this report was presented at the February 21, 2013 stakeholder workshop. The stakeholders provided input throughout the workshop, especially with regards to additional studies and data that needs to be collected in a Phase 3 effort. Details on the recommended additional studies are included in Chapter 8. Stakeholders also were given colored “dots” with which they could indicate which alternatives presented they preferred, as well as how much flow they felt needed to remain in the SCRE. It is important to note, however, that at least one stakeholder (and potentially others as well) refrained from using their dots as they felt there was not enough information to make a decision. In general, stakeholders were in support of using the treated water resource for augmenting potable supply through indirect or direct potable reuse.

At this time, there is some agreement among stakeholders and the City that the best uses of the reclaimed wastewater are those that will provide benefits to the City’s potable water supply system. In addition, the estuary studies suggest that a discharge flow into the SCRE of 4 to 5 mgd, and a nitrate concentration of 4 mg-N/L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide the greatest (or near greatest) habitat for the four focal species. Based on these findings, a treatment wetlands is needed to further reduce the nitrate concentrations in the VWRF effluent and a reasonable capacity for a recycled water project is 3.6 mgd (product water). Therefore, the recommended project includes IPR or DPR of 3.6 mgd and treatment wetlands.

For both of these alternatives advanced treatment processes would be constructed at the VWRF and conveyed to existing water treatment/distribution facilities or new groundwater injection wells. Chapter 8 includes detailed discussion on the recommended alternative. As shown in Table ES.3, the capital costs IPR (3.6 mgd) and DPR (3.6 mgd) alternatives are $94 million and $80 million, respectively.

There are several unknowns and issues that need to be resolved before final selection and refinement of an IPR or DPR alternative. The resulting recommendation is to implement an IPR or DPR project in a phased approach, where common components of these alternatives would be implemented first. This would allow the City to potentially take advantage of near term funding opportunities and to allow time for consensus on the project components and capacity.

A number of issues were considered in the development of this phased approach, including:

- Determination of the capacity of a recycled water alternative.
- Stakeholder input related to preferred uses for recycled water.
- Development of DPR Regulations.
- Assessment of the City's water supply needs.
- Public acceptance of IPR and DPR alternatives.
- Common components of the IPR and DPR alternatives.

The phased recommended alternative is summarized in Table ES.4, and includes completing additional studies to satisfy permit requirements and to determine the MEPDV, followed by construction of a treatment wetlands, the reclaimed water structure (advanced treatment processes) and a diversion pipeline (recycled water infrastructure),

Table ES.4 Phased Recommendations
Phase 2 Recycled Water Study
City of Ventura

Phase	Components	Description
A	Additional Studies	• Studies associated with determination of the MEPDV (Phase 3 Estuary study) • Integrated water management plan • Hydrogeologic study of the Mound Basin • Public outreach program • RO treatment feasibility study and pilot testing • Brine disposal study
B	Treatment Wetlands	• Modification of existing ponds and/or new treatment wetlands (offsite City-owned parcel)
C	Reclaimed Water Structure	• Advanced treatment at the VWRF • Brine disposal be determined
D	Diversion Pipeline	• Conveyance pipeline and associated infrastructure for IPR or DPR

BACKGROUND, STUDY AREA CHARACTERISTICS, STATEMENT OF PROBLEM AND NEEDS

1.1 BACKGROUND

The City of San Buenaventura (City of Ventura) (referred to as City, in this report) provides water and wastewater services. These services are provided by the City's water utility, Ventura Water. Ventura Water operates the Ventura Water Reclamation Facility (VWRF). The "City of Ventura Estuary Special Studies Phase 2: Facilities Planning Study for Expanding Recycled Water Delivery" (Phase 2 Recycled Water Study) is sponsored by the City. The purpose of the Phase 2 Recycled Water Study is to better define projects for expanding recycled water for the purpose of offsetting potable uses, recharging groundwater basins, offsetting agricultural use and to create wetlands that would serve as a public amenity and environmental enhancement to the community.

1.1.1 Previous Studies

The VWRF has been granted a National Pollutant Discharge Elimination System (NPDES) permit to discharge tertiary treated wastewater to the Santa Clara River Estuary (SCRE) through the Los Angeles Regional Water Quality Control Board (LARWQCB). However, under the Water Quality Control Policy for the Enclosed Bays and Estuaries of California, discharges of municipal wastewater to enclosed bays and estuaries are to be phased out except in circumstances where the discharge is shown to enhance the quality of receiving waters. To address this issue regarding a finding of enhancement, the LARWQCB required the City to complete the "Special Studies for the Santa Clara River Estuary" as a condition of the City's NPDES discharge permit (CA0053651).

The work conducted for the three studies included the following:

- Estuary Subwatershed Study –A synthesis of information regarding the SCRE ecosystem functioning under existing conditions (characterized by tertiary treated VWRF flows discharged to the Wildlife/Polishing Ponds and then to the SCRE) to determine if the current discharge results in fuller realization of beneficial uses within the SCRE. In addition, this study included a thorough assessment of a range of representative potential future VWRF effluent discharge alternatives and management measures that could be implemented to achieve further improvement in, and/or optimization of beneficial uses using water balance and water quality predictive tools developed with existing and newly-collected data.
- Treatment Wetlands Feasibility Study – Evaluation at a planning concept level the feasibility of implementing a constructed treatment wetland to achieve additional reductions in nutrients, copper and other metals in the VWRF tertiary treated discharge to further promote improvements in receiving water for beneficial uses.

- Recycled Water Market Study – Evaluation and quantification at a conceptual planning level the feasibility of expanding the City's existing reclaimed water system through evaluation of potential users within a five-mile radius of the VWRF for purposes of providing an alternative to discharging VWRF effluent flow to the SCRE.

The three Special Studies have been completed and submitted to the LARWQCB, and a series of six stakeholder workshops were held from 2009 to August 2011 to evaluate study methods and the results. The major findings of the three studies were:

1. Existing VWRF discharges to the Estuary provide a fuller realization of beneficial uses as compared to a zero discharge scenario, however, modification to VWRF flow volume and nutrients input to the SCRE during the dry season (Alternative 5 in the assessment) would improve overall habitat conditions and further improve beneficial uses in the SCRE. Additional detail on this conclusion, and the data and analyses used to support this conclusion, are provided in the Recommendations Memorandum (Carollo Engineers and Stillwater Sciences, 2011).
2. Treatment wetlands could provide additional nutrient reduction for the VWRF discharge thus improving the quality of the water that is discharged to the SCRE. In addition, wetlands could provide beneficial use through creation of wetland habitat.
3. Additional recycled water markets exist such that additional flows could be diverted from the estuary to be used for recycled water. However, more study was required to assess feasibility and further define water quality targets, treatment requirements, and infrastructure needs.

Directly following Phase 1, Phase 2 of the special studies was initiated to: (1) develop additional information (more hydrologic and water quality data) to improve the understanding of SCRE functioning and help assure protection of the sensitive wildlife and aquatic resources and habitats within the SCRE; and (2) integrate the conclusions of all three of the Phase 1 Studies into a process for selection, environmental review, and design of a preferred VWRF discharge/diversion alternative or combination of alternatives to create a discharge regime that further optimizes beneficial uses of the SCRE.

Key recommendations for Phase 2 studies identified at the end of Phase 1 included developing a suite of feasible VWRF effluent discharge reduction and/or improvement alternatives that utilize treatment wetland and recycled water approaches (i.e., variations of the Phase 1 Alternative 5) and assessing the impact of these alternatives on beneficial uses of the Estuary by assessing their impacts on SCRE habitat conditions and ecosystem functions using the developed predictive tools and SCRE stage-habitat area relationships (see Carollo Engineers and Stillwater Sciences 2011). Through close collaboration with the City, project Stakeholders, and other local entities, effluent discharge reduction and/or improvement alternatives were identified and evaluated as summarized in this report.

1.1.2 Legal Actions

Coincident with Regional Board's approval of the most recent VWRF NPDES permit, Heal the Bay and Wishtoyo Foundation's Ventura Coastkeeper Program pursued administrative challenges and legal actions to compel the City to discontinue releasing water to the Estuary. To resolve these challenges and actions, the City entered into a Tertiary Treated flows Consent Decree and Stipulated Dismissal with Heal the Bay and Ventura Coastkeeper, effective March 30, 2012. The settlement sets a goal to identify, select, plan, design engineer, environmental review, permit and construct infrastructure projects that have the capacity to reduce, by 2025, the amount of water entering the Estuary by 50 percent to 100 percent by diverting it to other recycled and reclaimed water uses, including uses that improve local supply and enhance conservation . At the same time, however, the Consent Decree obligates and allows the City to reduce discharges to the Estuary only by that amount approved and permitted by state and federal regulatory agencies with jurisdiction over discharges, the Estuary, and the endangered and threatened species and habitats it provides. The parties to the settlement have agreed to, among other points, to "use the best available science to determine the appropriate discharge reduction and diversion volumes," or the maximum ecologically protective diversion volume. The scientific analysis, or the best available science, will be provided by the Phase 1 and Phase 2 Special Studies, as well as future additional phases of these Special Studies.

1.1.3 Problem and Need

The regulatory issues and legal challenges associated with the discharge to the Estuary, as described in the previous sections, provide the need for investigating recycled water opportunities for the purpose of reducing the volume of the discharge. While reducing the discharge volume to the Estuary is an important driver, the City recognizes that implementing recycled water offers opportunities to offset potable demands and to provide a benefit to the City's potable source water supplies.

1.1.4 Report Outline and Crosswalk

Phase 2 Recycled Water Study received planning grant support from the State Water Resources Control Board (SWRCB) Proposition 13 Water Recycling Grant Program and the US Bureau of Reclamation (Reclamation) Title XVI Water Reclamation and Reuse Authority Projects. This report follows the SWRCB Water Recycling Program Funding Guidelines. The following chapters discuss the City's water supply characteristics and facilities (Chapter 2), wastewater characteristics and facilities (Chapter 3), treatment requirements for discharge and reuse (Chapter 4), potential recycled water market (Chapter 5), preliminary alternative analysis and screening (Chapter 6),and viable alternative development and economic analysis (Chapter 7), stakeholder Input and recommendations(Chapter 8) and financial plan/capabilities and next steps (Chapter 9). The report also complies with the Reclamation Title XVI grant requirements. A Title XVI Feasibility Study Report Contents Crosswalk is shown in Table 1.1.

Table 1.1 Title XVI Feasibility Study Report Contents Crosswalk
Recycled Water Feasibility Study
City of Ventura

Reclamation Manual Outline	Abbreviated Directives and Standards Section Title	Corresponding Report Location
1	**INTRODUCTORY INFORMATION**	
1a	Non-Federal project sponsor	Sec. 1.1
1b	Study area description	Sec. 1.2
1c	Site specific project area	Sec. 1.3, 1.4, 1.5, & 1.6
2	**STATEMENT OF PROBLEM AND NEEDS**	
2a	Problem and need	Sec. 1.1.3
2b	Current and projected water supplies	Sec. 2.1, 2.2 &2.5
2c	Current and projected water demands	Sec. 2.3
2d	Water quality concerns	Sec. 2.4
2e	Current and projected wastewater and disposal options, and new wastewater facilities	Sec. 3.1, 3.2
3	**WATER RECLAMATION AND REUSE OPPORTUNITIES**	
3a	Uses for reclaimed water	Sec. 5.1, 6.1 – 6.4
3bi	Potential users, peak use, conversion costs, letters of intent	Sec. 7.1 – 7.6, 5.3
3bii	Consultation with potential recycled water customers	Sec. 5.2
3biii	Market assessment procedures	Sec. 5.1
3c	Discussion of considerations, community incentives	Sec. 5.3
3d	Water and wastewater agencies jurisdictions	Sec. 2.1, Sec. 3.1
3e	Sources of water to be reclaimed	Sec. 3.2, 3,3
3f	Source water facilities	Sec. 2.1, 2.2
3g	Current water reuse taking place	Sec. 3.2
3h	Reuse technologies currently in use	Sec. 3.1. 3.2
4	**DESCRIPTION OF ALTERNATIVES**	
4a	Non-federal funding condition	Sec. 8.3
4b	Objective of alternatives	Sec. 6.1, 7.1 – 7.6
4c(i)	Other water supply alternatives: description	Sec. 8.3
4c(ii)	Other water supply alternatives: cost details	Sec. 8.3
4d(i)	Proposed project: complete description	Sec. 8.4
4d(ii)	Proposed project: assumptions	Sec. 7.2.2, 7.4.1,7.6.1 & 8.4

Table 1.1 Title XVI Feasibility Study Report Contents Crosswalk
Recycled Water Feasibility Study
City of Ventura

Reclamation Manual Outline	Abbreviated Directives and Standards Section Title	Corresponding Report Location
4e	Waste stream discharge	Sec. 3.2
4f	List of alternative measures or technologies	Sec. 7.1.2, 7.2.2, 7.3.2, 7.4.2, 7.5.2, 7.6.2
5	**ECONOMIC ANALYSIS**	
5a	With and without project economic analysis	Sec. 7.9.3, 8.4.5
5b	Comparison of alternatives	Sec. 6.5, 7.9, 7.10
5c	Benefits in terms of alternative costs	Sec. 7.9, 7.10
5d	Qualitative benefits	Sec 7.10
6	**SELECTION OF PROPOSED TITLE XVI PROJECT**	
6a(i-iv)	Reduction, postponement, or elimination of new supplies, existing diversions, Federal supplies, wastewater facilities	Sec. 7.9, 7.10
7	**ENVIRONMENTAL CONSIDERATIONS AND POTENTIAL EFFECTS**	
7a	Environmental discussion on each alternative	Sec. 7.8
7a(i-v) & (vii)	Environmental discussion of proposed project	Sec. 8.6, App. G
7a(vi)	Public involvement with study	Sec. 8.1
7b	If recommended to congress, meet NEPA	Sec. 8.6
8	**LEGAL AND INSTITUTIONAL REQUIREMENTS**	
8a	Water rights analysis	Sec. 8.5.2
8b	Legal and institutional requirements	Sec. 8.5
8c	Need for interagency agreements	Sec. 8.5.2
8d	Permitting Procedures	Sec 8.5.4
8e	Unresolved issues	Sec 8.2
8f	Current and Projected wastewater discharge requirements	Sec. 8.5.3
8g	Rights to wastewater discharges	Sec. 8.5.2
9	**FINANCIAL CAPABILITY OF SPONSOR**	
9a	Schedule	Sec. 8.7
9b	Willingness to pay	Sec. 9.1, 9.3
9c	Funding Plan	Sec. 9.3
9d	Sources of funding	Sec. 9.2
10	**RESEARCH NEEDS**	Sec. 8.9

The SWRCB and Reclamation report requirement guidelines can be found at the following websites:

- SWRCB (Water Recycling Funding Program Guidelines)- http://www.waterboards.ca.gov/water_issues/programs/grants_loans/water_recycling/
- Reclamation (WTR 11-01)- http://www.usbr.gov/recman/DandS.html

Information from numerous past reports was used to develop the content for the background information on the water, wastewater and recycled water systems. In addition, the technical analyses and findings of past studies were used to for the basis of the some of the technical analysis conducted for this study. All references used for this study are included in the References section of this report.

1.2 STUDY AREA CHARACTERISTICS

The City is located 62 miles north of Los Angeles and 30 miles south of Santa Barbara along the California coastline. The City currently occupies about 21 square miles being bound by the City of Oxnard to the south, by unincorporated Ventura County to the east and north, and by the Pacific Ocean to the west. The City is located within the County of Ventura. A vicinity map is presented in Figure 1.1.

1.3 HYDROLOGIC CHARACTERISTICS

1.3.1 Surface Watersheds

The City lies within both the Santa Clara River Watershed and the Ventura River Watershed. The majority of the City is within the Santa Clara River watershed, with only the northern most region of the City in the Ventura River Watershed. Figure 1.2 shows the City and watershed boundaries.

The Santa Clara River watershed is approximately 1,634 square miles and extends from the San Gabriel Mountains to the Pacific Ocean. The City is located on the north side of the Santa Clara River, at the most downstream end of the watershed. Portions of the City are adjacent to the Santa Clara River Estuary, which is the interface between the Santa Clara River and the Pacific Ocean.

When compared with many southern California coastal watersheds, the Santa Clara River watershed is relatively undeveloped; over 50 percent of the watershed is National Forest land (Angeles National Forest and Los Padres National Forest). Land cover in upland areas of the Santa Clara River watershed is dominated by scrub/shrub (chaparral) vegetation; grasslands and mixed, deciduous, and evergreen woodlands compose the remainder of upland land cover. Along floodplain and valley bottom areas of the Santa Clara River Valley, orchard and row crop agriculture is the dominant land use, with significant urban areas in the upper (Santa Clarita, Newhall) and lower (Santa Paula, Fillmore, Oxnard)

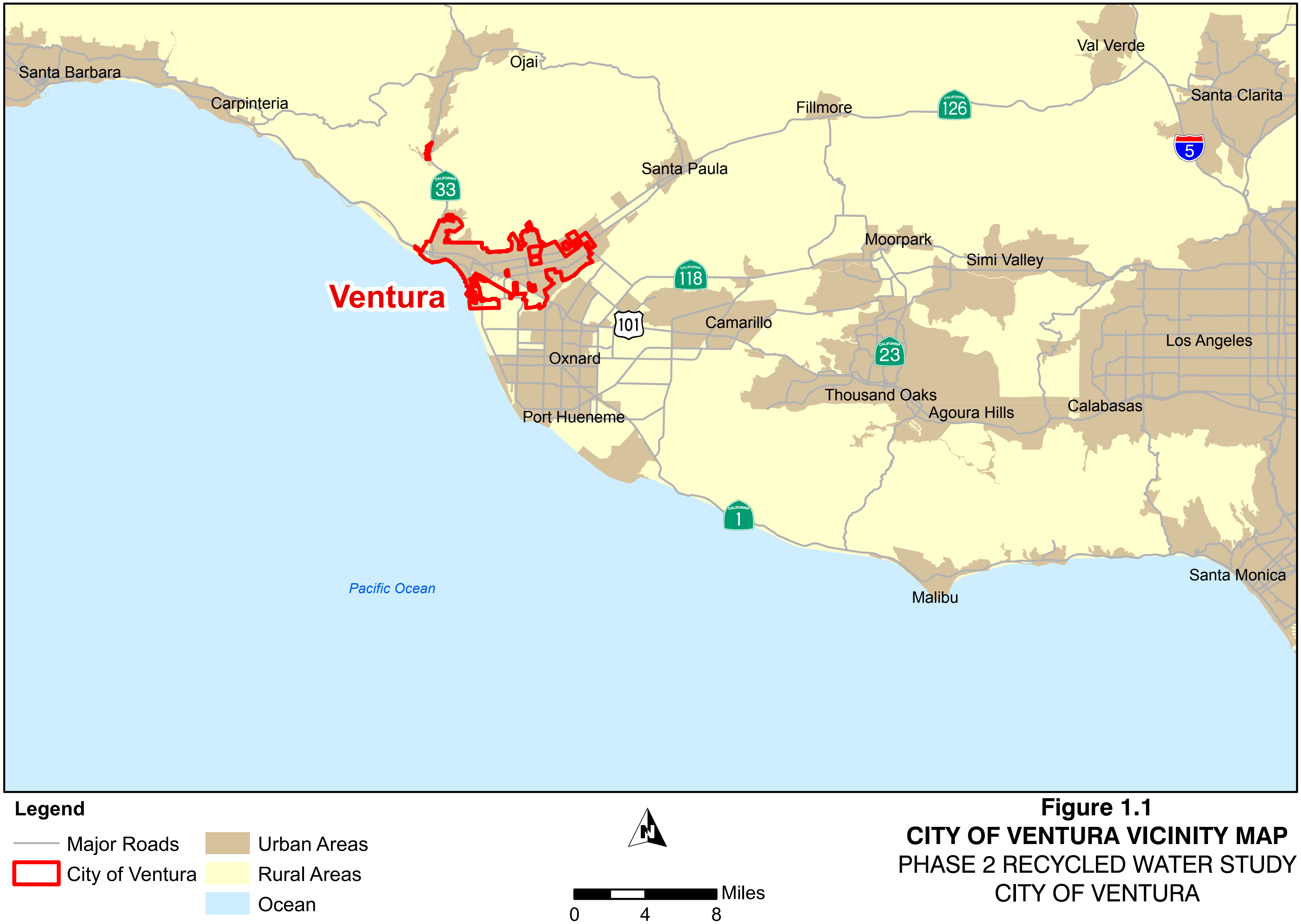

Figure 1.1
CITY OF VENTURA VICINITY MAP
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

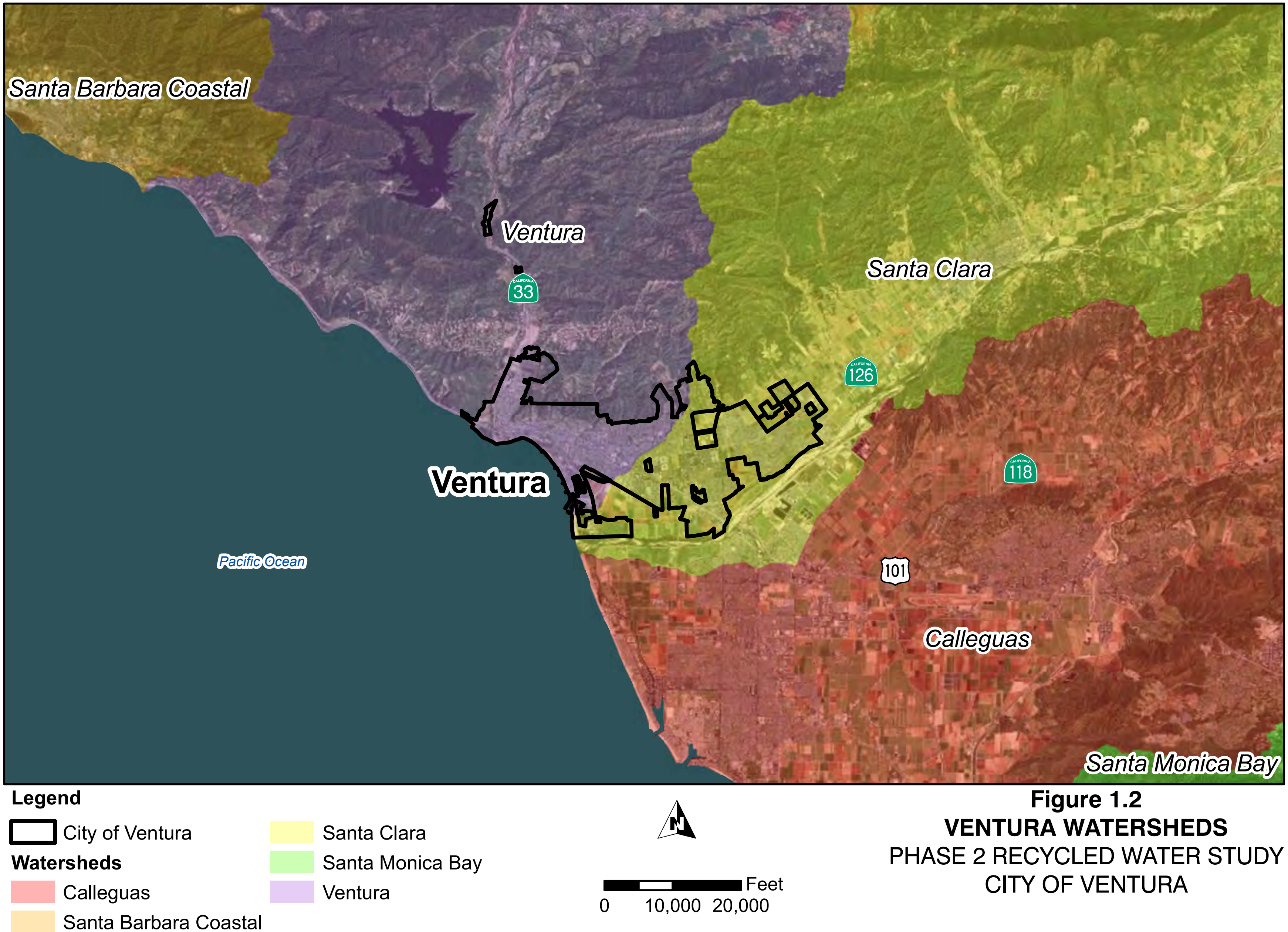

Figure 1.2
VENTURA WATERSHEDS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

valley areas (Stillwater Sciences, 2011) In the lower Santa Clara River below the confluence with Sespe Creek, agricultural and urban use account for 22 percent and 9 percent of land cover, respectively (Warrick 2002).

For this project, the most important stretch of the Santa Clara River, is the section between the Freeman Diversion and the Pacific Ocean. River flow into the SCRE is characterized by long durations of little to no flow punctuated by high flow events caused by short-duration, high-intensity precipitation events that travel quickly through the watershed (Stillwater Sciences 2011). In general, flows in the river are influenced by natural processes and variability in hydrologic conditions as well as anthropogenic activities/infrastructure including agricultural irrigation, water supply dams, and urbanization.

Flow gages at the Highway 101 bridge neat Montalvo (USGS 11114000, WY 1927-2004) and at the Victoria Avenue bridge (VCWPD 723, WY 2008-2009), suggest that the flow is highly variable. The 80 year period of record indicates that flows ranged from 0 to over 90,000 cfs (Stillwater Sciences, 2011). Analysis of these data show that mean daily discharge over the course of a water year (WY), or the period from October through the following September, is less than 1 cfs approximately 70 percent of the time and rarely exceeded 100 cfs. Monthly average daily mean discharge indicate that river flow into the SCRE is consistently low from May through December and reaches the annual maximum in February as a result of intense winter storms (Stillwater Sciences, 2011). Additional hydrologic analyses of the Santa Clara River are included in Stillwater Sciences (2011) and Nautilus Environmental (2005).

The SCRE is located at the interface between the Santa Clara River and the Pacific Ocean. For this project, the SCRE subwatershed is defined as the surrounding floodplain area where estuary infilling during closed-mouth, low river flow conditions is known to affect water-table elevation and influence sensitive habitat and human recreation (Stillwater Sciences 2011). This includes areas where the ground surface is equal or less than an elevation of approximately 3 m (10 ft) NAVD88, or the maximum SCRE stage currently reached during closed-mouth, low-flow conditions (Stillwater Sciences 2011). This area extends north to the VWRF and Ventura Harbor inlet, south into McGrath State Beach and to the southern edge of McGrath Lake, and east approximately 1.4 km (0.8 miles) upstream of Harbor Boulevard bridge (Figure 1.3).

The Ventura River watershed is approximately 228 square miles and extends from the San Rafael, Topatopa, Suphur and Santa Ynez mountains to the Pacific Ocean. The main stem of the river flows southward, approximately 16.5 miles from the confluence of Matilija Creek and North Fork Matilija Creek, to the river mouth at the Emma Wood State Beach in the City (Cardno ENTRIX 2012). Over 75 percent of the Ventura River Watershed is classified as rangeland covered with shrub and brush and 20 percent of the basin is classified as forested (Cardno ENTRIX 2012).

Legend

SCRE Boundary

Feet

0 1,500 3,000

Figure 1.3

SCRE BOUNDARY

PHASE 2 RECYCLED WATER STUDY

CITY OF VENTURA

1.3.2 Groundwater Basins

The City and surrounding region are within the Ventura River Valley Groundwater Basin (DWR Basin 4-3) and the Santa Clara River Valley Groundwater Basin (DWR Basin 4-4). Groundwater Subbasins in the area include the Lower Ventura River Valley Subbasin (DWR Subbasin 4-3.02), and the Oxnard, Mound and Santa Paula Basins (DWR Subbasins 4-4.02, 4-4.03 and 4-4.04, respectively). Figure 1.4 shows the approximate delineations of these groundwater basins.

The City relies on several of these basins for potable water supply (see Chapter 2), and several of the alternatives evaluated in this study include a component of groundwater recharge, either via recharge basins/ponds or via injection wells. For this reason, additional detail on the subsurface characteristics of these Mound, Oxnard Plain and Santa Paula Basins is provided.

1.3.2.1 Mound Basin

The Mound Groundwater Subbasin is bounded on the north by the Santa Ynez and Topatopa Mountains, on the south by the Oak Ridge and Saticoy faults, on the northeast by the Santa Paula Subbasin, and one the west by the Pacific Ocean (DWR, 2003). The 10,000 acre subbasin forms an elongated east-west trending ellipsoid with a maximum aquifer thickness along the syncline axis that generally parallels State Highway 126 (Fugro West 1996).

The main fresh water-bearing strata of the Mound Basin are the upper units of the San Pedro Formation and the overlying Pleistocene deposits, which is approximately 300 feet in thickness.

Groundwater generally flows from east to west with eventual discharge to the Pacific Ocean (Fugro 1996). DWR (2003) reports that sources of recharge to the subbasin include percolation of surface flow in the Santa Clara River, subsurface flow from the Santa Paula Subbasin, percolation of direct precipitation into the San Pedro Formation which crops out along the northern edge of the subbasin, and irrigation return flow.

The documentation and evaluation of groundwater levels within the basin is complicated by the location of the monitoring wells, which are predominantly in the southern and western portion of the basin. Since they are not evenly distributed across the basin, conclusive trends in the water levels throughout the basin are hard to determine. (UWCD, 2011)

Municipal pumping in the Mound Basin peaked in 2003 but has been on a steady decline in recent years with the 2011 total at 1,525 acre-feet. Agricultural pumping has predominated since 2007 with an average rate of 4,200 acre-feet per year and a total of 3,120 acre-feet in 2011.

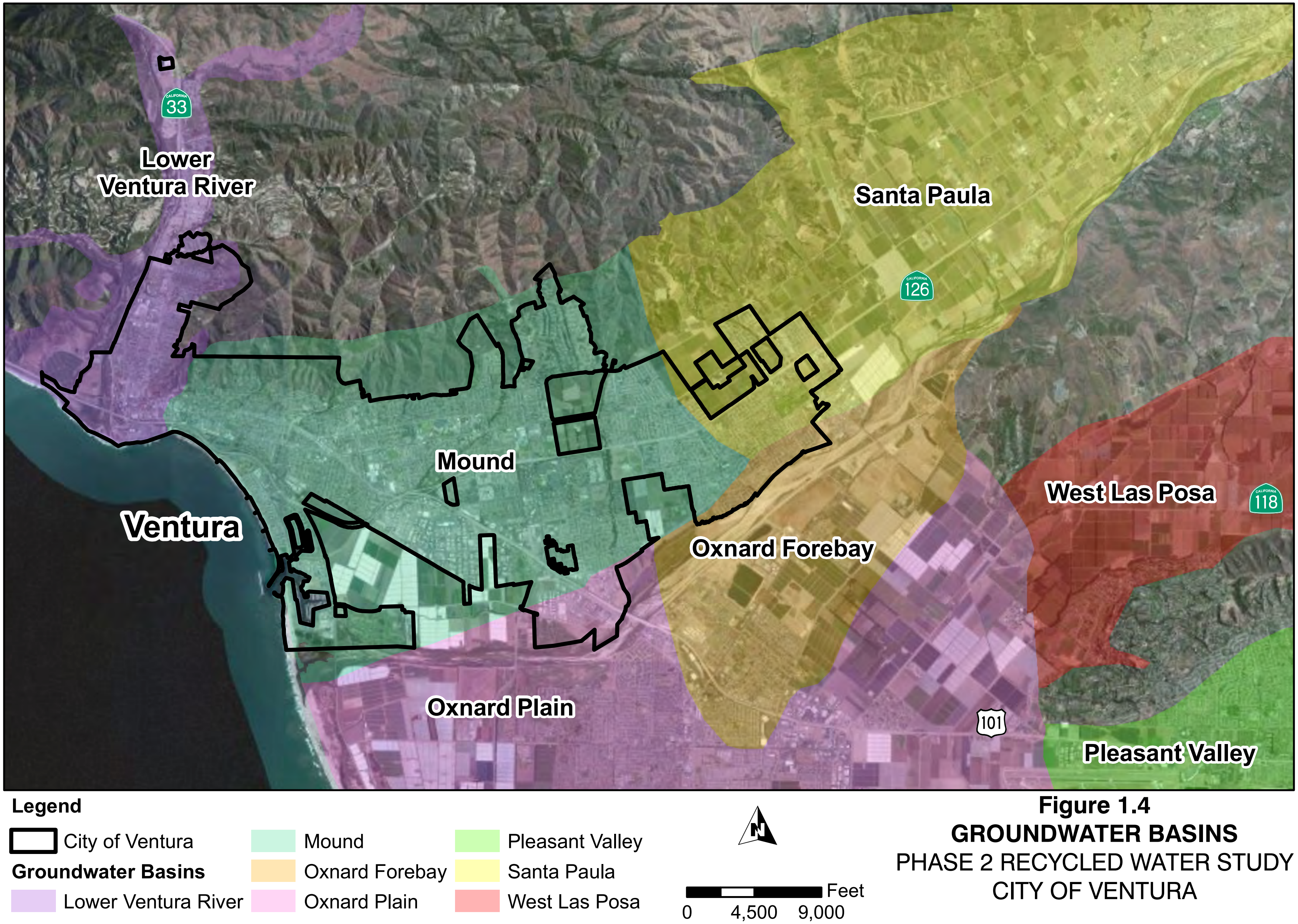

Figure 1.4
GROUNDWATER BASINS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Water quality is highly variable between wells but generally, the basin has elevated levels of TDS, sulfate, hardness and other analytes. Municipal wells constructed in the central portion of the basin have experienced degrading water quality, through increased TDS values over recent years. About half of that TDS is attributable to sulfate. (UWCD, 2011).

1.3.2.2 Oxnard Plain

The Oxnard Plain Groundwater Basin is identified in DWR Bulletin 118, 2003 Update as the Oxnard Subbasin of the Santa Clara River Valley Basin (Basin No. 4-4.02), located in southern Ventura County. The basin is bounded on the north by the Oak Ridge fault, the south by the Santa Monica Mountains, the east by the Pleasant Valley and Las Posas Valley Basins, and the west by the Pacific Ocean (UWMP, 2010).

The Oxnard Plain Basin is recharged primarily with underflow from the Oxnard Forebay as opposed to deep percolation of water from surface sources. Vertical gradients also exist between the aquifer units on the Oxnard Plain resulting in substantial leakage of upper aquifer water into lower aquifer water. (UWCD, 2011)

In 2011, 60,300 acre-feet was pumped from the Oxnard Plain Basin, as sharp decline from the peak in 1990 of 103,000 acre-ft. Municipal and industrial pumping has been subject to cutbacks mandated by the Basin’s management authority beginning with 5 percent in 1992 and currently at 25 percent.

In the early 1870s, the Oxnard Plain Basin was home to a number of Artesian wells. Today, however, due to pumping demands on the aquifer, those wells now are equipped with pumping to bring water to the surface. Saltwater intrusion into this groundwater basin has been a concern since the 1930s. In areas not impacted by seawater, the water quality is acceptable for most agricultural and municipal/industrial uses. Elevated nitrate levels have been found in wells in the northern portion of the basin, which is likely a result of the vertical groundwater gradient that exists in this area. (UWCD, 2011)

1.3.2.3 Santa Paula Basin

The Santa Paula Groundwater Basin is identified in DWR Bulletin 118, 2003 Update as the Santa Paula Subbasin (Basin No. 4-4.04). The basin is bound on the north by the Topatopa Mountains, the south by the Oak Ridge and South Mountain, the Oak Ridge fault, and the Saticoy fault, the east by a bedrock constriction, and the west by the Oxnard Plain and Mound subbasins. (UWMP, 2010)

The main fresh water-bearing strata of the Santa Paula Basin are the Pleistocene San Pedro Formation Pleistocene river deposits of the ancient Santa Clara River, alluvial fan deposits from uplifted mountain blocks and recent river and stream sediments deposited locally along the Santa Clara River and its tributaries.

The Santa Paula Basin is thought to be in hydraulic connection with the Fillmore Basin and to a lesser degree the Mound Basin. Underflow from the Fillmore Basin is likely the main source of recharge for the Santa Paula Basin. Water levels in the Santa Paula Basin, however, are not as recoverable as the Fillmore Basin and have showed a steady long-term decline. (UWCD, 2011)

According to a 2003 study investigating the yield of the Santa Paul Basin, it was suggested that the yield of this basin was near 26,000 acre-feet per year, which is roughly equal to the historic average pumping rate. (UWCD, 2011)

Water quality in the basin is highly variable with the worst water quality in the western portion of the basin. TDS levels hover around 1000 mg/L with sulfates being a large contributor to that in the western portion of the basin. Deeper wells have elevated levels of iron and manganese concentrations. (UWCD, 2011)

1.4 BENEFICIAL USES AND WATER QUALITY

The SCRE is currently designated to support eleven of the twenty four beneficial uses protected under the water quality control plan (Basin Plan) for the Los Angeles Region (LARWQCB 1994), including:

- Navigation (NAV).
- Water Contact and Non-Contact Recreation (REC-1, REC-2).
- Commercial and Sport Fishing (COMM).
- Marine Habitat (MAR).
- Estuarine Habitat (EST).
- Wetland Habitat (WET).
- Rare, Threatened, or Endangered Species (RARE).
- Spawning, Reproduction, and/or Early Development (SPWN).
- Migration of Aquatic Organisms (MIGR).
- Wildlife Habitat (WILD).

In addition to the beneficial uses that are listed above, there are many ecosystem functions and services that the SCRE provides to the immediate and surrounding areas.

- **Flow regulation** – specifically storage and attenuation of floodwater delivered from the contributing watershed to the SCRE through large storm events; flood water storage can affect sediment deposition, upland and aquatic habitat maintenance, and groundwater recharge rates.
- **Sediment storage and beach building** – sediments deposited during storm events to the SCRE can help maintain existing vegetation and habitat, create new habitat, counteract soil compaction and ground subsidence as well as contribute to beach building.

- **Water quality regulation** – because of its location between freshwater outlets and the saline environment, the SCRE can provide a gradual transition between the freshwater and saline water qualities (often referred to as brackish)
- **Aquatic habitat maintenance** – provides suitable habitat for steelhead and tidewater goby.
- **Wildlife habitat maintenance** – provides suitable nesting and foraging habitat for the least tern and snow plover.
- **Recreational opportunities** – The estuary offers a number of activities such as camping (at adjacent McGrath State Beach), surfing, hiking, bird watching, nature observation and swimming; some of these activities (such as camping) can be adversely impacted depending upon water level in the SCRE.

The SCRE water quality was reviewed and summarized as part of an Estuary Study performed by Stillwater Sciences in 2011 (Stillwater, 2011). Water quality within the SCRE is monitored regularly both through in-situ grab sampling as well as continuous monitoring. Parameters routinely monitored include DO, pH, temperature, conductivity and turbidity. In addition to the routine monitoring within the estuary, the City conducts regular receiving water monitoring as part of their NPDES permit.

The City's VWRF meets its NPDES permit requirements for its receiving water including metals with only occasional exceedances of copper (with none in recent years). However, there are some water quality concerns within the estuary that are now being investigated and addressed. The SCRE was been placed on the CWA 303(d) list for coliform bacteria, nitrate, and toxaphane (a pesticide) in 1998 and toxicity (due to elevated nitrate levels) in 2008. Though ammonia concentration in the estuary is low, elevated nutrient levels within the SCRE may be contributing to significant algal growth and resulting in dissolved oxygen (DO) fluctuations. Algal growth degrades the overall water quality of the estuary by introducing suspended solids and re-introducing nitrogen into the ecosystem.

As a condition of its NPDES Permit, the City has completed annual Benthic Macroinvertebrate (BMI) studies to investigate further the issue of toxicity within the SCRE and the VWRF's role in that. Due to sediment conditions and frequent flood scour events within the estuary, the likelihood of bioaccumulation to toxic levels within the ecosystem is relatively low.

1.5 CLIMATE

Carollo investigated potential effects of climate change on the SCRE by analyzing three specific impacts on the ecosystem: 1) local atmospheric temperature, 2) mean sea level and 3) precipitation patterns/events. (Carollo, 2011) The key results of that study are summarized in Table 1.2.

Table 1.2 Projected Climate Change Impacts for the SCRE Phase 2 Recycled Water Study City of Ventura

Climate Change Parameter	Project Impact, by 2050	Projected Impact, by 2100
Local Atmospheric Temperature Increase	1.0 to 3.0 deg C, average of 2.0 deg C	1.1 to 5.0 deg C, average of 3.0 deg C
Mean Sea Level Rise	0.7 to 2.0 feet	1.6 to 6.6 feet
Precipitation Patterns/Events	Frequency of extreme daily events increases by 2[(1)]	Frequency of extreme daily events increases by 3[(1)]

Note:
Source: Carollo, 2011.
(1) Extreme daily event considered equivalent to a 24-hour storm.

1.6 LAND USE AND POPULATION

In 2005, the City adopted the 2005 Ventura General Plan to redirect future growth toward ‘Infill First’ with an emphasis on encouraging more intense development of housing alongside commercial uses. The 2005 General Plan outlines land use and population throughout the City, which are summarized here.

1.6.1 Land Use

Land use in the City has changed over time and land that was predominantly agricultural land was annexed to the City and then became a mix of land uses including residential, commercial, industrial, and institutional areas. Table 1.3 summarizes the information on land use types and areas in the General Plan Boundary provided in the 2005 General Plan. Figure 1.5 shows the land use distribution as presented in the 2005 General Plan.

1.6.2 Population

The City’s estimated population growth for the City is shown in Table 1.4. The population numbers include both the population within the City of Ventura limits as well as the population served by the public water system that is not within the City limits.

Included for comparison is the EIR population projection for 2025 reflecting the two possible growth scenarios: (1) 1.14 percent annual population growth, which is equivalent to the annual growth rate in the City from 1984 to 2004; and (2) 0.88 percent annual population growth, which is equivalent to the annual growth from 1994 to 2004.

Table 1.3 Existing Land Use within City General Plan Boundary
Recycled Water Market Study-Phase 1 Report
City of Ventura

Land Use	Area (Acres)	Percentage of Total Area (%)
Neighborhood Low	4,629	17
Neighborhood Medium	1,061	4
Neighborhood High	303	1
Commerce	808	3
Industry	1,401	5
Public and Institutional	571	2
Park and Open Space	11,693	42
Agriculture	6,857	25
Downtown Specific Plan	307	1
Harbor District	254	1
Total	27,884	100

Table 1.4 Population Projections for the City
Phase 2 Recycled Water Study
City of Ventura

	2010	2015	2020	2025	2030	2035
Projected Planning Area Population	113,478	118,416	123,575	128,963	134,592	140,472
General Plan EIR[1] (0.88%)				126,153		
General Plan EIR[1] (1.14%)				133,160		

Note:

Source: UWMP, 2010.
(1) General Plan EIR only provides estimates for 2025.

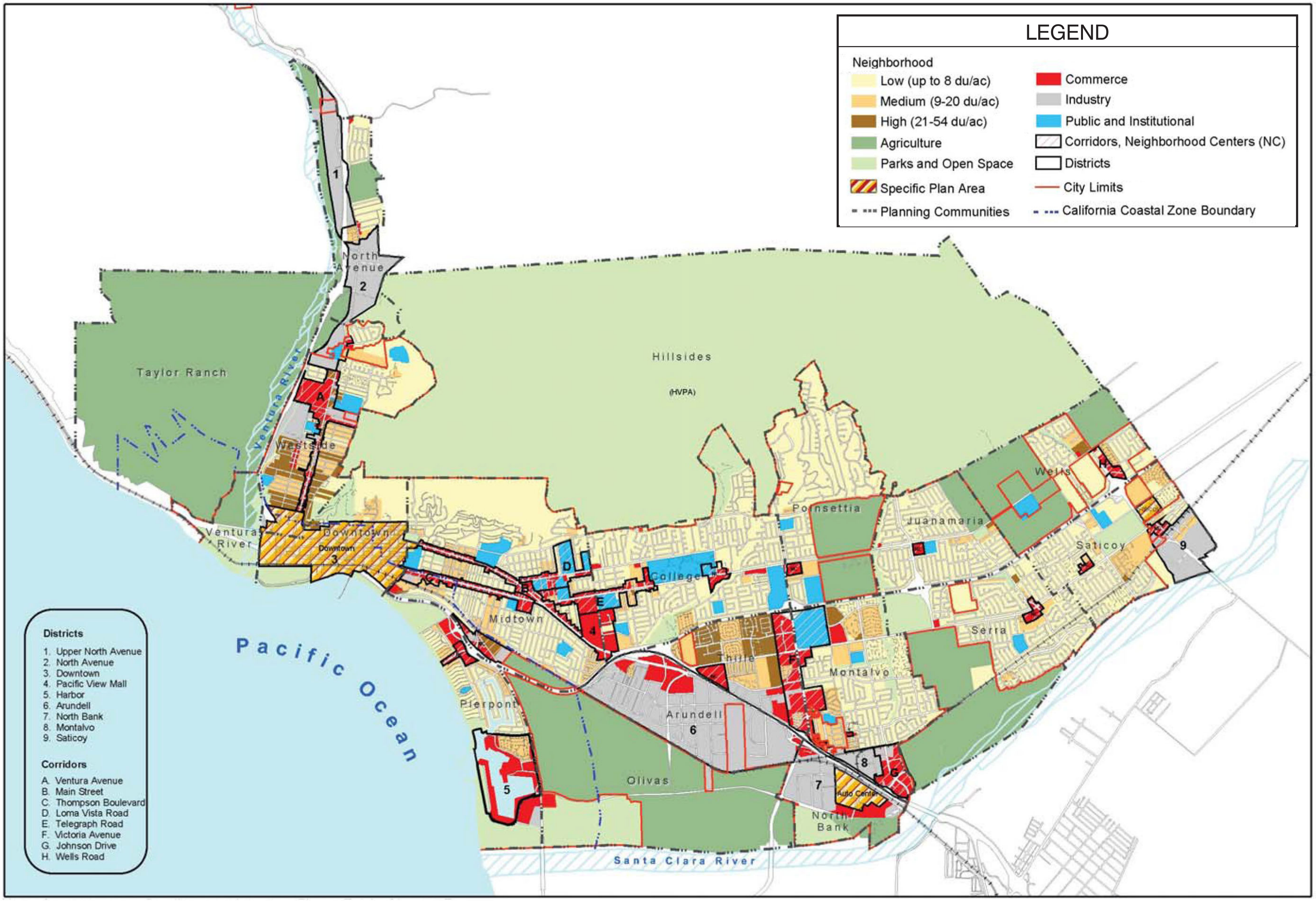

Figure 1.5
LAND USE (2005 GENERAL PLAN)
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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WATER SUPPLY CHARACTERISTICS AND FACILITIES

2.1 OVERVIEW OF WATER SUPPLY SYSTEM

The City provides drinking water to a population of approximately 113,500 persons through approximately 32,000 water service connections. The City's water service area includes all areas within the City limits, portions of the unincorporated areas within Ventura County, and the Saticoy Country Club area. To serve the water service area, the City owns and operates a water system consisting of more than 380 miles of distribution pipeline, three water treatment facilities, 23 pump stations, and 31 storage reservoirs. The City draws their drinking water from three main sources: 1) the Ventura River, 2) Lake Casitas, and 3) the local groundwater basins. In addition to the drinking water supply, the City provides recycled water from the Ventura Water Reclamation Facility (VWRF) to two municipal golf courses, a City Park, and landscape irrigation areas along the existing distribution alignment.

Details on the City's water system are included in the City's Water Master Plan (RBF, 2011). There are several recent documents that include analysis of existing and projected water supplies and demands (City's Water Master Plan (2011) and the November 2012 Ventura Local Agency Formation Commission (LAFCo) Municipal Service Reviews Report). The most recent analysis of water supplies and demands are included in the Final Comprehensive Water Resources Report (2013 CWRR), and this document is the source of supply and demand information presented in Sections 2.2 and 2.3. It should be noted that the Saticoy Country Club areas supply and demand information is not included in the 2013 CWRR since the supply source in that area is separate from the rest of the City's system.

2.2 WATER SUPPLY SOURCES

As mentioned, the City's domestic water supply is derived from local groundwater basins, Lake Casitas, surface water from the Ventura River, and sub-surface water from the Ventura River. The City also has a 10,000 acre-foot per year allocation from the California State Water Project (SWP). To date, the City has not received any of this water because the City does not have the facilities needed to receive SWP water into the distribution system.

There are presently three main water sources that provide water to the City water system:

- Lake Casitas –Water is purchased from Casitas Municipal Water District (CMWD) and delivered to the City at two turnouts.
- Ventura River Surface Water – River water is withdrawn via shallow collection system and groundwater wells and is treated at the Ventura Avenue Treatment Plant.

- Groundwater Basins – Groundwater is drawn from three separate basins: Mound, Oxnard Plain, and Santa Paula. Water from the Santa Paula basin is treated at the Saticoy Conditioning Facility while water from the Oxnard Plain and Mound basins are treated at the Bailey Conditioning Facility.

Figure 2.1 shows the locations of the turnouts, the treatment plants and the groundwater wells.

In addition, potable water demands are offset with the use of recycled water by several customers.

The future water supply projections are based on a number of planned capital improvements to the existing water system and potential changes in the City's water supply portfolio due to continued years of drought, tightening water restrictions and environmental responsibilities (2013 CWRR). Table 2.1 highlights the present and planned water supply (including recycled water) for the City.

Table 2.1 Current and Future Water Supply
Phase 2 Recycled Water Study
City of Ventura

Source	Average Annual Supply AFY(1)	Future (2020) Supply Projections AFY(2)
Casitas Municipal Water District	5,000	5,390
Ventura River Surface Water	4,200	4,200-6,700
Mound Basin	4,000	4,000
Oxnard Plain Basin	4,100	4,100
Santa Paula Basin	1,600	0-3,000
Recycled Water	700	700
Total	19,600	18,390-23,890

Notes:
(1) Table 4-1 (2013 CWRR).
(2) Table 4-2 (2013 CWRR).

2.2.1 Groundwater Management

2.2.1.1 Mound Basin

The United Water Conservation District (UWCD) was formed in 1950 under the State of California's Water Conservation District Law of 1931, and is organized as a governmental special district. The UWCD boundary includes a 214,000 acre area that encompasses the Santa Clara River Valley and the Oxnard Coastal Plain. UWCD serves as the conservator of groundwater resources that includes the Mound Groundwater Basin as well as other

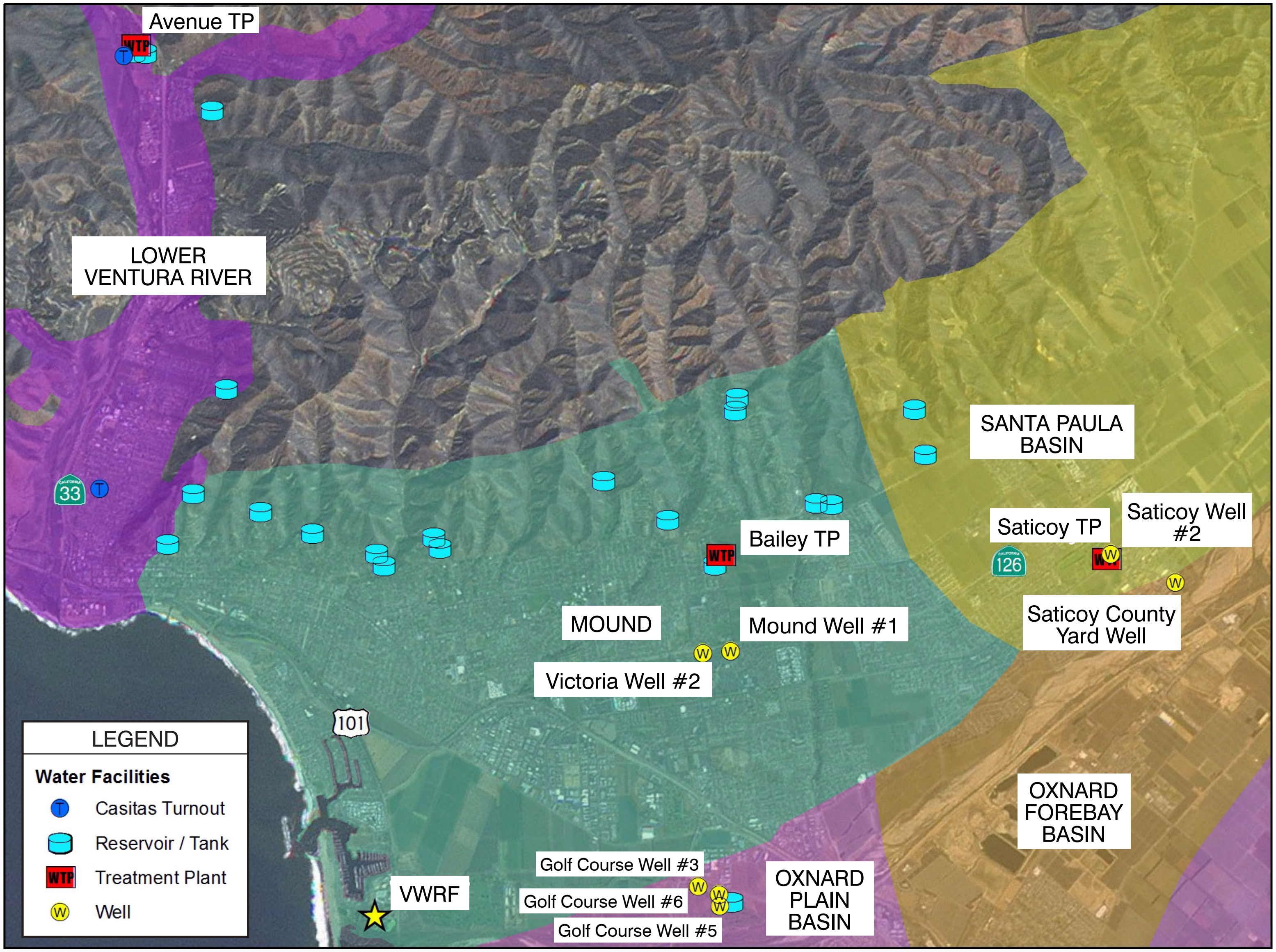

Figure 2.1
CITY OF VENTURA WATER SUPPLY FACILITIES
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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groundwater basins. UWCD does not produce water from the basins, but is authorized to engage in groundwater management of the basins. The City operates two wells in the Mound Basin. In addition, historical agricultural and private wells have utilized this groundwater supply source.

2.2.1.2 Oxnard Plain Basin

The Fox Canyon Groundwater Management Agency (FCGMA) was created by state legislation in 1982 to manage local groundwater resources in a manner to reduce overdraft of the Oxnard Plain and stop seawater intrusion. A major goal of the FCGMA is to regulate and reduce future extractions of groundwater from the Oxnard Plain aquifers, in order to operate and restore the basin to a safe yield. The City's historical allocation was set by the FCGMA at 5,472 AFY, which was the average extraction from the City's wells in the basin for the base period 1985 to 1989. In August 1990, the FCGMA passed Ordinance No. 5, which required existing Municipal and Industrial (M&I) groundwater users to reduce their extractions by five percent every five years until a 25 percent reduction is reached by the year 2010. Therefore, the City's reliable water supply is estimated to be 4,100 AF per year. The City currently operates two wells in the Oxnard Plain Basin and has a third well that could be used as an emergency source.

2.2.1.3 Santa Paula Basin

In March 1996, the Superior Court of the State of California for the County of Ventura filed a stipulated judgment for the Santa Paula Basin. The Judgment recognized that all the parties have an interest in the Santa Paula Basin and in the proper management and protection of both the quantity and quality of this ground water supply. Members of the Santa Paula Basin Pumpers Association (an association of ranchers and businesses) and the City exercise rights to pump water from the basin. The City currently has one well in the Santa Paula Basin and is in the process of installing a second well. It is anticipated that these two wells will be able to pump the City's allocation of 3,000 AFY from the Santa Paula Basin. There is potential for future reductions in the available supply, depending on the determination of the safe yield of the Santa Paula Basin (2013 CWRR).

2.3 HISTORICAL AND PROJECTED WATER USE TRENDS AND DEMANDS

The City's water system provides potable water to residential, commercial, industrial, public/institutional, and parks/landscape/irrigation customers. Recycled water is provided for landscaping to two municipal golf courses, a City Park, and to areas along the existing distribution alignment. The City has a raw water pipeline that has historically provided water for petroleum recovery operations and a few irrigation customers. The City's water use sectors are generally described below:

- **Residential Sector** - The residential sector of the City is comprised of single family (SF) and multi-family (MF) residential customers. The residential sector has historically represented approximately 60 percent of the City’s total water consumption. Within the residential sector, single-family accounts make up two thirds of the total residential demand.

- **Commercial/Retail/Hotel Sector -** The City contains several different types of commercial customers, including gas stations, large shopping complexes, auto dealerships, restaurants, business parks, office buildings and hotels. Hospitals have historically been included in this group for water consumption data. This sector’s accounts have historically accounted for approximately 20 percent of the City’s total water consumption.
- **Industrial Sector -** The City contains a relatively small industrial sector. Historically the industrial sector utilizes approximately 1 percent of the City’s total water consumption.
- **Public/Institutional (Municipal/Church/School) Sector** - The City’s institutional and governmental buildings as well as school facilities and churches are included in this sector. Historically the Public/Institutional Sector utilizes approximately 3 percent of the City’s total water consumption.
- **Parks/Landscape/Irrigation Sector -** The City’s landscape metered uses include assessment districts, contract parks, City parks, and other large irrigation areas, and includes the use of recycled water to landscape areas in the Marina area and two (2) 18 hole tournament class public golf courses within the City’s service area. Landscape accounts have historically comprised approximately 6 percent of City’s total water consumption.
- **Other –** "Other" category includes all other accounted-for water such as construction water, water/sewer system maintenance, measured leakage. In addition, this includes 'grandfathered' users with water entitlements requiring special service conditions. Historically this category has accounted for approximately 10% of City’s total water consumption.

2.3.1 Current (Calendar Year 2012) and Projected Water Demand

According to the 2013 CWRR the City’s 2012 water consumption was 18,004 AFY.

The 2013 CWRR evaluates how current and future anticipated water demands match current and future anticipated water supply. The 2013 CWRR is the source of supply and demand information presented in Sections 2.2 and 2.3. The 2013 CWRR focused only on the near-term demand growth projections. The near-term growth estimates were based on proposed development projects that have been approved by the City but are not yet connected to the City’s water system. The projected demands, presented in Table 2.2, were based on a baseline demand estimate and City-specific water usage factors were utilized for the near term development projects estimated demands.

Table 2.2	Target Water Demands (AFY) Phase 2 Recycled Water Study City of Ventura
Year	**Projected Water Demand**
2015	18,062
2020	18,643

Source: Table 3-8, 2013 CWRR

2.3.2 Potable Water Rates

All of the City's retail customers are metered and billed with commodity rates for both water and sewer service. The City does not have any unmetered services and all new connections are metered and billed volumetrically.

Residential water accounts are billed bimonthly on an increasing block rate schedule, nonresidential water accounts are billed with uniform rates (Table 2.3) and reclaimed water is charged a reduced, uniform rate. Since there is no direct measure of sewer discharge by residential customer, water use is used to estimate the sewer discharge.

Table 2.3 Current Water Rates[1]
Phase 2 Recycled Water Study
City of Ventura

Customer Class	July 2012 Rate ($/HCF)	July 2013 Rate ($/HCF)
Single Family		
Tier 1 – 0 to 14	$1.98	$2.15
Tier 2 – 15 to 30	$2.69	$2.92
Tier 3 – 30+	$4.41	$4.79
Multi-Family		
Tier 1 – 0 to 10	$1.98	$2.15
Tier 2 – 11 to 16	$2.69	$2.92
Tier 3 – 16+	$4.41	$4.79
Non-Residential	$2.48	$2.70
Institutional/Interruptible	$1.98	$2.15
Reclaimed Water	$0.64	$0.68
Untreated Water	$1.88	$2.04
Outside City Rates	Add $0.73/hcf	Add $0.76/HCF

Notes:
Source: Ventura Water, 2012.
(1) This does not include a bi-monthly service and fireline charges, which are based on meter size.

2.4 QUALITY OF WATER SUPPLIES

The City's water system is operating in compliance with the Safe Drinking Water Act (SDWA) and California Department of Public Health (CDPH) drinking water regulations are identified in Titles 17 and 22 of the California Code of Regulations. There are several regulations that are currently under review by the EPA and CDPH, which may be enforced at a later date.

The City does consistently exceed the secondary MCL regarding the upper contaminant drinking water standard of 1,000-ppm for total dissolved solids (TDS) on the east side of the City. Blending is acceptable by CDPH to keep the TDS below the short-term secondary maximum contaminant level (SMCL) of 1,500 ppm on a continual basis as an interim measure pending construction of treatment facilities or development of acceptable new sources [Title 22, CCR Sec. 64449 (d)(3)].

Blending TDS below this SMCL has not been completely attainable due to the high TDS in the Mound Well when other wells are inoperable. The annual average on the east side of the City is about 1,300 ppm. The west side of the City is in compliance with the upper TDS limit and generally is between 500 to 700 ppm. The CDPH Water Supply Permit issued August 3, 2007 has required a TDS reduction study and a preliminary plan and schedule for complying with the upper contaminant level of 1,000 ppm in the water delivered to the public. The City must also apply for a waiver for the TDS secondary standards.

Casitas Municipal Water District (CMWD) operates Lake Casitas, treats their wholesale water and sells it to the City. Common lake turnover has been the source of short-term taste and odor concerns for customers. CDHP does not consider this biannual change in water quality to be a health hazard. The City has no direct control over the water received from CMWD. The City has no feasible or cost effective treatment capability or processes to improve the taste and odor.

2.5 WATER FACILITIES

As mentioned previously, the City owns, operates and maintains a water system consisting of more than 380 miles of transmission and distribution pipeline divided into 16 pressure zones, three water treatment plants, 23 pump stations, and 31 reservoirs and two Casitas turnouts. Figure 2.2 shows an overall map of the City's water system facilities and pressure zones.

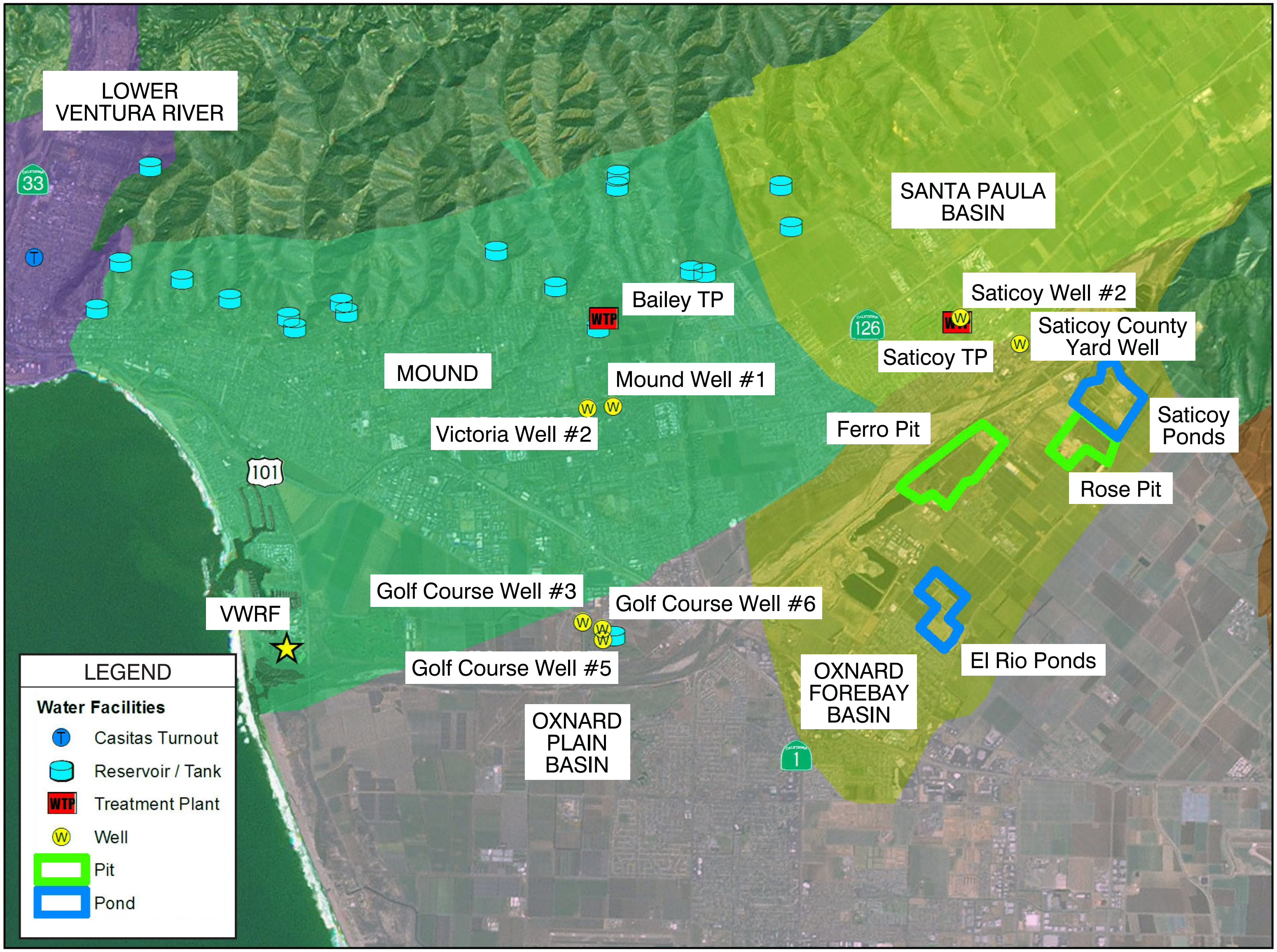

Figure 2.2
VENTURA WATER AND UWCD FACILITIES
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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2.5.2 Turnouts

The City distribution system receives a portion of its potable water supply from two turnout connections to the Casitas Municipal Water District (Casitas) system. Casitas Turnout No. 1 is located at the Avenue Treatment Plant with a capacity of 4,300 gallons per minute (GPM). Casitas Turnout No. 2, located at the intersection of Olive and Ramona Streets, fills the Hall Canyon Reservoirs at a capacity of 8,333 gpm.

2.5.3 Treatment Plants

The City's three treatment plants have a combined capacity of 25 million gallons per day (mgd); the details of those three plant are highlighted below. A water supply analysis conducted as part of the Master Plan concluded that the City will need additional distribution system facilities (e.g., pipelines and wells) to provide reliability and redundancy for the distribution system when particular facilities or their associated supply source is unavailable and/or reduced. Many of these projects are currently in the City's CIP and will provide for the additional supply capacity.

2.5.3.1 Avenue Treatment Plant

The Avenue Treatment Plant is the City's main water treatment facility, treating and disinfecting water derived from the Ventura River. The facility is located off of North Ventura Avenue. The Avenue Treatment Plant recently underwent a major upgrade, which was completed in August of 2007. The new treatment plant consists of a state of the art in-line ultrafiltration membrane filter system that is capable of producing up to 10 mgd. The updated treatment process was designed to meet current and anticipated drinking water regulations and is expandable up to 15 mgd.

2.5.3.2 Bailey Conditioning Facility

The Bailey Conditioning Facility is one of two iron and manganese conditioning facilities within the distribution system. The Bailey Conditioning Facility conditions water derived from the Oxnard Plain and Mound groundwater basins. This facility is located off of Fremont Street. The Bailey Conditioning Facility has an existing capacity of 11.5 mgd and has space for an additional filter, which would increase the capacity to about 13.8 mgd.

2.5.3.3 Saticoy Conditioning Facility

The Saticoy Conditioning Facility is the other conditioning facility operated by the City. The Saticoy Conditioning Facility is an iron/manganese removal facility which conditions water derived from the Santa Paula groundwater basin. This facility is located off of Telephone Road near South Wells Road. The facility has an existing capacity of 3.5 mgd, and the City is evaluating the possible upgrade of this facility.

2.5.4 Pump Stations

The City operates twenty one (21) pump stations that supply water to various pressure zones within the City. The pumps range in type, size and capacity (from 349 to 8,300 gpm). Pump stations are used to boost water from a lower hydraulic gradient to a higher hydraulic gradient, as well as to move water from groundwater wells to upper hydraulic gradients.

2.5.5 Reservoirs

The City has a combination of both concrete reservoirs and steel tanks that provide storage for the distribution system. The City currently has four concrete reservoir sites in the distribution system, ranging in storage capacity from 1.12 million gallons (MG) to 14.68 MG, totaling approximately 32 MG. The City currently has 23 steel tanks in the distribution system, ranging in storage capacity from 0.08 MG to 2.54 MG, totaling approximately 20 MG. The reservoirs and tanks provide storage to meet peak demands and emergency storage for fire protection. Storage is utilized to minimize pumping requirements during on-peak energy (Southern California Edison) hours.

The results of both the existing system storage capacity evaluation and the near-term storage capacity evaluation indicate that all pressure zones, with the exception of the 210 Pressure Zone, are deficient in capacity. In the near-term demand condition, the citywide storage deficiency is 7.64 MG, assuming that the excess capacity in the 210 Pressure Zone can be utilized in other areas. The excess capacity available is all located in the 210 Zone, which is the lowest HGL in the system. Therefore, to utilize the excess storage, there must be excess pumping capacity available to move the water to the higher zones in need.

Seven pressure zones are considered to have significant deficiencies that require further evaluation and potential action. In order for the excess storage in the 210 Zone to be used by the higher zones, a reliable pumping supply with adequate excess pumping capacity must be available. To be conservative, it is assumed that those zones that can directly take suction from the 210 Zone will be able to tap into the excess storage available.

Based on the analysis conducted in the Master Plan, the City is evaluating potential improvements to the City's existing and future storage capacity of the system.

2.5.6 Pressure Reducing Stations

The City operates ten (10) pressure-reducing stations, which supply water from a higher pressure gradient to a lower pressure gradient. The pressure reducing stations consist of valves set to maintain a constant downstream pressure.

2.5.7 Pipelines

The City's distribution system is comprised of pipelines ranging in size from 2-inches to 36-inches. The majority of pipelines are 6, 8 and 12-inches in diameter. There are approximately 380 miles of pipeline within the distribution system.

2.5.8 Recycled Water Facilities

Flows from the City's wastewater collection system are treated at the City's VWRF. Average annual flows to the reclamation facility total about 9.3 mgd. Recycled water from the VWRF is used for general irrigation of the two golf courses, a City park and landscape irrigation areas located along the existing distribution alignment. A portion of the effluent is pumped to these reclaimed water customers and a portion is lost to evaporation and percolation losses. The remaining effluent is discharged to the Santa Clara River Estuary (SCRE).

WASTEWATER CHARACTERISTICS AND FACILITIES

3.1 WASTEWATER ENTITIES AND FACILITIES

The City of Ventura (City) owns and operates the Ventura Water Reclamation Facility (VWRF), which discharges tertiary treated municipal wastewater to the Santa Clara River Estuary (SCRE) just south of the City near the mouth of the Santa Clara River. The location of the VWRF is shown in Figure 3.1.

The City provides sewer service to approximately 98 percent of City residences. The total area served includes a population over 109,000. Wastewater collection and treatment for McGrath State Beach Park and the North Coast Communities are also provided.

Approximately 9 million gallons (MG) of wastewater are generated per day and are carried by more than 375 miles of sewer mains and 14 lift stations to the VWRF.

3.1.1 Wastewater Facilities

The VRWF provides tertiary wastewater treatment for the community with processes consisting of screenings and grit removal, primary sedimentation, flow equalization, activated sludge nitrification and denitrification, tertiary filters, ammonia addition, and chlorination. The VRWF currently treats approximately 9.3 million gallons per day (mgd) of influent annual flow. In addition, solids processing consists of a primary sludge thickener, dissolved air flotation (DAF) secondary sludge thickener, anaerobic digestion, and dewatering. Figure 3.2 presents a schematic of the existing treatment plant processes.

Treated wastewater is conveyed to a 20-acre system of wildlife ponds prior to final discharge to the SCRE. Prior to entering the ponds, a portion of the treated wastewater is diverted as recycled water for landscape irrigation by several users. The remaining treated wastewater is conveyed via the effluent transfer station (ETS) to the wildlife ponds and flows from west to east through “Bone,” “Snoopy,” and “Lucy.” The effluent is discharged through the outfall junction structure (OJS) to the SCRE via an effluent channel.

3.1.2 Existing and Projected Wastewater Flows

The City evaluated the VWRF and determined future flow projections in its 2010 Wastewater Master Plan (Kennedy Jenks, 2010). A summary of the City’s existing and projected average dry weather influent wastewater flows are shown in Table 3.1, based on the Master Plan. Wastewater flow projections were developed in the Master Plan for near-term, and ultimate development levels. The ultimate buildout projection is for 13 mgd of influent flow assuming flows from the City service area as well as other tributary areas.

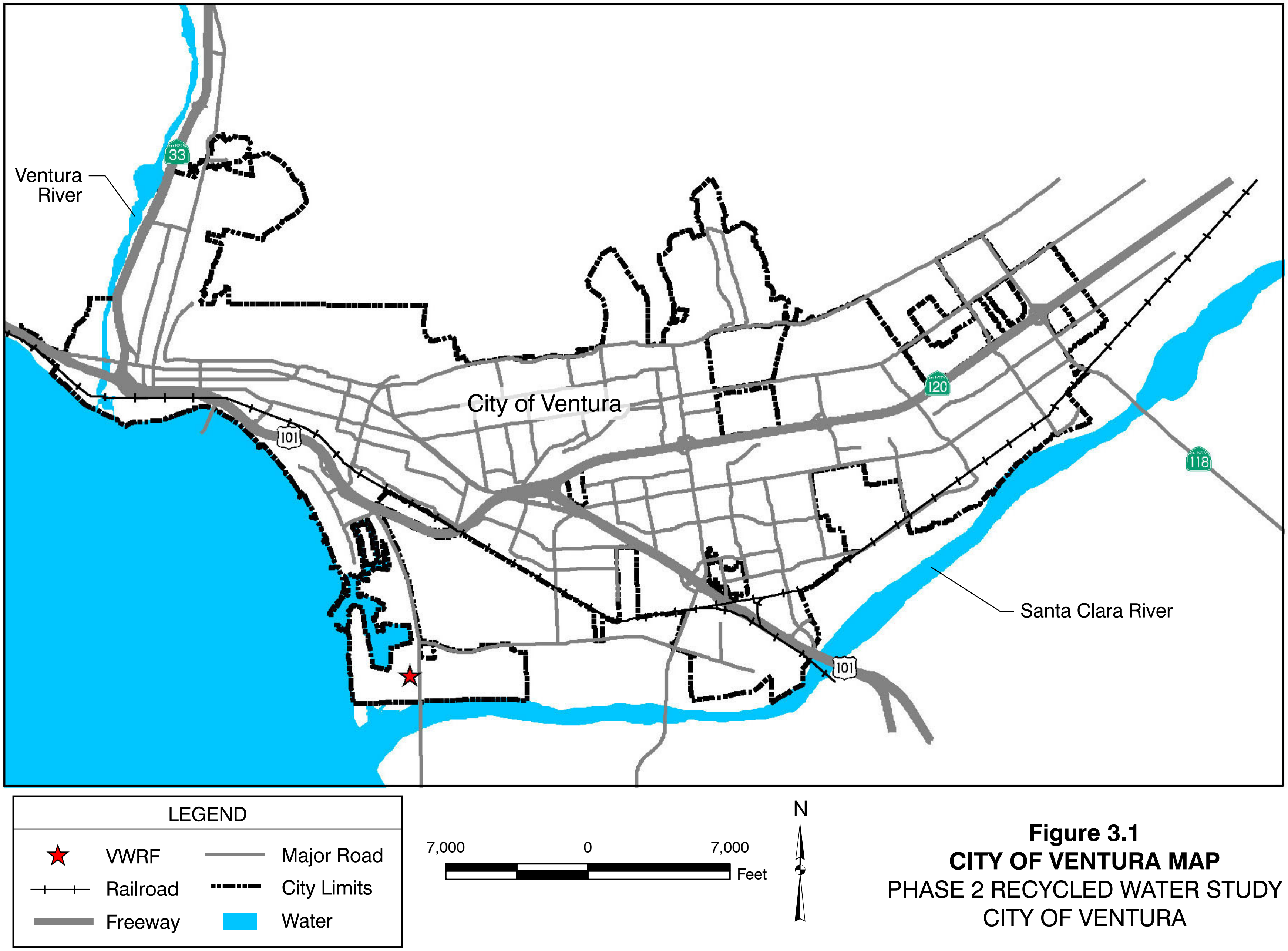

Figure 3.1
CITY OF VENTURA MAP
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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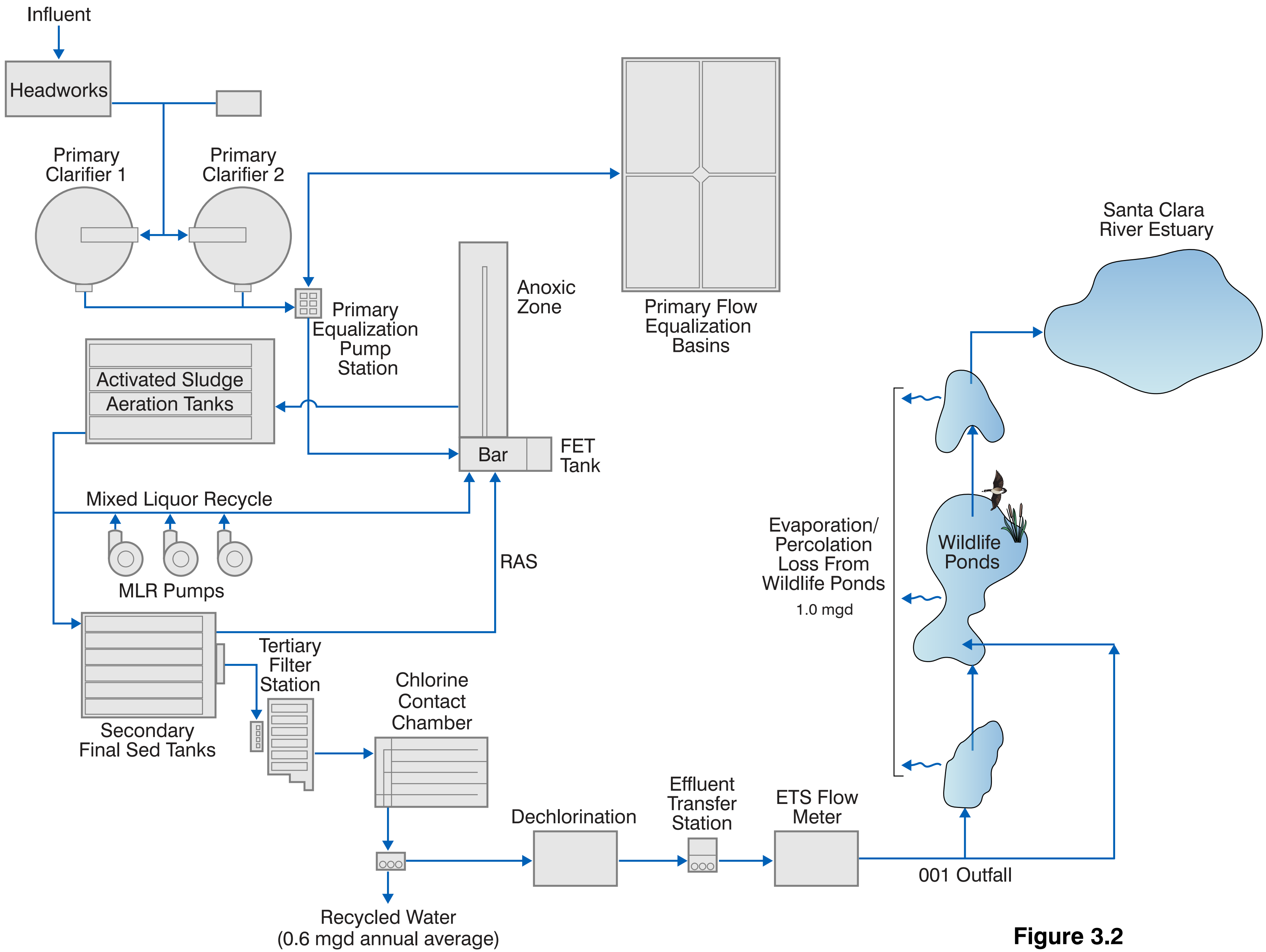

Figure 3.2
PROCESS FLOW SCHEMATIC
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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Also shown in Table 3.1 are the current influent flows, which are lower than flows during the development of the Master Plan. The other tributary area projections are shown in Table 3.2, including existing and anticipated flows from McGrath State Beach Park, the North Coast Communities, the Montalvo Municipal Improvement District, and the Saticoy Sanitary District.

Table 3.1 Historic and Projected Average Dry Weather Influent Flows
Phase 2 Recycled Water Study
City of Ventura

Development Condition	Study Area Flow, mgd	Other Tributary Areas, mgd	Total Flow, mgd
2004-2006 flow monitoring (1)	9.3	0.1	9.4
2010-11 average influent flow (2)	NA	NA	8.8
Near Term(1)	11.1	0.3	11.4
General Plan Buildout(1)	12.6	0.4	13.0

Notes:
(1) Based on 2010 Wastewater Master Plan.
(2) Based on 2010-2011 influent flow meter data.

Table 3.2 Outside Sources of Wastewater Flows
Phase 2 Recycled Water Study
City of Ventura

Tributary Area	Existing gpd	Near Term gpd	Ultimate gpd
McGrath(1)	5,000	21,000(2)	21,000 (2)
North Coast (3)	56,760	56,760 (3)	73,330 (4)
Montalvo	0	250,000 (5)	250,000 (6)e
Saticoy	0	0	50,000 (6)
Total	**61,760**	**327,7760**	**394,330**

Source – 2010 Wastewater Master Plan.
Notes:
(1) City's estimate of existing flows.
(2) From Sewerage Agreement.
(3) Average daily flow from monthly totals provided by the City from Jan 2002 to Aug 2007.
(4) From Sewerage Agreement (2.2 MG/month).
(5) Per January 2, 2007 letter from City.

Although the most recent VWRF flows are less than shown in the Master Plan report for existing flows, it was decided for the purposes of this report that the ultimate projection of 13 mgd was the best available information for potential future flows. Therefore, this buildout flow is used in subsequent chapters in determining available water supply for recycled water as well as for determining effluent discharge volumes.

3.1.3 VWRF Effluent Flow

The VWRF effluent flows are measured at the ETS. Flow data at the ETS is the effluent flow before the effluent enters the wildlife ponds. There are losses due to evaporation and percolation in the wildlife ponds prior to final discharge of effluent to the SCRE.

The average annual effluent flow (as measured at the ETS) from 2010 to 2011 was 7.8 mgd. Differences between the influent flows and the effluent flows are due to recycled water streams and the diversion of water to the existing reuse system.

The effluent flows vary seasonally with hydrologic condition and with recycled water use, as recycled water is diverted prior to the meter at the ETS. The 2010 to 2011 average monthly flows range from 7.2 to 8.7 mgd. Figure 3.3 shows the monthly average effluent flows, with the greatest flows occurring in the winter months and the lowest flows occurring in the summer months.

As shown in Figure 3.2, the VWRF include equalization of primary effluent. As a result, there is relatively low diurnal (hourly) variability in flow at the ETS and at the point of diversion to the recycled water system. Per discussion with VWRF staff, flows through the treatment plant are recorded on a daily basis, but not on a smaller increment (e.g. hourly) and therefore it is not possible to provide an example of the diurnal variation in treatment plant flows after the equalization basins.

3.2 EXISTING RECYCLED WATER

3.2.1 Recycled Water Facilities

The existing VWRF produces recycled water that has undergone tertiary filtration and disinfection, meeting the requirements of Title 22 for unrestricted reuse. As discussed in section 3.1.1, the treated wastewater that is not diverted for recycled water use is discharge to the existing Wildlife Ponds and then to the SCRE. Treated wastewater that is diverted for recycled water use, is pumped into a pressurized recycled water system network. Figure 3.4 shows the alignment of the existing recycled water pipeline and the locations of recycled water meters, used to quantify use by the recycled water customers.

The existing recycled water system pipeline network consists of a 12-inch pipeline that extends west from the VWRF along Olivas Park Drive and a 4-inch pipeline that extends north from the VWRF to the Marina Park. The existing recycled water pump station provides pressurized water through these pipelines.

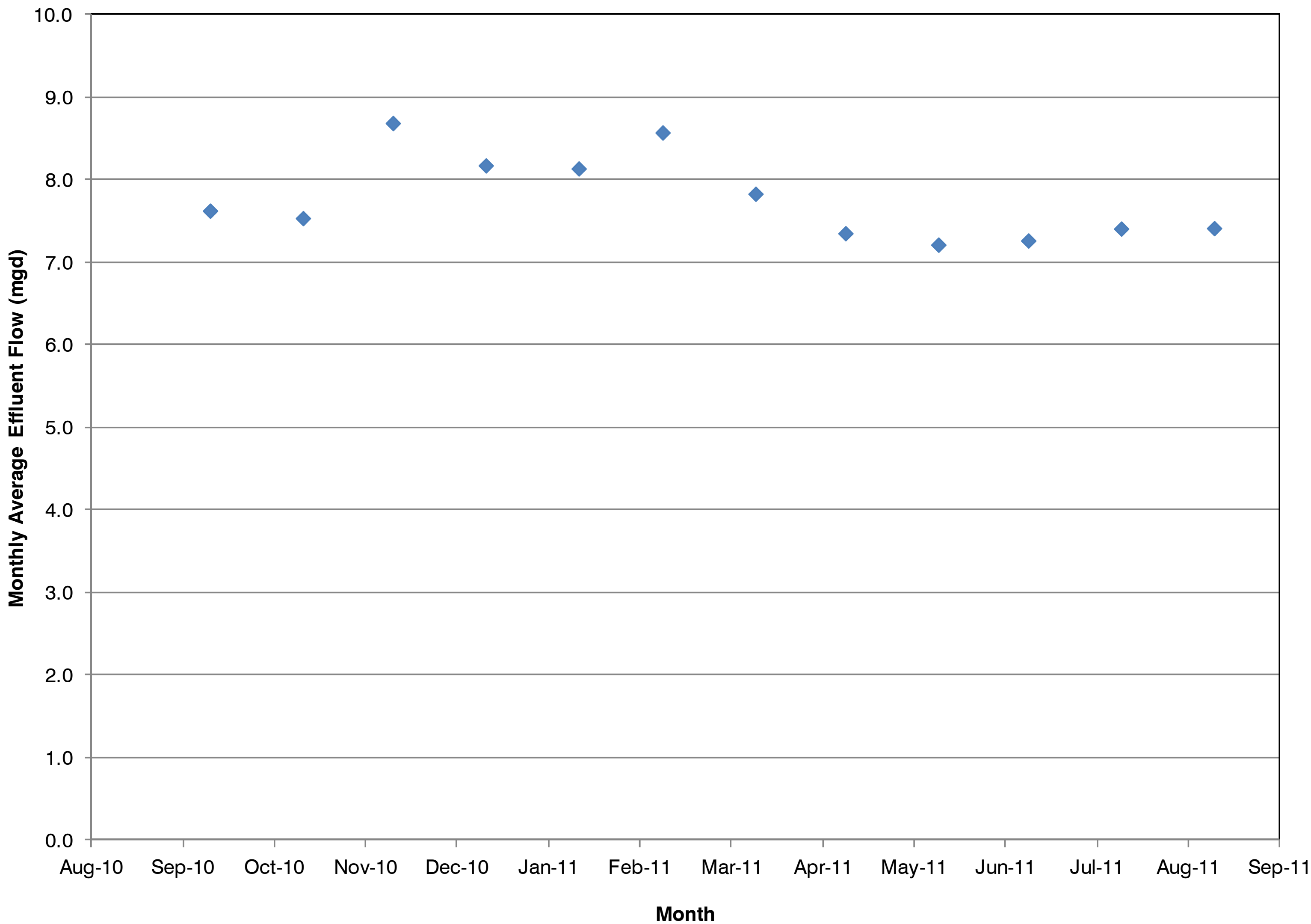

Figure 3.3
VWRF MONTHLY AVERAGE EFFLUENT FLOWS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

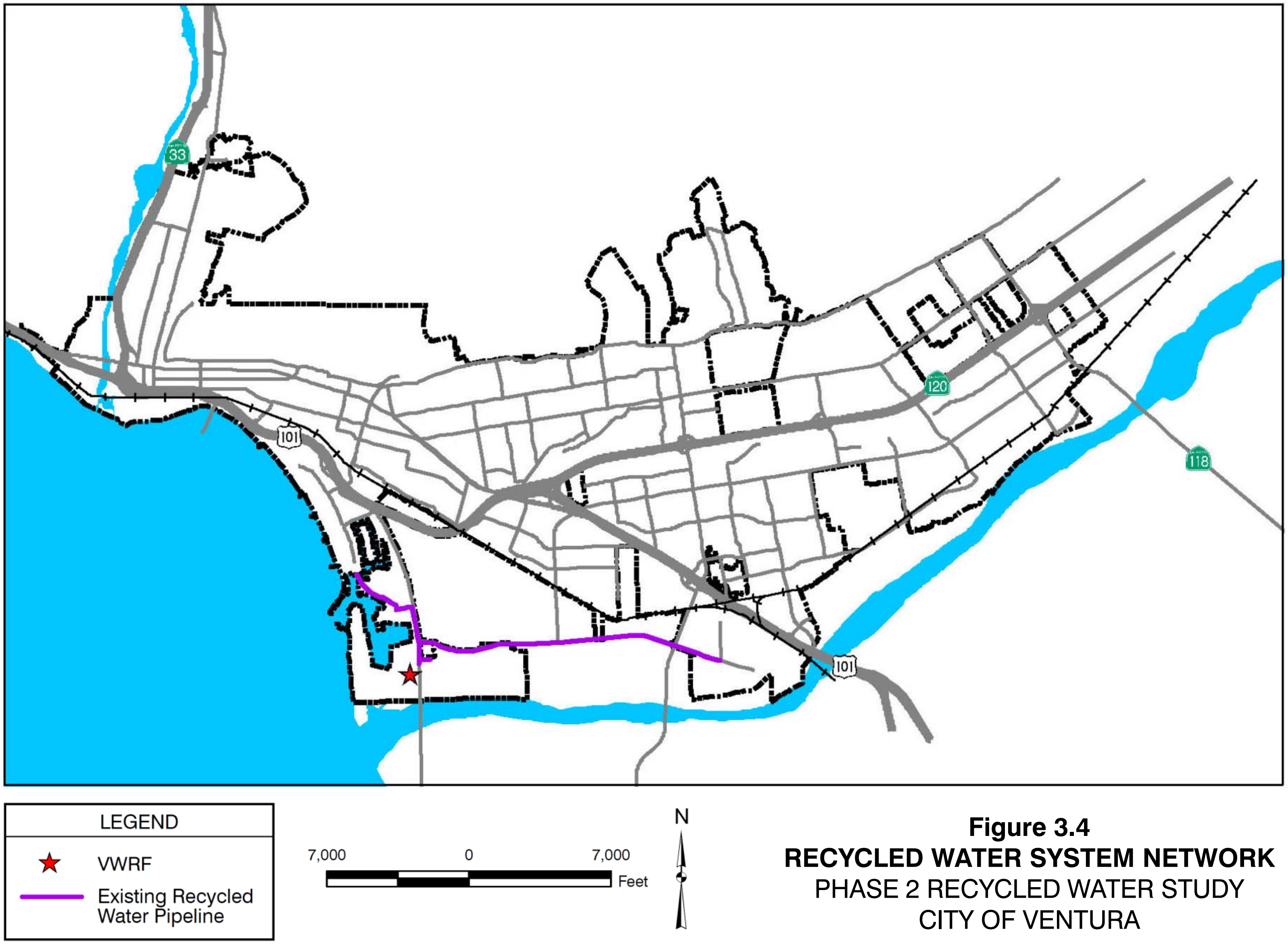

Figure 3.4
RECYCLED WATER SYSTEM NETWORK
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

3.2.2 Current Users and Demands

Recycled water from the VWRF is used for general irrigation of golf courses, parks and similar landscape areas. Existing recycled water customers include:

- BuenaVentura Golf Course.
- Olivas Links Golf Course.
- MBL Golf Course LLC.
- Harbortown Point HOA.
- Ventura Port District.
- Harbor Island Hotel Group LP.
- Harbor Island Hotel.
- Ventura Port District.
- Marina Park.
- Michael Viola.
- MBL Olivas LLC.
- MBL Olivas Project LLC.
- Olivas Adobe.

Figure 3.5 presents the total historical monthly average demands from 2009 through 2012. The recycled water demand varies seasonally with minimum demands in the winter and maximum demands in the summer. Monthly demands range from approximately 0.07 mgd to 1 mgd, with an average demand of 0.5 mgd.

3.2.3 RECYCLED WATER RIGHTS

The City owns the rights to their tertiary effluent and is able to enter into agreements with potential recycled water users, as needed. No other entities claim the rights to the City's recycled water.

3.3 POTENTIAL SOURCES OF RECYCLED WATER

The current source for recycled water for the City is water from the service area and treated by the VRWF. As discussed in section 3.2, the VWRF service area may be expanded in the future to incorporate smaller wastewater service areas (Montalvo and Saticoy). Flows from these areas would be routed to the VWRF for treatment. The VWRF already produces tertiary treated water that meets Title 22 requirements for unrestricted reuse and has adequate capacity to incorporate these additional flows.

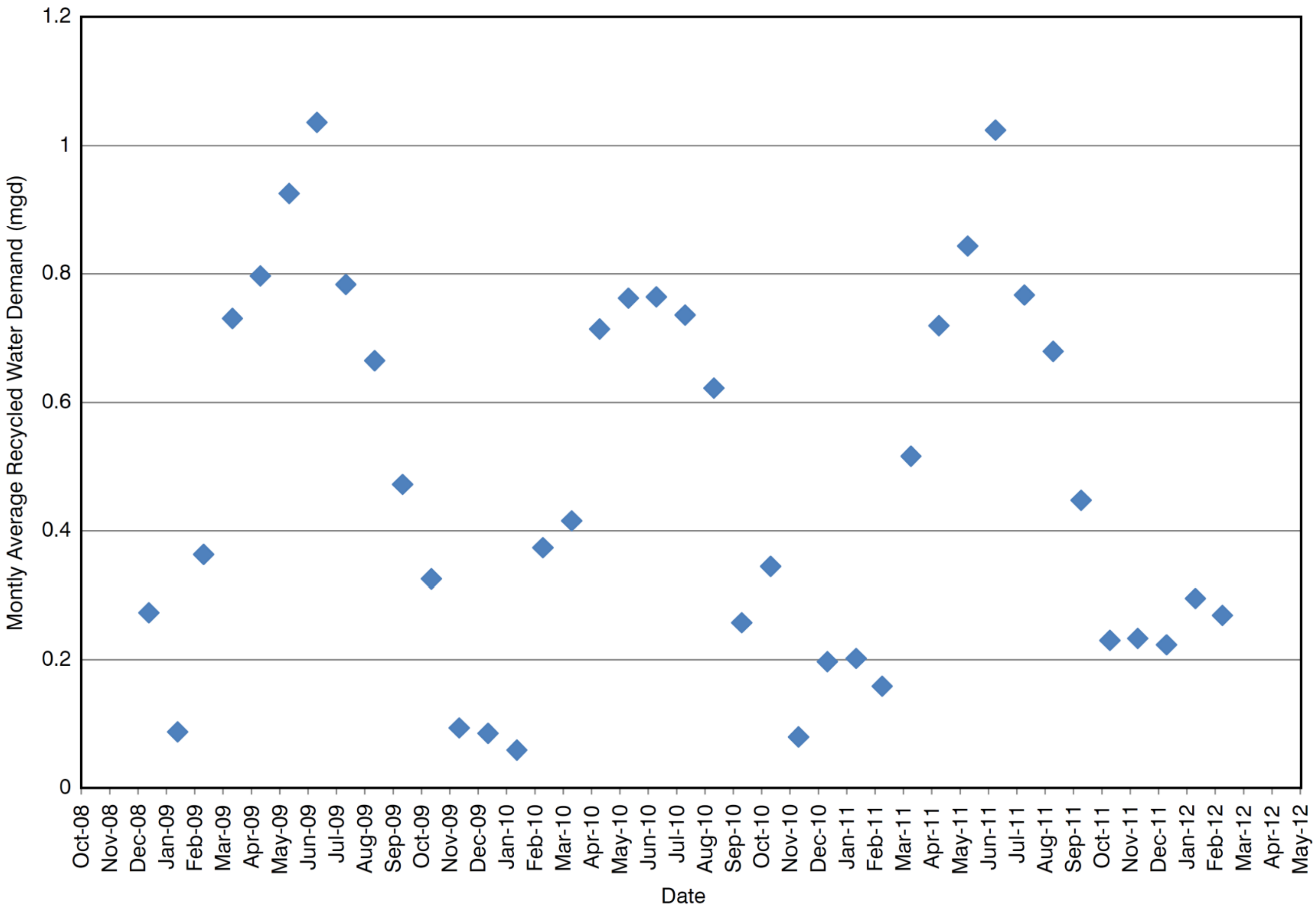

Figure 3.5
AVERAGE RECYCLED WATER DEMANDS 2009 - 2012
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

The alternatives being considered in this report (see Chapters 6 and 7) include options to provide advanced treatment for reducing TDS and chloride for specific crop water quality needs as well as for potential groundwater recharge. Satellite or decentralized treatment plants located nearer to potential uses is also under consideration. These options would require new treatment facilities to be constructed to meet reuse requirements. The specific details on the additional treatment needed for each alternative are discussed in Chapters 6 and 7.

REGULATORY REQUIREMENTS

4.1 OVERVIEW OF REGULATORY REQUIREMENTS

Wastewater discharges are governed by both federal and state requirements. The primary laws regulating water quality are the Clean Water Act (CWA) and the California Water Code. The primary regulation governing recycled water use is the California Water Code Regulations, Title 22 (Title 22).

Under the CWA, the Environmental Protection Agency (EPA) or a delegated State agency regulates the discharge of pollutants into waterways through the issuance of National Pollutant Discharge Elimination Systems (NPDES) permits. NPDES permits set limits on the amount of pollutants that can be discharged into the waters of the United States. The California Water Code and the Porter-Cologne Act, a provision of the Water Code, require the State to adopt water quality policies, plans, and objectives for the protection of the State’s waters. The State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) meet this requirement by establishing water quality criteria in regional Basin Plans, the Inland Surface Waters, Enclosed Bays and Estuaries Plan, the Thermal Plan, and the Ocean Plan. The SWRCB and the RWQCBs also have regulatory authority along with the California Department of Public Health (CDPH) over projects using recycled water.

The SWRCB establishes general policies governing the permitting of recycled water projects consistent with its role of protecting water quality and sustaining water supplies. The SWRCB also exercises general oversight over recycled water projects, including review of RWQCB permitting practices. The DPH is charged with protection of public health and drinking water supplies and with the development of uniform water recycling criteria appropriate to particular uses of water. The RWQCB is charged with protection of surface and groundwater resources and with the issuance of permits that implement DPH recommendations.

The Ventura Water Reclamation Facility (VWRF) is located in the Los Angles Region, and therefore the Los Angeles Regional Water Quality Control Board (LARWQCB) has authority to issue permits for wastewater discharge and recycled water use. The VWRF currently discharges to the Santa Clara River Estuary under existing NPDES permit (CA0053651) which was adopted by the LARWQCB on March 6, 2008. The NPDES permit is currently under review for a 2013 permit renewal. The VWRF also currently produces Title 22 tertiary quality water that is used for local landscape irrigation that is regulated by a separate Waste Discharge Requirements and Waster Recycling Requirements Order No. 87-45, CI No. 6190.

4.2 WASTEWATER DISCHARGE REQUIREMENTS

The VWRF's 2013 NPDES permit establishes discharge limits for conventional constituents, nutrients, metals, and organics. These limits are established to be protective of aquatic life and other beneficial uses of the receiving water. Table 4.1 provides a list of conventional constituents and metals, respectively, along with their permit limit.

Table 4.1 VWRF NPDES Permit Limits
Phase 2 Recycled Water Study
City of Ventura

Constituent (Units)	Averaging Period	Permit Effluent Limits
BOD_5 (mg/L)	Monthly	20
Total Suspended Solids (mg/L)	Monthly	15
Turbidity (NTU)	24-hour	2
Total Coliform (MPN/100 mL)	7 day median	2.2
Total Residual Chlorine (mg/L)	Maximum Daily	0.1
pH	Instantaneous Minimum and Maximum	6.5 to 8.5
Oil and Grease	Monthly	10
Settleable Solids	Monthly	0.1
MBAS	Monthly	0.5
Total Ammonia (mg/L)	Monthly	1.07 May-Oct 1.3 Nov-Apr
Nitrate + Nitrite as Nitrogen (mg/L)	Monthly	10
Nitrite as Nitrogen (mg/L)	Monthly	1
Nitrate as Nitrogen (mg/L)	Monthly	10
Copper (µg/L)	Monthly	6.1
Lead (µg/L)	Monthly	7.0
Nickel (µg/L)	Monthly	7.2
Selenium (µg/L)	Monthly	2.9

In addition to the discharge limits on the constituents, nutrients, and metals provided above, there are additional receiving water and groundwater limitations that are required to be met based on water quality objectives contained in the Basin Plan. These additional limitations are listed in the NPDES permit.

4.3 RECYCLED WATER REGULATIONS

The SWRCB and the RWQCBs have regulatory authority along with the California Department of Public Health (CDPH) over projects using recycled water. The following sections summarize existing regulations that govern recycled water systems. The types of recycled water under consideration include urban irrigation, agricultural irrigation, indirect potable reuse (groundwater recharge) and direct potable reuse.

4.3.1 Title 22 of the California Code of Regulations

CDPH is the State primary agency responsible for the protection of public health, the regulation of drinking water, and the development of uniform water recycling criteria appropriate to particular uses of water. CDPH has promulgated regulatory criteria in Title 22, Division 4, Chapter 3, Section 60301 et seq., California Code of Regulations (Title 22). Additional information on recycled water regulations and a link to Title 22 of the CCR can be found at http://www.cdph.ca.gov/CERTLIC/DRINKINGWATER/Pages/Lawbook.aspx.

Title 22 regulations define four types of recycled water determined by the treatment process and total coliform, bacteria, and turbidity levels. The four treatment types of recycled water that are currently permitted by CDPH under Title 22 regulations are summarized in Table 4.2.

Table 4.2 Approved Uses of Recycled Water
Phase 2 Recycled Water Study
City of Ventura

Treatment Level	Approved Uses	Total Coliform Standard (median)
Disinfected Tertiary Recycled Water	Spray Irrigation of Food Crops Landscape Irrigation(1) Nonrestricted Recreational Impoundment	2.2 / 100 ml
Disinfected Secondary - 2.2 Recycled Water	Surface Irrigation of Food Crops Restricted Recreational Impoundment	2.2 / 100 ml
Disinfected Secondary - 23 Recycled Water	Pasture for Milking Animals Landscape Irrigation(2) Landscape Impoundment	23 / 100 ml
Undisinfected Secondary Recycled Water	Surface Irrigation of Orchards and Vineyards(3) Fodder, Fiber and Seed Crops	N/A

Notes:
(1) Includes unrestricted access golf courses, parks, playgrounds, school yards, and other landscaped areas with similar access.
(2) Includes restricted access golf courses, cemeteries, freeway landscapes, and landscapes with similar public access.
(3) No fruit is harvested that has come in contact with irrigating water or the ground.

4.3.2 Recycled Water State Policy

The SWRCB recognizes that a burdensome and inconsistent permitting process can impede the implementation of recycled water projects. The SWRCB adopted a Recycled

Water Policy (RW Policy) in 2009 to establish more uniform requirements for water recycling throughout the State and to streamline the permit application process in most instances.

The RW Policy includes a mandate that the State increase the use of recycled water over 2002 levels by at least 200,000 AFY by 2020 and by at least 300,000 AFY by 2030. Also included are goals for stormwater reuse, conservation and potable water offsets by recycled water. The onus for achieving these mandates and goals is placed both on recycled water purveyors and potential users.

Absent unusual circumstances, the RW Policy puts forth that recycled water irrigation projects that meet CDPH requirements, and other State or Local regulations, be adopted by Regional Boards within 120 days. These streamlined projects will not be required to include a monitoring component.

The RW Policy requires that salt/nutrient management plans for every basin in California be developed and adopted as Basin Plan Amendments by 2015. These Management Plans will be developed by local stakeholders and funded by the regulated community. Salt/nutrient management plans have not yet been developed in the Ventura area but are under initial development.

The SWRCB Staff has proposed an amendment to the RW Policy to add monitoring requirements for constituents of emerging concern (CECs) in recycled water. In 2009, in accordance with the Recycled Water Policy, the State Water Board convened a science advisory panel (Panel) to provide guidance on future actions related to monitoring CECs in recycled water. This Panel submitted a report titled: “Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water – Recommendations of a Science Advisory Panel” (Panel Report). The Panel Report provided recommendations for monitoring specific CECs in recycled water used for groundwater recharge reuse. For recycled water used for landscape irrigation, the Panel did not recommend monitoring of CECs, but recommended monitoring of some surrogates. The State Water Board incorporated the Panel’s recommendations into a proposed amendment to the Recycled Water Policy, which consists of two parts. The first part revises the original Recycled Water Policy. The second part is a new Attachment A for the Recycled Water Policy. After a series of public workshops and public comment periods, the proposed amendment is now scheduled for consideration of adoption during the January 22, 2013, board meeting.

4.3.3 Groundwater Recharge Requirements

The CDPH published new draft regulations related to the replenishment of groundwater with recycled municipal wastewater (CDPH, 2013). The 2013 draft regulations include revisions to the previous, 2011, draft regulations. The phrase “Groundwater Replenishment Reuse Project,” or GRRP, is a defined term meaning a project using recycled municipal wastewater for the purpose of replenishment of groundwater that is designated a source of water supply in a Water Quality Control Plan, or which has been identified as a GRRP by the Regional Water Quality Control Board (RWQCB). GRRPs can employ surface spreading basins or subsurface injection methods, and there are separate regulations described for both methods. Both methods are considered to be "indirect potable reuse (IPR)". SB 918 (2010) requires that on or before December 31, 2013, the State department shall adopt uniform water recycling criteria for indirect potable reuse for groundwater recharge. However, it is possible that this date will be extended. Until final regulations are adopted, the draft regulations are used to implement projects.

Full advanced treatment (FAT) is defined in the draft CDPH regulations as "the treatment of an oxidized wastewater […] using a reverse osmosis and an oxidation treatment process […]". According to the draft CDPH regulations, FAT is the required treatment process for groundwater augmentation using direct injection, unless an alternative treatment has been demonstrated to CDPH as providing equal or better protection of public health and has received written approval from CDPH. Surface spreading requires treatment to tertiary recycled water standards.

The draft CDPH regulations for GRRPs also require a minimum "response retention time" or minimum groundwater travel time of two months. Groundwater travel time can be estimated by various methods, including intrinsic tracer studies, numerical modeling, or analytical modeling. Depending on the method used, the "response time credit" is discounted by a factor of 0.67 (for tracer tests) to 0.25 (for analytical modeling). The more rigorous the estimating approach, the more advantageous the discounting factor.

For many potable reuse projects in California, the purified recycled water is diluted with other potable water supplies prior to injection into the groundwater. The draft CDPH regulations require that the ratio of purified recycled water to the total injected water, known as the recycled water contribution (RWC), be determined periodically, and that it is not to exceed a value determined during the CDPH's review of the engineering report and the results of public hearings (Article 5.2, Section 60320.216). Only water that is either a CDPH-approved drinking water, or meets certain quality criteria (e.g., does not exceed primary or secondary MCLs or notification levels) may be used as diluents water (Article 5.2, Section 60320.216). The new draft regulations allow, however, the RWC to be 100% if it can be demonstrated that sufficient protections are afforded within the total project design and proposed operational scheme.

Table 4.3 summarizes the key regulatory requirements for groundwater recharge or IPR projects as established by the 2011 Draft Groundwater Recharge Regulations. The draft regulation and additional information can found at http://www.cdph.ca.gov/healthinfo/environhealth/water/pages/waterrecycling.aspx .

Table 4.3	Summary of CDPH Recycled Water 2011 Draft Regulations for Groundwater Recharge Phase 2 Recycled Water Study City of Ventura	
	Type of Recharge	
	Surface Applications	**Subsurface Applications**
Treatment	Disinfected tertiary	100% RO and AOP treatment for the entire waste stream
Retention time[1]	Minimum 2 months (however addition treatment may be required for < 6 months)	Minimum 2 months
Recycled Water Max Initial Contribution (RWC_{max})	Up to 20% disinfected tertiary Up to 100% with RO & AOP	Up to 100% with RO & AOP
Total Nitrogen	Average <5 mg/L, Max 10 mg/L	
Total Organic Carbon	Mound < 0.5 mg/L ÷ RWC	< 0.5 mg/L
Dilution water compliance calculation	Based on 120-month running average	

Notes:
RO – reverse osmosis
AOP- advanced oxidation process
mg/L – milligrams per liter
(1) Must be verified by a tracer study.

4.3.4 Direct Potable Reuse

Direct potable reuse (DPR), is the incorporation of purified recycled water directly into the raw water supply of a community without the use of an environmental buffer such as an aquifer or a surface water. Thus, DPR allows for potable reuse and avoids the problems related to groundwater injection and extraction. DPR has become a reality in the United States, with two projects now starting operation (Big Springs Texas and Cloudcroft New Mexico). In California, the state legislature has directed the CDPH to develop a regulatory framework for DPR by December 31, 2016. Further, there is ongoing research on how to properly implement DPR projects in California and nationally. It is anticipated that treatment technologies similar to FAT will be required for DPR and online monitoring will be a critical component of DPR.

4.4 SALT AND NUTRIENT MANAGEMENT PLANS

In 2009, the State Water Resources Control Board adopted a new Recycled Water Policy (SWRCB Res No. 2009-0011). It mandated that a Salt and Nutrient Management Plan

(SNMP) be prepared for basins where recycled water was to be used. The plans are to include collaboration from local water, wastewater, and contributing stakeholders.

Ventura County is the lead agency in the Lower Santa Clara River SNMP and the City of Ventura is one of several participating agencies. The project area for the Lower Santa Clara River SNMP includes the Mound, Santa Paula, Oxnard Forebay, Fillmore and Piru basins. The LSCR SNMP is expected to be completed mid-2014.

The City's recycled water permit will ultimately incorporate findings from the updated Salt and Nutrient Management Plan.

4.5 WATER QUALITY-RELATED REQUIREMENTS

Water quality related requirements of the RWQCB to protect surface or groundwater from problems resulting from recycled water use are discussed herein. Potential groundwater quality impacts are a considerations for this project since the City overlays one of the main drinking water basins, the Mound Basin. In addition, several of the alternatives being considered propose to recharge one of the several groundwater basins in the study area.

4.5.1 Specific Water Quality Requirements

Specific water quality requirements may be established based on the specific use of recycled water or based on the objectives established in the Basin Plan to be protective of the groundwater.

For agricultural reuse applications, advanced treatment for TDS and chloride would be required to meet crop specific water quality thresholds. Strawberries are the most sensitive crop (grown in the study area) to chloride concentrations in irrigation water. The Upper Santa Clara River Chloride TMDL, established a maximum chloride concentration of 117 milligrams per liter (mg/L) to be protective of agricultural beneficial uses (irrigation of salt sensitive crops) (LARWQCB Final Basin Plan Amendment (TMDL), 2008).

In addition, there are specific water quality objectives established in the Basin Plan, including the several relevant objectives discussed herein. The water quality objectives for the Oxnard Forebay include TDS and chloride concentrations of 1200 mg/L and 150 mg/L, respectively. The on going development and adoption of a Salt and Nutrient Management Plan for the Lower Santa Clara River will result in a Basin Plan amendment that could establish water quality requirements for recycled water projects.

4.5.2 Incidental Runoff

The City's recycled water permit will establish requirements to prevent runoff of recycled water into surface water bodies. The RW Policy defines incidental runoff as unintended small amounts of runoff from recycled water use areas, such as unintended, minimal over-spray from sprinklers that escapes the recycled water use area. Water leaving a recycled water use area is not considered incidental if it is part of the following:

- Facility design.
- Excessive application.
- Intentional overflow or application.
- Negligence.

Incidental runoff may be regulated by waste discharge requirements, or when necessary, through a NPDES permit. Regardless of the regulatory instrument, the project shall include the following practices:

- Implementation of an operations and management plan that provides for detection of leaks, and correction within 72 hours of learning of the runoff, or prior to the release of 1,000 gallons, whichever occurs first.
- Proper design and aim of sprinkler heads.
- Refraining from application during precipitation events.
- Management of any ponds containing recycled water such that no discharge occurs unless discharge is a result of a 25-year, 24-hour storm event or greater, and there is notification of the appropriate Regional Water Board Executive Officer of the discharge.

4.5.3 Title 22 Use Area Requirements

Title 22 has two main requirements that could affect a project and will need to be considered during the design phase. There are a number of drinking water wells that exist throughout the study area owned by the City. Per Title 22, no irrigation with disinfected tertiary recycled water shall take place within 50 feet of any domestic water supply well unless the well meets certain criteria such as:

- An annular seal.
- Well housing to prevent recycled water spray from contacting the wellhead.
- The City approves of the elimination of the buffer zone, etc.

Also per Title 22, no impoundment of disinfected tertiary recycled water shall occur within 100 feet of any domestic water supply well. This will need to be considered during design.

4.5.4 General Irrigation Use Guidelines

Water quality guidelines for general landscape irrigation are based on practical limits for using different types of irrigation approaches as well as the tolerance of various plants for specific constituents found in irrigation water. Table 4.4 includes a comparison of constituent guidelines/criteria and the VWRF recycled water quality.

The constituents that can impact use of recycled water for general landscape irrigation primarily include minerals and nutrients. The shaded criteria ranges in Table 4.4 indicate that the VWRF effluent concentrations fall within the shaded range. In general, comparison of most constituents suggests that there may be slight restrictions in the use of VWRF effluent for general landscape irrigation. The SAR level and hardness concentrations indicate that there could be severe restrictions for landscape irrigation use. However, existing use of the VWRF effluent for landscape irrigation suggests that the water quality is sufficient for this type of use.

In addition, there are operational techniques for the use of recycled water for landscape irrigation that can improve and sustain a specific use. The successful long-term use of irrigation water depends on rainfall, leaching, soil drainage, irrigation water management, salt tolerance of plants, soil management practices, as well as water quality. Since salinity problems may eventually develop from the use of any water, the following guidelines are given, should they be needed, to assist water users to better manage salinity:

- Irrigate more frequently to maintain an adequate soil water supply.
- Select plants that are tolerant of an existing or potential salinity level.
- Routinely use extra water to satisfy the leaching requirements and to drive salts below the root zone.
- If possible, direct the spray pattern of sprinklers away from foliage. To reduce foliar absorption, try not to water during periods of high temperature and low humidity or during windy periods. Change time of irrigation to early morning, late afternoon, or night.
- Maintain good downward water percolation by using deep tillage or artificial drainage to prevent the development of a perched water table.
- Salinity may be easier to control under sprinkler and drip irrigation than under surface irrigation. However, sprinkler and drip irrigation may not be adapted to all qualities of water and all conditions of soil, climate, or plants.

Table 4.4 Comparison of VWRF Effluent with Irrigation Water Quality Criteria
Phase 2 Recycled Water Study
City of Ventura

Parameter	Units	Established Criteria Degree of Use Restriction[1,2]			VWRF Effluent (Median Value)[4]
		None	Slight	Severe	
Salinity					
Electrical Conductance	µS/cm	<700	700-3000	>3000	2240
Total Dissolved Solids (TDS)	mg/L	<450	450-2000	>2000	1489
Permeability					
SAR[3] = 0 - 3 and EC		700	700-200	<200	
= 3 - 6 and EC		≥1200	1200-300	<300	
= 6 - 12 and EC		≥1900	1900-500	<500	SAR = 10.1, EC = 2240
= 12 - 20 and EC		≥2900	2900-1900	<1900	
= 20 - 40 and EC		≥5000	5000-2900	<2900	
Sodium					
Root Absorption	SAR	<3	3-9	>9	10.1
Foliar Absorption	mg/L	<70	>70	-	258
Chloride					
Root Absorption	mg/L	<140	140-355	>365	290
Foliar Absorption	mg/L	<100	>100	-	290
Boron	mg/L	<0.7	0.7-3.0	>3.0	0.7
Total Alkalinity (as $CaCO_3$)	mg/L	<90	90-500	>500	201
pH	–	6.5-8.4 (normal range)			7.3
Ammonia (NH_4-N)	mg/L	(see total N values below)			1.4
Nitrate (NO_3-N)	mg/L	(see total N values below)			14.6
Nitrate (NO_2-N)	mg/L	(see total N values below)			-
Total Nitrogen	mg/L	<5	5-30	>30	17.6
Hardness (as $CaCO_3$)[5]	mg/L	<90	90-500	>500	701

Notes:
(1) Adapted from University of California Committee of Consultants (1974) and Water Quality for Agriculture (Ayers and Westcot 1985).
(2) Definition of the "Degree of Use Restriction" terms:
None = Reclaimed water can be used similar to the best available irrigation water.
Slight = Some additional management will be required above that with the best available irrigation water in terms of leaching salts from the root zone and/or choice of plants.
Severe = Typically cannot be used due to limitations imposed by the specific parameters.
(3) SAR = Sodium absorption ratio. SAR is a ratio of the sodium concentration to the calcium and magnesium concentrations.
(4) Median VWRF concentrations based on data from 2006 through 2008.
(5) Presence of bicarbonate can result in unsightly foliar deposits.

RECYCLED WATER MARKET

5.1 RECYCLED WATER MARKET ASSESSMENT

There have been several efforts to quantify potential recycled water opportunities in the last few years. In addition to this project, the following reports provide additional information:

- Recycled Water Market Study Phase 1 Report (Carollo, March 2010) http://www.cityofventura.net/files/file/public-works/Recycled%20Water%20Market%20Study_Final,March2010.pdf
- Treatment Wetlands Feasibility Study (Carollo, March 2010) http://www.cityofventura.net/files/file/public-works/Treatment%20Wetlands%20Feasibility%20Study%20Report_Final,March2010.pdf
- Potential Recycled Water Market within the City of Ventura (K/J, 2007)
- Phase 1 Recycled Water Master Plan for the City of Oxnard (K/J, 2009).
- Draft Ventura-Oxnard Recycled Water Interconnect Feasibility Study (K/J, 2012)

5.1.1 2010 Recycled Water Market Assessment

The recycled water opportunities within a 5-mile radius from the Ventura Water Reclamation Facility (VWRF) were evaluated in the Recycled Water Market Study Phase 1 Report (Phase 1 Recycled Water Report), dated March 2010. The March 2010 study used GIS layers including land use and planning designations, and City of Ventura (City) water billing records, to do an initial assessment of the different types of potential recycled water use in the 5 mile radius from the VWRF. In addition, the previous studies were referenced and used in the development of the Phase 1 Report. The following three types of potential recycled water usage were identified in the study area:

- Urban Uses - These uses include general landscape irrigation of parks, golf courses, recreational fields, municipal areas, churches, roadway medians, cemeteries, and other landscaped areas. In addition, these uses include commercial entities and industries.
- Agricultural Uses - This use involves spray or drip irrigation of various types of crops grown in the region.
- Groundwater Recharge - This use involves percolation or injection of recycled water into underlying groundwater aquifers. This study focused on the potential for groundwater recharge at the United Water Conservation District (UWCD) Facilities, where the groundwater recharge via spreading ponds (i.e., percolation) is currently practiced. While UWCD is located more than 5 miles from the VWRF, the Phase 1

Recycled Water Study focused on this opportunity because of the existing facilities, an existing source of diluent water, and potential available capacity.

The results presented in the Phase 1 Recycled Water Report are shown in Table 5.1 and in Figures 5.1, 5.2 and 5.3. These results were used as a starting point for this study, which focused on investigating these options and others in more detail.

Table 5.1 Summary of Urban Irrigation, Agricultural Irrigation and Groundwater Recharge Opportunities (as presented in Phase 1 Recycled Water Report)
Phase 2 Recycled Water Study
City of Ventura

Recycled Water Use	Potential Demand (mgd)	Cost (millions of dollars)	Treatment Requirements	Challenges
Urban Irrigation	2.2 Annual Ave 3.7 Max Month	62	None	• Demand varies seasonally (1 mgd in winter to 3.7 in summer) • Extensive pipeline network • Feasibility of serving the River Ridge Golf Course is unknown
Agricultural Irrigation	6.5 Annual Ave 11 Max Month	145	MF and RO	• Demand varies seasonally (1.6 in winter to 11 in summer) • Requires brine treatment and disposal • Requires conversion of wildlife ponds to recycled water storage reservoirs • Requires agreement by growers
Groundwater Recharge at UWCD	7 Annual Ave 12.6 Max Month	36 (1)	Possibly MF and RO	• Assuming a partial year diversion scenario the demand varies seasonally with more potential in fall, winter and spring (ranges from 0 mgd in summer to 12.6 winter) • May require additional treatment (MF/RO and brine treatment • Requires agreement with UWCD • Requires long term monitoring effort

Note:

This is a minimum cost because treatment costs for TDS and chloride removal are not included.

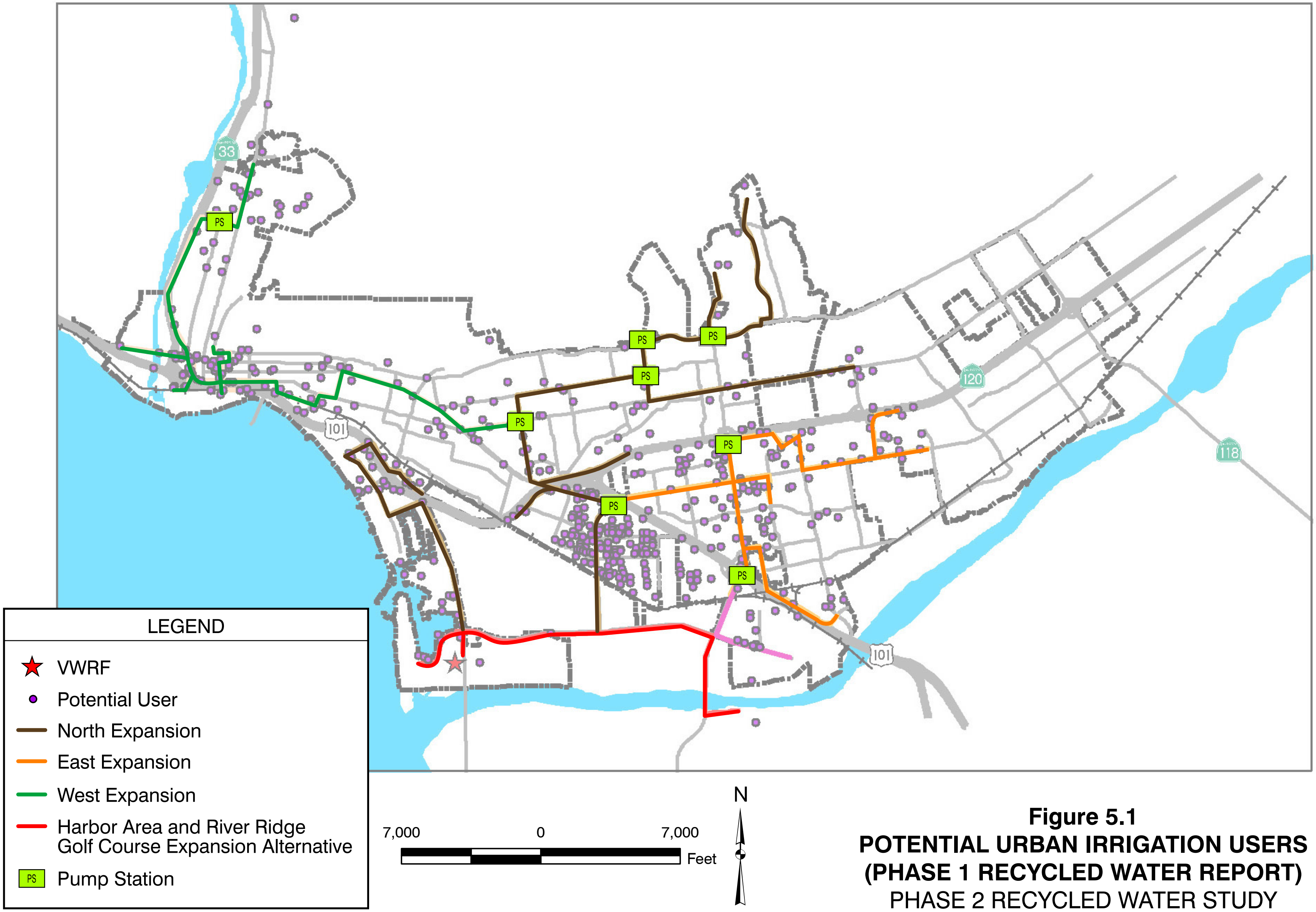

Figure 5.1
POTENTIAL URBAN IRRIGATION USERS
(PHASE 1 RECYCLED WATER REPORT)
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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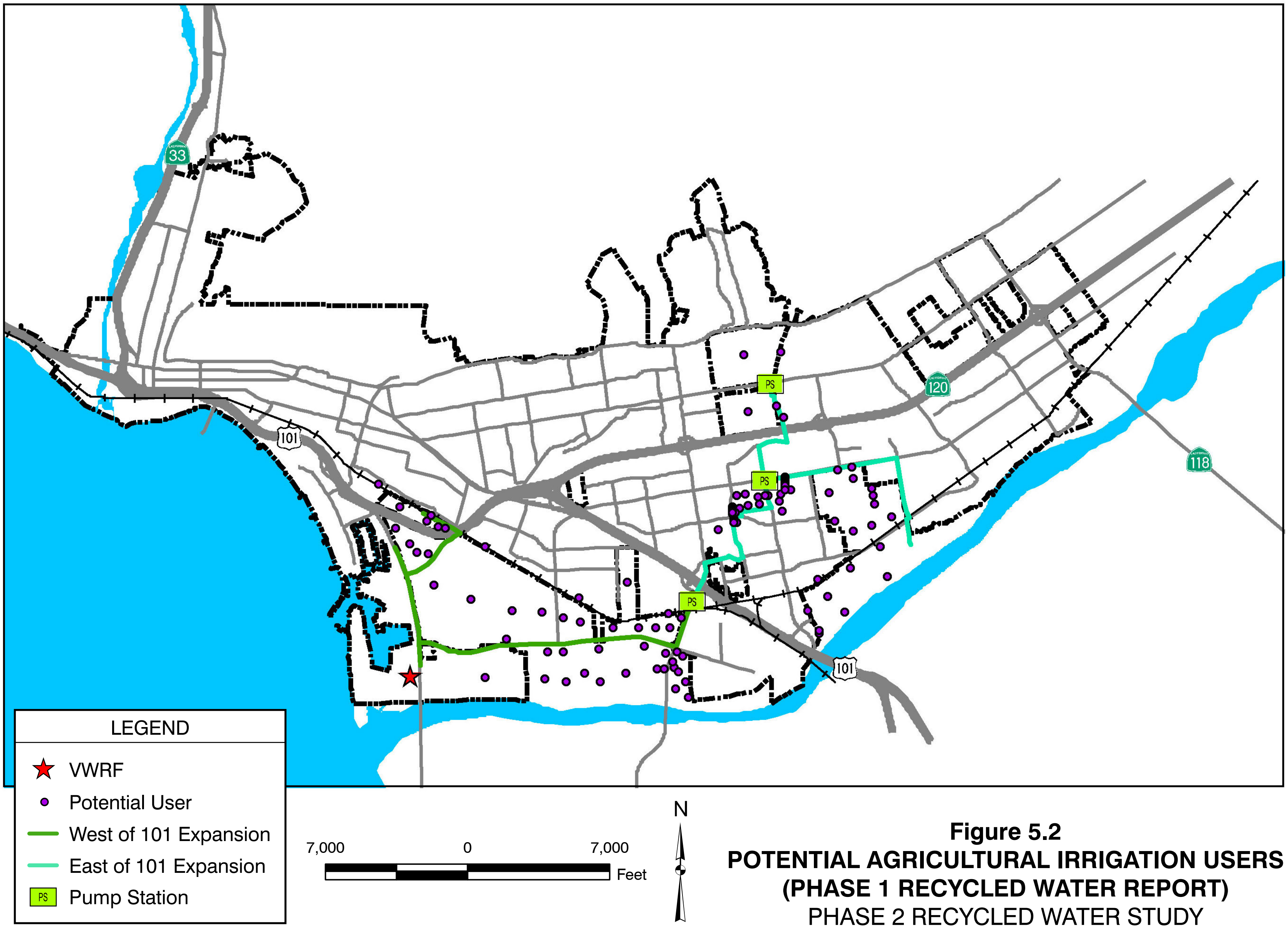

Figure 5.2
POTENTIAL AGRICULTURAL IRRIGATION USERS
(PHASE 1 RECYCLED WATER REPORT)
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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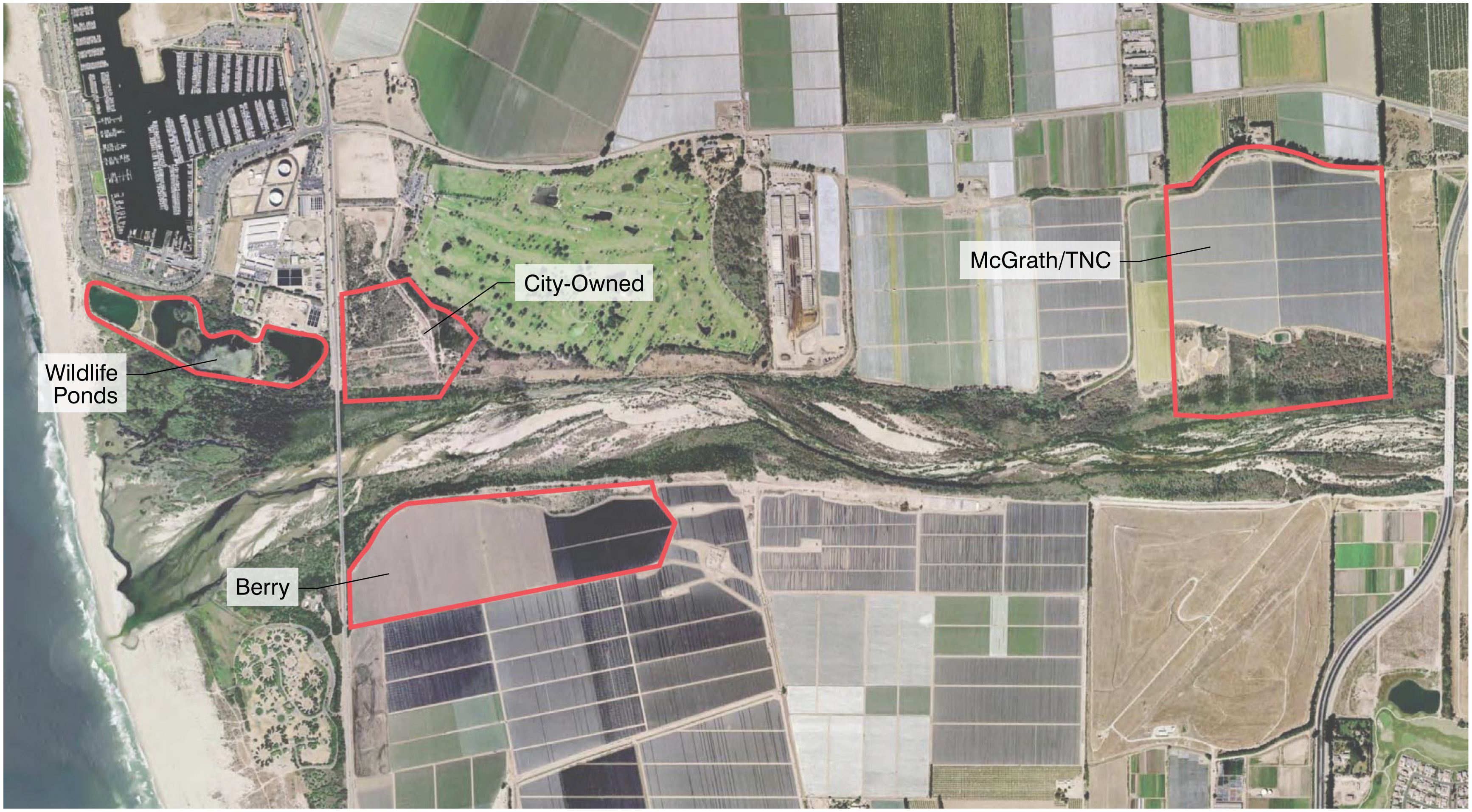

Figure 5.3
POTENTIAL SITES FOR TREATMENT WETLANDS
(PHASE 1 WETLAND FEASIBILITY REPORT)
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

5.1.2 2010 Treatment Wetlands Study

In addition to using evaluating additional recycled water opportunities, the Treatment Wetlands Feasibility Study (2010) (Phase 1 Wetland Feasibility Report) study evaluated the potential benefits of using the recycled water to create wetlands adjacent to the Santa Clara River.

The results of the Phase 1 Wetlands Study are shown in Table 5.2.

Table 5.2 Summary of Treatment Wetland Alternatives (as presented in Phase 1 Wetland Feasibility Report)
Phase 2 Recycled Water Study
City of Ventura

Alternatives	Wetland Size, acres	Estimated Project Costs	Issues/Benefits
1 Retrofit existing wildlife ponds 1&2	12	$2,800,000	Existing utilities (e.g., sewer trunk line) limit the useable area Closest to the VWRF (shortest pipeline, lowest cost)
2 City-Owned Land adjacent to VWRF	29	$11,350,000	Existing utilities (e.g., sewer trunk line) limit the useable area Closest to the VWRF (shortest pipeline, lowest cost)
3 Berry	92	$30,250,000	Large area Pipeline needs to cross the Santa Clara River Unwilling seller(1)
4 McGrath/TNC	120	$44,550,000	Largest area (some planned for restoration) Disturbance of existing habitat at the southern end and discharge to the Santa Clara River may make permitting difficult Furthest from the VWRF (longest pipeline, highest cost)

Note:
(1) While there is an unwilling seller, stakeholders (specifically, representatives from State Parks and Fish and Wildlife Services) requested this site be kept for further examination.

5.1.3 Phase 2 Study

This current study builds on the Phase 1 studies and Draft Ventura Oxnard Recycled Water Interconnect Study (K/J, 2012). The potential uses/market for recycled water were expanded through discussion with City staff and through stakeholder input provided in the form of comments on the Phase 1 studies, and in workshops held throughout the development of the Phase 2 studies. In particular, the July 18, 2012 workshop introduced several additional recycled water market concepts, and small group sessions were convened to allow stakeholders to comment and provide additional ideas for expanding the potential uses/market for recycled water.

The potential recycled water uses for this study included:

- Urban and agricultural reuse of reclaimed water from the VWRF.
- Urban and agricultural reuse of reclaimed water from new facilities in within the City's wastewater service area, i.e. the concept of decentralized treatment.
- Groundwater recharge using the UWCD facilities.
- Groundwater recharge, for the purpose of indirect potable reuse (IPR), in the Mound Basin or in the Oxnard Plain Basin.
- Direct potable reuse (DPR) of reclaimed wastewater from the VWRF as well as other new facilities (i.e. decentralized treatment plants).
- Conveyance of wastewater to the Oxnard Advanced Water Purification Facility.
- Treatment Wetlands/Habitat Creation using reclaimed wastewater from the VWRF.
- The combination of treatment wetlands/habitat creation combine with groundwater recharge of the perched zone.

The alternatives that were developed to target these potential recycled water markets are described in more detail in Chapters 6 and 7.

5.2 OUTREACH WITH POTENTIAL CUSTOMERS

In addition to the many stakeholder meetings during the Phase 1 and Phase 2 studies, there were also individual meetings held with several of the potential user groups. In June 2012, separate meetings were held with UWCD, The Nature Conservancy, and the Ventura County Farm Bureau to discuss potential reuse opportunities for recharge, wetlands creation and agricultural reuse, respectively. In addition, there were numerous calls with City staff that included discussion of the City as a user of recycled water generated by IPR and DPR projects. Appendix A includes a letter from the City that documents City interest in using recycled water for IPR/DPR.

5.2.1 Project Website

The City set up a website for the Santa Clara River Special Studies.

http://www.cityofventura.net/rivers

This website includes study documents, reports, workshop agendas, workshop presentations, and workshop minutes. The website provides potential recycled water users with information on the types of reuse being considered in the studies, the development of reuse alternatives/projects, and the evaluation of reuse alternatives.

5.2.2 Stakeholder Informational Meeting

Many stakeholder meetings have been held to discuss the potential options for using the VWRF effluent for additional reuse options and the resulting impact to the estuary:

- July 15, 2009.
- Nov 10, 2009.
- Feb 2, 2010.
- Sept 28, 2010.
- Feb 10, 2011.
- Aug 18, 2011.
- July 18, 2012.
- Oct 31, 2012.
- Feb 21, 2013.

Attendees to these workshops have included RWQCB staff, fishery resource agencies' staff (California Fish and Game, NOAA and USFWS), UWCD, TNC, California State Parks, City of Oxnard, Army Corps of Engineers, Ventura County Watershed Protection District, local NGOs (Ventura Coast Keeper, Heal the Bay, Audubon and Friends of the River) and local residents. The presentation materials and attendee lists for each of these meetings is available on the City's website.

5.3 CUSTOMER INCENTIVES

Recycled water projects can be costly and burdensome to residents and customers, so in many instances incentives are used to help attract the customer to convert to the use of recycled water. Since most water and wastewater systems already exist, and were developed with federal clean water funds years ago, the cost for a new reuse system can be overwhelming when placed entirely on a community or worse yet, on one large customer. Below summarizes some common incentive concepts that are seen when recycled water projects are constructed, retrofit, and/or operated. The following list summarizes some of the incentives that can be put into place.

- Significantly lower unit cost than the next best water supply alternatives. This can be seen when recycled water is compared to current and future City water rates.

- Loan programs to pay for customer retrofit costs. This could be built into the rate structure or be provided through another department that benefits from water offsets. Retrofit payback programs should also be considered and are usually proposed for many customers who need help in funding the on-site upgrades needed to accept recycled water. This is a common approach for schools and public facilities with extremely limited funds.
- Grants or other programs to help customers with retrofit costs. Some grants are available to communities when combined with other programs such as water conservation, energy savings/conversion to solar, low-income areas of a City, City greening programs, etc.
- Waiving connection fees. For customers that eliminate irrigation meters or eliminate their water meters, there could perhaps be a return of part of their original connection fee (assuming they paid one and proof of payment exists).
- Recycled Water Use Ordinances. These are more along the line of a requirement, but can be used to promote and enforce more use.

The City intends to implement a mandatory Recycled Water Use Ordinance in the future instead of individual customer agreements. The intention of the use ordinance will be to define the user site requirements and those needing to connect to the recycled water system.

IDENTIFICATION AND PRELIMINARY SCREENING OF ALTERNATIVES

6.1 OVERVIEW OF ALTERNATIVES

As discussed in Chapter 5, the recycled water market was expanded beyond the potential uses described on the Phase 1 Recycled Water Report. With input from City of Ventura (City) staff and stakeholders, numerous alternatives were developed. The alternatives were identified based on fulfilling one or more of the following primary objectives:

- Reducing the discharge volume.
- Improving discharge quality.
- Providing habitat.

The alternatives can be generally grouped into three categories that are discussed in subsequent sections of this chapter:

- Urban and agricultural reuse.
- Groundwater recharge reuse.
- Treatment/habitat wetlands creation.

Sections 6.2 through 6.4 include brief descriptions of the alternatives, and a preliminary screening analysis of the alternatives. The preliminary screening analysis focuses on major issues related to feasibility of each alternative, and in this sense is a “fatal flaws” type analysis. In addition, the screening analysis includes a comparison of the alternatives in each category based on several key evaluation criteria, including the effects on:

- The Ventura Water Reclamation Facility (VWRF) discharge volume to the Santa Clara River Estuary (SCRE).
- The quality of the final discharge of VWRF effluent to the SCRE.
- Creation of new wetland habitat.
- Benefits to available water supply and quality.
- The need for advanced wastewater treatment processes.
- The need to purchase additional land for recycled water infrastructure.

At the July 18th, 2012 stakeholder workshop, various initial concepts for alternatives were presented and discussed, and stakeholders had the opportunity to provide input in small group sessions. Some of the discussion focused on the major issues related to the feasibility of some of these alternatives, and stakeholder input informed the preliminary screening analysis and the decisions associated with developing a list of alternatives for further development and consideration.

6.2 URBAN AND AGRICULTURAL REUSE

This category of alternatives includes several approaches to reduce the discharge volume implementing urban irrigation, agricultural irrigation, and direct potable reuse (i.e. municipal water supply). The alternatives use different sources of reclaimed water and approaches to convey/use the water for urban and agricultural reuse. These alternatives include:

- Expanding the existing recycled water system to provide more urban irrigation.
- Agricultural irrigation in the vicinity of the VWRF without blending.
- Agricultural in the vicinity of the VWRF with blending.
- A decentralized treatment plant on the north side of the City for urban and agricultural irrigation.
- A decentralized treatment plant on the east side of the City for urban and agricultural irrigation.
- Direct potable reuse (DPR).
- Conveyance to the Oxnard Wastewater Treatment Plant (WWTP) and Advanced Water Purification Facility (AWPF).

6.2.1 Expand Urban Reuse

The Phase 1 Recycled Water Report describes opportunities for expanding the existing urban reuse system within a five mile radius of the VWRF. Estimates of potential demands were revisited based on information available since the completion of the Final Phase 1 Recycled Water Report. The most significant adjustment to potential demands was removing the estimated demand for the River Ridge Golf Course, as the City of Oxnard has plans to serve this customer with recycled water. The average demand and maximum month demands of the remaining identified urban irrigation reuse customers are 1.3 million gallons per day (mgd) and 1.8 mgd, respectively. However, serving these customers would involve construction of an extensive pipe network to deliver recycled water to users located throughout the city. Figure 6.1 shows the pipe network that would be required to deliver recycled water to potential customers. Additional treatment would not be required because the VWRF currently treats wastewater to meet Title 22 standards for unrestricted reuse.

Major components of this alternative include:

- Recycled water pipelines, pump stations and reservoirs.

6.2.2 Agricultural Reuse without Blending

The Phase 1 Recycled Water Report describes opportunities for implementing water reuse for the purpose of agricultural irrigation. Estimates of potential demands were revisited

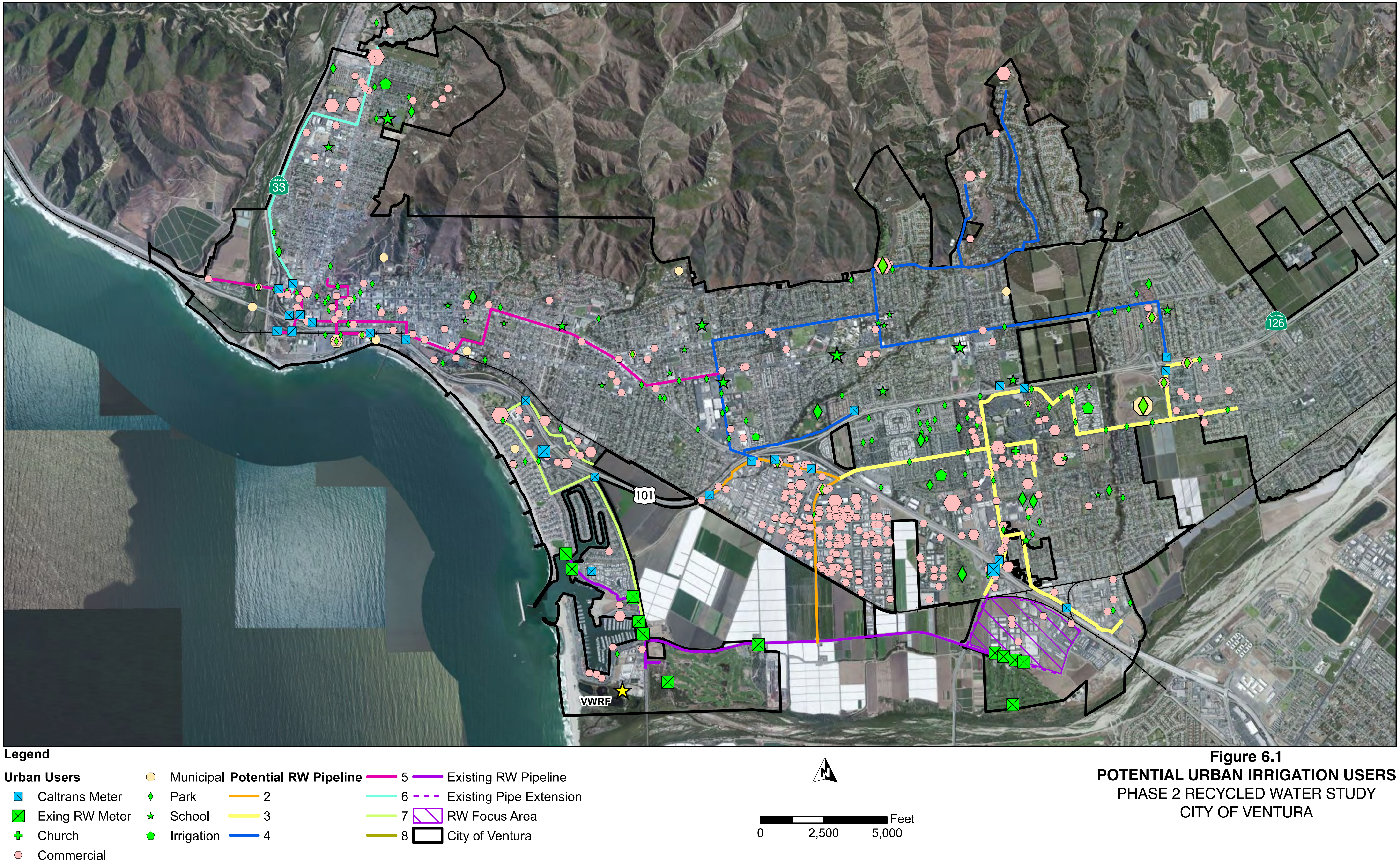

Figure 6.1

POTENTIAL URBAN IRRIGATION USERS

PHASE 2 RECYCLED WATER STUDY

CITY OF VENTURA

based on information available since the completion of the Final Phase 1 Report. The most significant adjustments to the demands include:

- Excluding the agricultural areas immediately adjacent to the north side of the Santa Clara River. It is anticipated that The Nature Conservancy (TNC) will be successful at purchasing these parcels as part of their Santa Clara River Parkway Project and that in the future these parcels will not be used for agriculture.
- Using crop specific, rather than an average, water demands to estimate the total demand of the agricultural parcels.
- Focusing the market on the agricultural areas that are along either side of Olivas Park Drive and either side of the railroad, as these areas present a potential demand in close vicinity to the VWRF.

The potential agricultural users are presented in Figure 6.2. The potential average and maximum month demands for these agricultural areas are 2.8 mgd and 4.6 mgd, respectively.

As discussed in the Phase 1 Recycled Water Report, advanced treatment for total dissolved solids (TDS) and chloride would be required to meet crop specific water quality thresholds. Strawberries are the most sensitive crop (grown in the study area) to chloride concentrations in irrigation water. The Upper Santa Clara River Chloride total maximum daily load (TMDL), established a maximum chloride concentration of 117 milligrams per liter (mg/L) to be protective of agricultural beneficial uses (irrigation of salt sensitive crops) (LARWQCB Final Basin Plan Amendment (TMDL), 2008). The advanced treatment train would include ultra or microfiltration (UF/MF) and reverse osmosis (RO) to meet this water quality goal. The brine waste from the RO process would require treatment and/or disposal.

In addition to the pipelines and pump stations required to deliver recycled water to potential agricultural irrigation customers, this alternative requires infrastructure that would allow growers the ability to control their source water through infrastructure that allows access to either the reclaimed water or the groundwater. (Personal communication with John Krist [Ventura County Farm Bureau], 2012).

Major components of this alternative include:

- Microfiltration and RO treatment facilities at the VWRF.
- Brine treatment/disposal facilities.
- Recycled water pipelines, pump stations and reservoirs.

6.2.3 Agricultural Reuse with Blending

This alternative would serve the same demands as described in Section 6.1.1.2. However, this alternative involves using existing groundwater blended with VWRF effluent (no additional treatment) to meet the crop specific water quality thresholds. The VWRF effluent

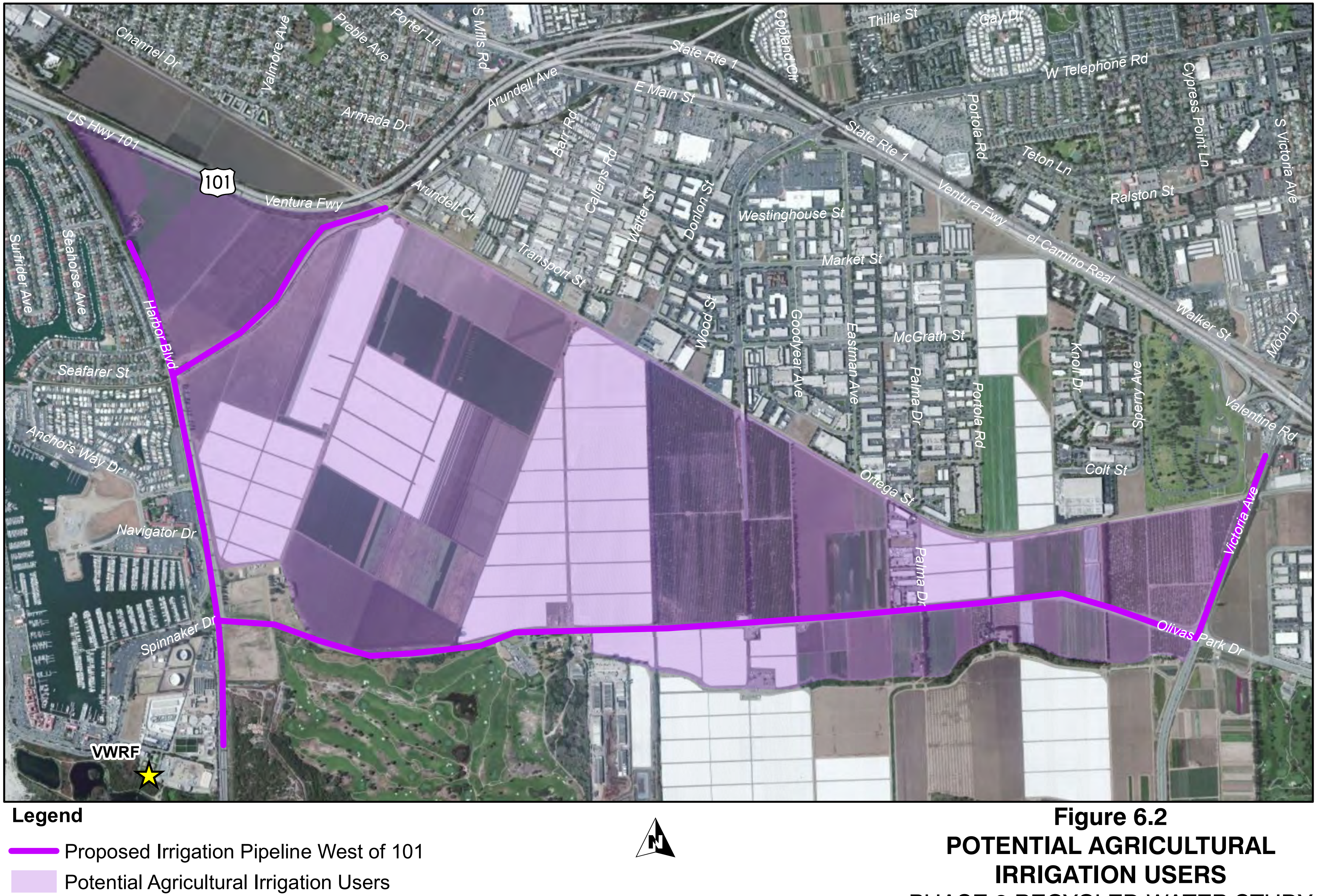

Figure 6.2
POTENTIAL AGRICULTURAL IRRIGATION USERS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

TDS and chloride concentrations are approximately 1489 mg/L and 290 mg/L. Groundwater quality data (UWCD, 2012) from wells located in the agricultural area west of 101, indicate ranges of TDS and chloride concentrations of 1100 mg/L to 1800 mg/L and 60 mg/L to 80 mg/L, respectively. The VWRF average TDS effluent concentration is within the range of the groundwater TDS concentrations, suggesting that there is not significant opportunity to reduce the effluent TDS by blending it with groundwater. However, the chloride concentrations in the groundwater are much less than in the VWRF effluent and therefore present an opportunity for improving effluent water by blending it with groundwater.

To protect the strawberry crops, the appropriate target chloride concentration for the blended water is 117 mg/L. To meet this limit, a blend of approximately 85 percent groundwater and 15 percent VWRF effluent would be required. At this blend ratio, to meet the average and maximum month demands, the VWRF effluent contribution would be limited to 0.4 mgd and 0.7 mgd respectively.

In addition to the pipelines and pump stations required to deliver recycled water to potential agricultural irrigation customers, this alternative requires infrastructure that would allow blending of reclaimed water and groundwater. Growers in the area would want a system that would allow them to access both the blended water sources, and the unblended groundwater source (Personal communication with John Krist, 2012).

Major components of this alternative include:

- Recycled water pipelines, pump stations and reservoirs.
- Point of use blending systems.

6.2.4 North Side Decentralized Treatment Plant for Agricultural and Urban Reuse

As described in the previous sections, there are opportunities for urban and agricultural irrigation throughout the City. This alternative includes the construction of a small wastewater treatment plant (decentralized treatment plant) for the purpose of providing an upstream supply of recycled water at a location in the vicinity of potential reuse opportunities.

The north side of the City presents opportunity for implementing a decentralized treatment plant. There are potential recycled water customers for urban and agricultural irrigation in the north side of the City. The wastewater in this area has low concentrations of TDS and chloride because the potable water supply in this area has low TDS and chloride concentrations, and therefore provides the potential for agricultural irrigation without advanced treatment. Also, the site of a former wastewater treatment plant, located near the Seaside Pump Station, could be use for the site of a new decentralized treatment facility.

Raw wastewater would be diverted from the collection system for treatment at a new treatment plant, located near the Seaside Pump station. The diverted flow would be approximately 2.6 mgd. The potential average and maximum month urban irrigation demands in the vicinity of the potential site for a new decentralized treatment plant are 0.17 and 0.24 mgd, respectively. The potential average and maximum month agricultural irrigation demands are approximately 1.1 mgd and 1.8 mgd, respectively. The combined agricultural and urban average and maximum month demands are 1.3 and 2.0 mgd, respectively. Figure 6.3 shows the potential location for a north side treatment plant and the customers that could be served.

The treatment plant would be designed to meet Title 22 regulations for unrestricted reuse, and sized to achieve 100 percent reuse. The solids from the treatment plant would be routed to the VWRF collection system for treatment.

The acceptance of recycled water for agricultural irrigation would depend on the effluent water quality. In August 2012, the City of Ventura collected samples from 2 locations in the collection system located near the Seaside Pump Station. Measured TDS and chloride concentrations were 676 mg/L and 68 mg/L, respectively. These TDS and chloride concentrations are acceptable for sensitive crops and no additional treatment beyond treatment required to meet Title 22 would be required.

Major components of this alternative include:

- New wastewater treatment plant designed to meet Title 22 requirements.
- Diversion structure from the wastewater collection system.
- Infrastructure to convey solids back to the VWRF collection system.
- Recycled water pipelines, pump stations and reservoirs.

6.2.5 East Side Decentralized Treatment Plant for Agricultural and Urban Reuse

Similar to the decentralized treatment plant alternative described in Section 6.2.4, this alternative would include construction of a small wastewater treatment plant for the purpose of providing an upstream supply of recycled water at a location in the vicinity of potential reuse opportunities.

On the east side of the City, there are potential recycled water customers for urban and agricultural irrigation, and there is a potential site of the decentralized treatment plant at the Saticoy Sanitary District WWTP. In the future, it is possible that the City will annex the Saticoy Sanitary District WWTP, and would therefore provide a source of wastewater and a site for a decentralized treatment facility. In addition, wastewater from the City’s collection system would be diverted to the decentralized treatment plant.

Depending on the diversion location (from the VWRF collection system to the decentralized treatment plant), the average amount of flow available ranges from 0.3 mgd to 1.4 mgd. An additional 0.5 mgd would potentially be available form the Saticoy Sanitary District. The potential average and maximum month urban irrigation demands are approximately

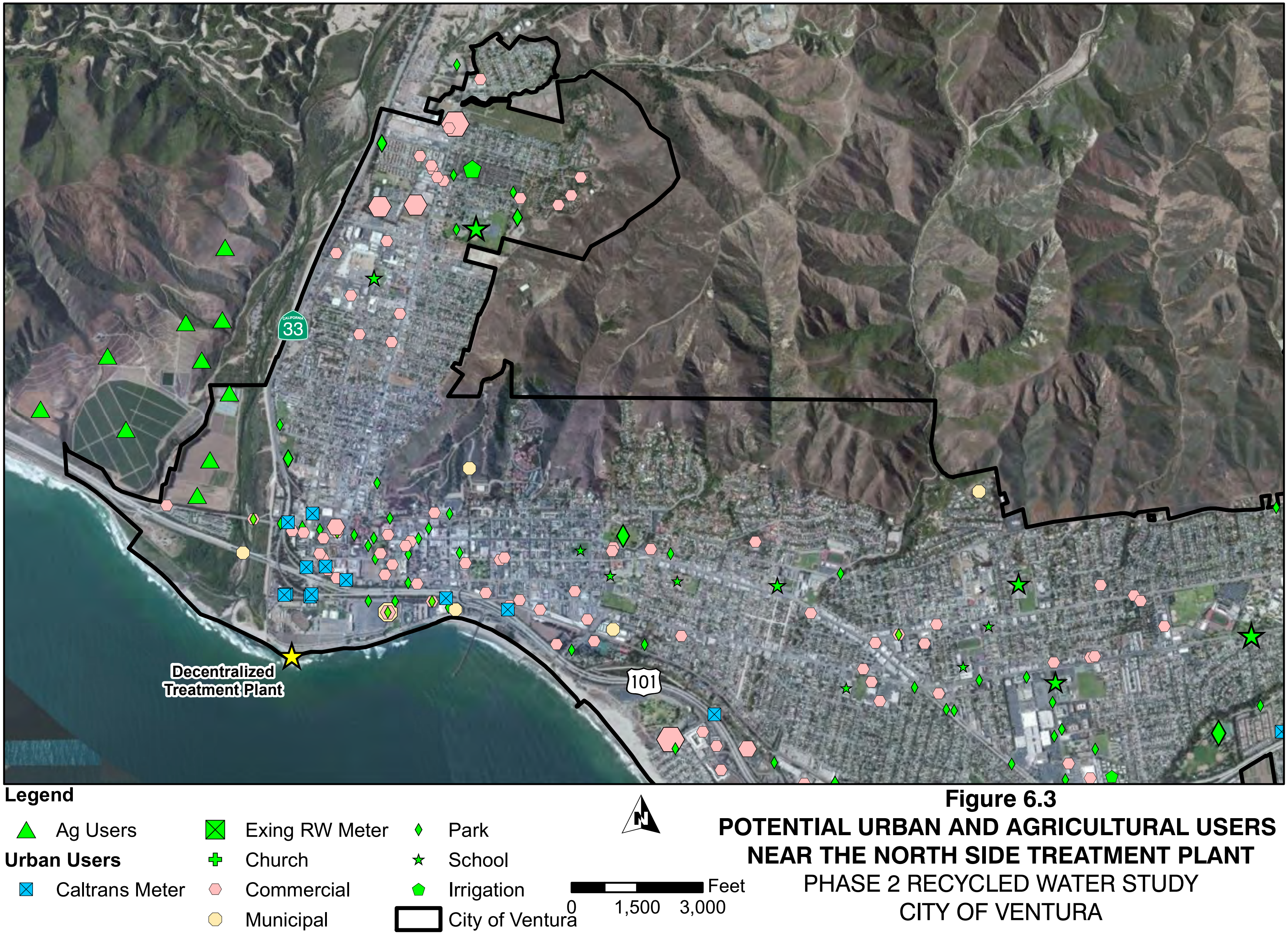

Figure 6.3

POTENTIAL URBAN AND AGRICULTURAL USERS NEAR THE NORTH SIDE TREATMENT PLANT

PHASE 2 RECYCLED WATER STUDY

CITY OF VENTURA

0.24 mgd and 0.44 mgd, respectively. The potential average and maximum month agricultural irrigation demands are approximately 2.0 mgd and 3.3 mgd, respectively. The combined agricultural and urban average and maximum month demands are 2.2 and 3.7 mgd, respectively. Figure 6.4 shows the potential location for a east side treatment plant and the customers that could be served.

Similar to the north side decentralized treatment plant alternative, the treatment plant would be designed to meet Title 22 regulations for unrestricted reuse, and sized to achieve 100 percent reuse. The solids from the treatment plant would be routed to the VWRF collection system for treatment. The acceptance of recycled water for agricultural irrigation would depend on the effluent water quality.

In July 2012, the City collected water quality data from two sites near the Saticoy Sanitary District. Measured TDS and chloride concentrations were 1095 mg/L, and 319 mg/L, respectively. These concentrations exceed crop specific requirements for agricultural irrigation. Therefore, to serve the potential agricultural users, the scalping plant would need to include RO, and brine treatment/disposal.

Major components of this alternative include:

- New wastewater treatment plant designed to meet Title 22 requirements.
- RO for TDS and chloride removal.
- Brine treatment and disposal.
- Diversion structure from the wastewater collection system.
- Infrastructure to convey solids back to the VWRF collection system.
- Recycled water pipelines, pump stations and reservoirs.

6.2.6 Direct Potable Reuse

DPR involves using recycled water directly as a water supply without an environmental buffer such as a large reservoir or the groundwater basin. There are currently no established regulations for DPR in California. However, the State has directed the Department of Public Health develop regulations for DPR by 2016. There is a significant amount of research and discussion currently underway regarding the levels of treatment and controls required to safely apply DPR. Based on these ongoing discussions and the current regulations for indirect potable reuse, it is expected that VWRF effluent would need to be treated by MF/UF, RO, and UV with advanced oxidation (UV/AOP). Between the RO and UV/AOP processes, the permeate from the RO process would be stored in a tank for a set period of time to allow monitoring to ensure quality standards are met. The use of two tanks and an equalization tank would allow a continuous supply of water. Water from the tanks would be treated by UV/AOP and then be conveyed to a location within the City's potable water distribution system.

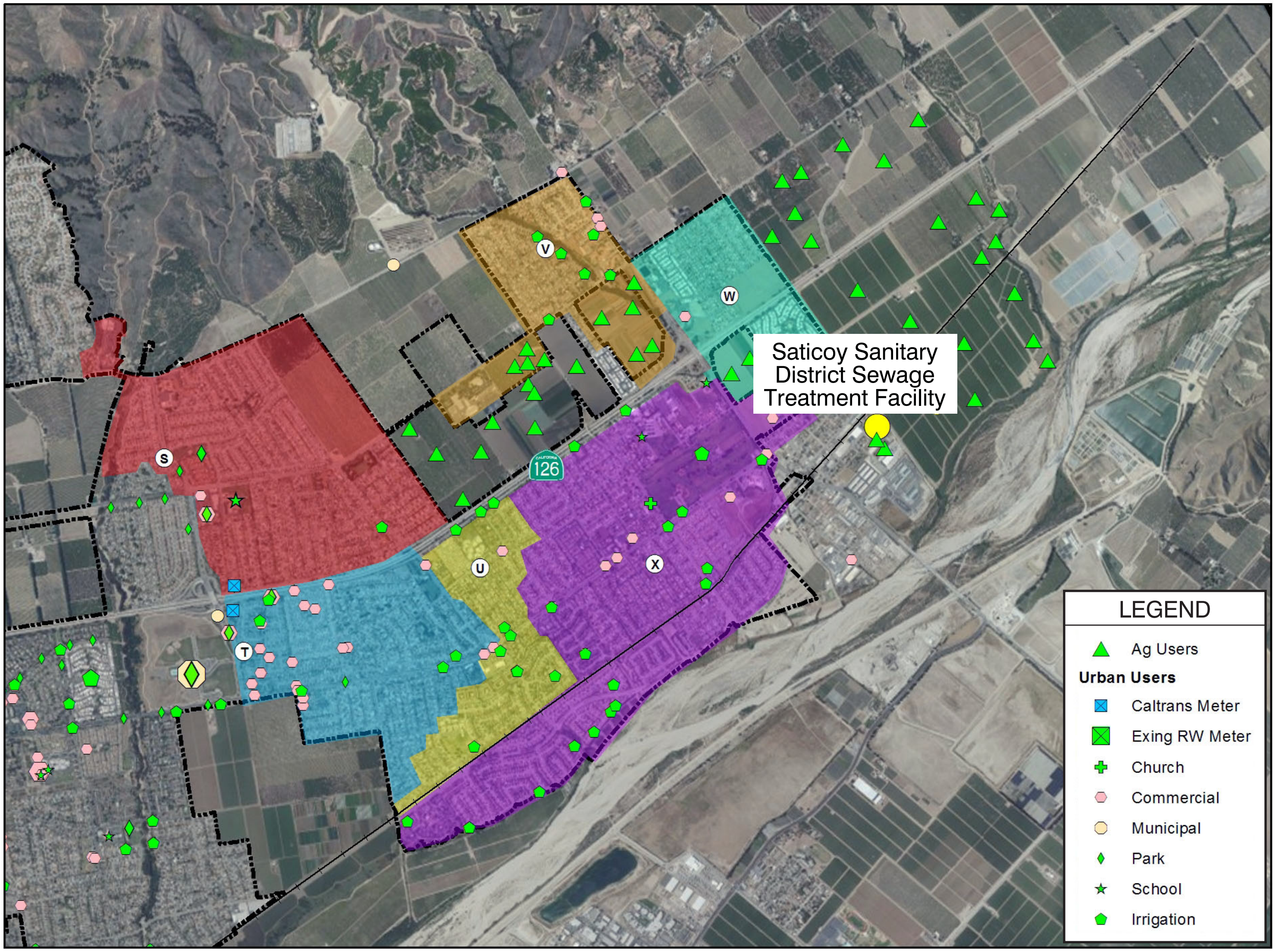

Figure 6.4
POTENTIAL URBAN AND AGRICULTURAL USERS NEAR THE EAST SIDE TREATMENT PLANT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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The City water and wastewater system provide opportunities for DPR projects. One alternative would be to provide advanced treatment at the VWRF and convey the treated water to the Bailey conditioning facility where it would be mixed in the distribution system with water treated at Bailey and water that bypasses treatment at the Bailey WTP.

Another alternative is to provide advanced treatment at a new wastewater treatment facility. Section 6.2.4 presents the concept of a north side decentralized treatment plant. DPR could be implemented in a phased approach, where initially a new decentralized treatment facility would be designed to meet Title 22 standards for unrestricted reuse. In the future, this facility could be expanded to include advanced treatment processes for DPR. In this scenario, approximately 2.6 mgd would be available for a DPR project. The treated water would be conveyed to the potable water distribution system, at the location of Casitas Turnout No. 2. Figure 6.5 shows these two alternative locations for DPR projects.

In addition to the advanced wastewater treatment processes, the brine treatment and/or disposal would be required.

Major components of this alternative include:

- Advanced wastewater treatment processes including MF/UF, RO and UV/AOP.
- Brine treatment and disposal.
- Storage basins and an equalization tank to provide adequate time for monitoring.
- If a decentralized treatment plant provides the supply then additional pretreatment, upstream of the MF/UF, would need to be constructed.
- Pipelines, reservoirs and pump stations required to convey the product water to the water distribution system.

6.2.7 Oxnard WWTP

The City of Oxnard’s Advanced Water Purification Facility (AWPF) is a part of their Groundwater Recovery Enhancement and Treatment (GREAT) program. Initial uses of the reclaimed water may include irrigation of parks, medians, golf courses and athletic fields; agricultural irrigation; and industrial process water. In addition, the recycled water may be used to provide a seawater barrier and to recharge groundwater aquifers (GREAT Program, Recycled Water Fact Sheet).

The Draft Ventura-Oxnard Recycled Water Interconnect Feasibility Study (Kennedy Jenks, 2012) investigates the feasibility of conveying VWRF effluent to the City of Oxnard's Advanced Water Purification Facility (AWPF), and, if treatment capacity is not available or if there is not enough demand, discharging the effluent to either the City of Oxnard's ocean outfall or Calleguas Municipal Water District's (Calleguas) Salinity Management Pipeline.

The proposed alternative includes conveyance of VWRF effluent to the AWPF for treatment and eventual utilization as high-quality recycled water. In the temporary event that the

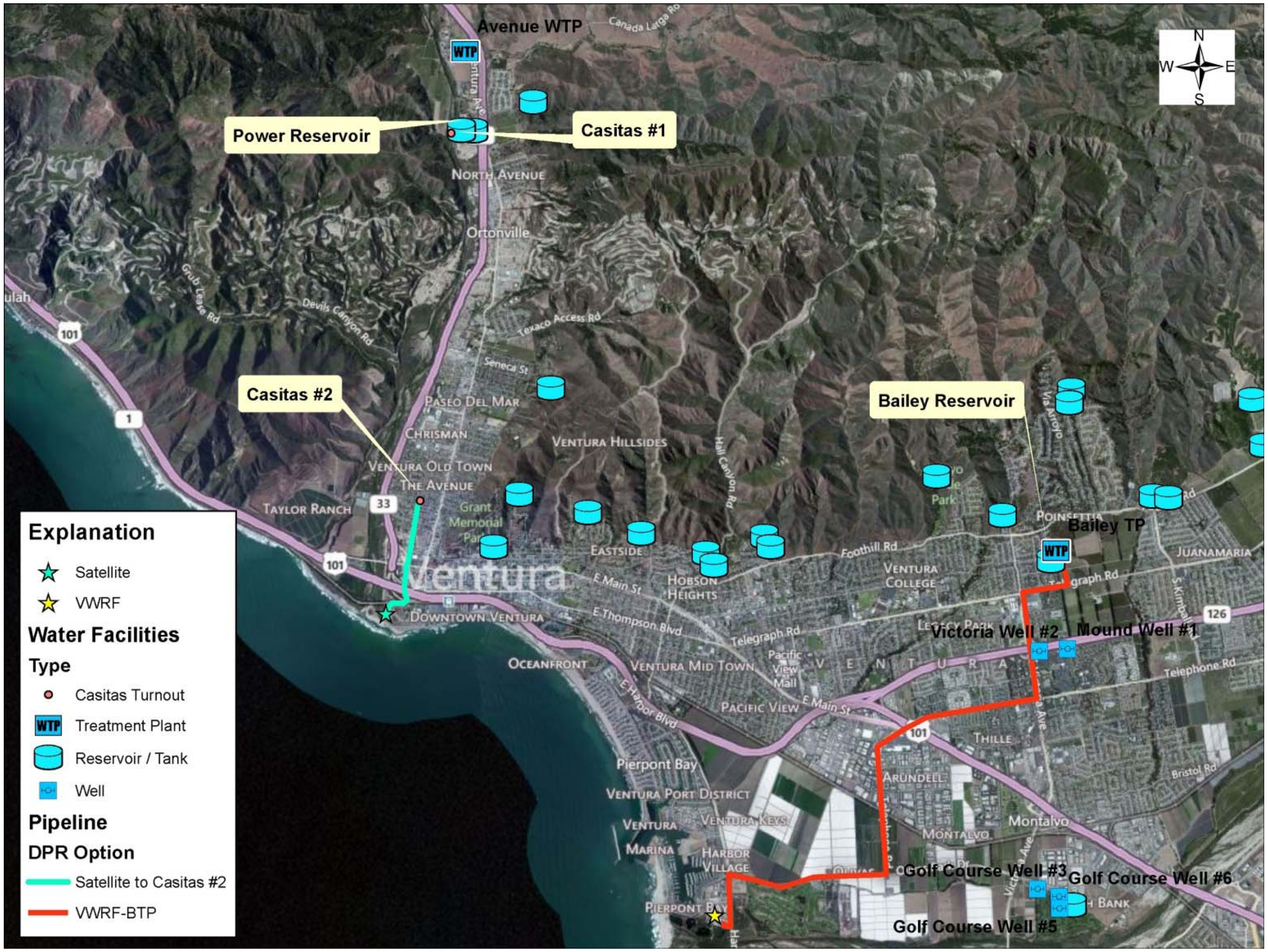

Figure 6.5
POTENTIAL LOCATIONS FOR DPR
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

AWPF could not receive the effluent, it could either be disposed of through the Salinity Management Pipeline or Oxnard's ocean outfall (Kennedy Jenks 2012). Figure 6.6 shows the potential pipe line routing for the Oxnard alternative.

Major components of this alternative include:

- Pipelines, reservoirs and pump stations required to convey VWRF effluent to Oxnard's AWPF.
- VWRF disinfection improvements.
- Expansion of the AWPF.
- Connection to the Oxnard Outfall.
- Connection to the Salinity Management Pipeline.

6.2.8 Preliminary Screening of Urban and Agricultural Alternatives

The preliminary screening analysis is summarized in Table 6.1 and in the discussion that follows. In the table, each of the alternatives is compared using the evaluation criteria discussed in Section 6.1. Where appropriate a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned to provide a relative scaling of attainment of the criteria.

The preliminary evaluation of these alternatives and the rationale for including or excluding the alternatives for more detailed development and evaluation is described below. Note that none of the alternatives improve the water quality of the final discharge to the SCRE and none of the alternatives provide habitat, therefore these criteria are not discussed.

6.2.8.1 Expand Existing Urban Reuse System

Expanding the existing urban reuse system has the following benefits/disadvantages:

- Results in a lower discharge volume, but the potential reuse demand is small (average and maximum month demands of 1.3 mgd and 1.8 mgd, respectively) and requires and extensive pipe network to convey tertiary treated water to potential customers.
- Provides a small water supply benefit through offsetting potable demands.
- No additional investment in treatment processes is required since Title 22 standards for unrestricted reuse are currently being attained.

The urban irrigation market is small and is characterized by numerous very small users dispersed throughout the City. Conveying recycled water from the VWRF to these numerous customers via an extensive pipe network is not the most efficient approach to reducing the discharge volume and offsetting potable demands. Therefore, this alternative is not selected for further evaluation as a stand alone alternative. However, urban irrigation

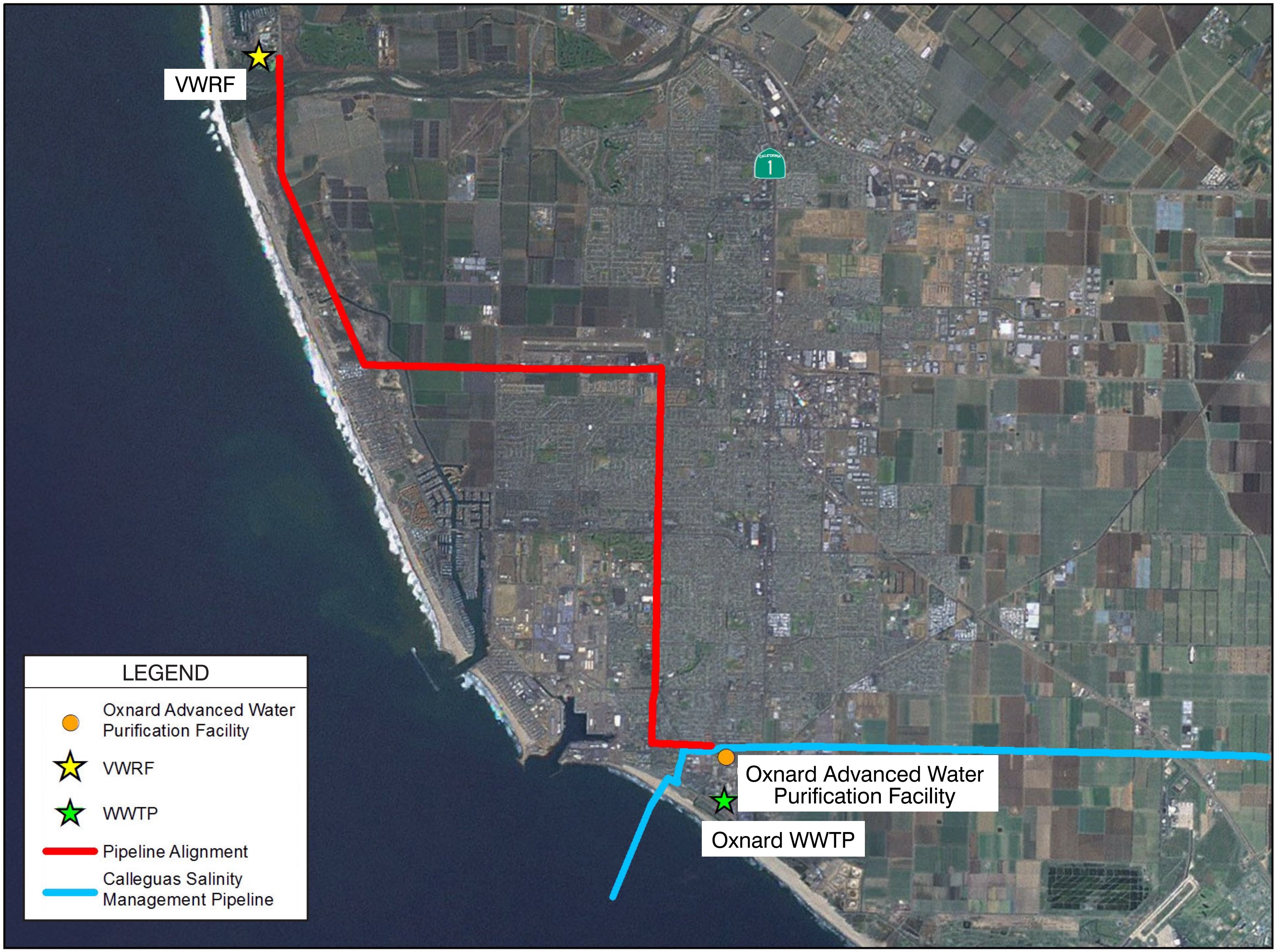

Figure 6.6
VWRF TO OXNARD AWPF PIPELINE ALIGNMENT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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Table 6.1 Preliminary Screening of Reuse Alternatives
Phase 2 Recycled Water Study
City of Ventura

Alternatives	Criteria: Lowers Discharge Volume	Improves the Quality of Final Discharge to the SCRE	Provides Habitat	Provides a Water Supply Benefit	Relies on Existing Treatment	Selected for Further Evaluation
Expand Existing Urban Reuse System	3	N	N	3	Y	Only as part of other alts
Agricultural Irrigation without Blending	1	N	N	3	N	Only as part of other alts
Agricultural Irrigation with Blending	3	N	N	3	Y	N
North Side Decentralized Treatment Plant	3	N	N	3	N	Y
East Side Decentralized Treatment Plant	3	N	N	3	N	N
Direct Potable Reuse	1	N	N	1	N	Y
Reuse at Oxnard WWTP	1	N	N	N	Y	Y

Note:
Where appropriate a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned in lieu of a Y to provide a relative scaling of attainment of the criteria.

can be combined with many other alternatives, especially given that the VWRF effluent quality currently meets Title 22 standards. For example, if VWRF effluent is being conveyed past potential users on the way to an end point defined by other alternatives, then connection to the users on the way should be considered. The urban irrigation market analysis in Phase 1 and the additional information provided in this report provide sufficient information for evaluating the potential benefits of combining urban irrigation with other alternatives.

In addition, it is important to note that the City is committed to expanding its existing urban reuse system. As opportunities arise, the City will implement recycled water projects in the Recycled Water Focus Area and elsewhere in the City.

6.2.8.2 Agricultural Irrigation without Blending

Agricultural irrigation without blending has the following benefits/disadvantages:

- Results in a relatively large reduction in discharge volume through diverting water for agricultural irrigation in an area that is relatively close to the VWRF.
- Provides a water supply benefit in reducing groundwater withdrawals from the Mound Basin, which is used for the City's potable supply.
- The existing treatment processes do not produce water quality that meets crop specific requirements and therefore blending with groundwater would be required in lieu of treatment, groundwater some fraction of the flow diverted for irrigation would need to be routed through MF/UF and RO. Brine treatment and disposal would also be required.

The relatively large, and close proximity, of the agricultural irrigation market provides an opportunity for a significant reduction in discharge volume. This potential benefit is offset by the need for MF/UF, RO, and brine treatment/disposal. If advanced treatment processes were implemented, the resulting water quality would be similar to the quality required for many types of end uses, including uses such as groundwater recharge and augmentation of potable water supplies. In comparison to other end uses that require similar advanced treatment processes and brine treatment/disposal, agricultural irrigation offers less of a direct benefit on the City's water supply. For these reasons, agricultural irrigation is not is not selected for further evaluation as a stand alone alternative. However, agricultural irrigation could be implemented in combination with other alternatives that require MF/UF and RO. In this scenario, agricultural irrigation could provide a means of further reducing the VWRF discharge to the SCRE especially in the summer months when there are increased agricultural demands.

6.2.8.3 Agricultural Irrigation with Blending

Agricultural irrigation with blending has the following benefits/disadvantages:

- Results in a relatively low reduction in discharge volume (average and maximum month demands of 0.4 mgd and 0.7 mgd, respectively) through diverting water for agricultural irrigation in an area that is relatively close to the VWRF.
- Provides a water supply benefit in reducing groundwater withdrawals from the Mound Basin, which is used for the City's potable supply.
- The existing treatment processes do not produce water quality that meets crop specific requirements, and to avoid the need for advanced treatment, the VWRF effluent would be blended with groundwater.

The close proximity of the agricultural irrigation market provides an opportunity for reducing the discharge volume without extensive conveyance and pumping. However, to meet crop specific criteria, approximately 85 percent of the total flow would be groundwater, which limits the amount of VWRF effluent that would be diverted for agricultural irrigation. In addition, a criterion for the acceptance of recycled water by growers in the region is that any alternative water supply must be provided through a simple, low maintenance system that does not require additional effort by the growers. Growers would not be willing to do onsite blending of the VWRF effluent and extracted groundwater. Therefore, the City would need to take on the responsibility of blending, which is complicated by the need for a supply of blending water with low TDS and chloride. This alternative is not considered for further evaluation based on the low demand for VWRF effluent (15 percent of the total demand) and the complications with providing a blended water supply to growers.

6.2.8.4 North Side Decentralized Treatment Plant

- The north side decentralized treatment plant has the following benefits/disadvantages: Results in relatively low reduction in discharge to the SCRE. The combined agricultural and urban average and maximum month demands are 1.3 and 2.0 mgd, respectively.
- Provides a small water supply benefit through offsetting potable demands for the urban irrigation customers.
- The use of recycled water for agricultural irrigation provides a water supply benefit in the sense the groundwater extractions from the Ventura Basin would be reduced.
- Does not rely on the existing VWRF and requires construction of a new tertiary treatment plant located near the Seaside Pump Station.

While the supply and potential demand is relatively small, there are some advantages to this alternative, including the availability of City owned property at the Seaside Pump Station for new treatment facilities, the low chloride and TDS concentrations in the wastewater, and the similarity between the available supply of recycled water and the demand in the vicinity of the Seaside Pump Station. Therefore, this alternative is selected for further evaluation.

6.2.8.5 East Side Decentralized Treatment Plant

The east side decentralized treatment plant has the following benefits/disadvantages:

- Results in a moderate reduction discharge volume. The combined agricultural and urban average and maximum month demands are 2.2 and 3.7 mgd, respectively.
- Provides a small water supply benefit through offsetting potable demands for the urban irrigation customers.
- The use of recycled water for agricultural irrigation provides a water supply benefit in the sense the groundwater extractions would be reduced.
- Does not rely on the existing VWRF and requires construction of a new tertiary treatment plant, with the most feasible site being the Saticoy Sanitary District. If the

recycled water is to be use for agricultural irrigation then RO, and brine treatment and disposal is required.

There is potential for a moderate reduction in discharge volume, however, the majority of the potential demand is agricultural irrigation that would require advanced treatment to remove TDS and chloride. The location of this scalping plant limits the brine treatment and disposal options to evaporation ponds or physical/chemical treatment processes, which are the most land intensive and costly brine treatment/disposal alternatives. It is possible that if advanced treatment were considered for this scalping plant then the recycled water could be used for groundwater recharge. However, regardless of the recycled water use, any alternative that required brine treatment/disposal is going to be limited by the land based or physical /chemical brine treatment /disposal alternatives at this location. For these reasons, this alternative was not selected for further evaluation.

6.2.8.6 Direct Potable Reuse

Direct potable reuse has the following benefits/disadvantages:

- Has the potential to result in a relatively large reduction in the discharge volume to the SCRE.
- Provides a water supply benefit.
- Does not rely solely on the VWRF treatment processes and would require advanced treatment facilities at either the VWRF or a decentralized treatment plant near the Seaside Pump Station, consisting of UF/MF, RO, and UV/AOP. Brine treatment and/or disposal would be required.

This alternative has the potential to result in a large reduction in the discharge volume to the SCRE and provide a direct water supply benefit to the City. While there are challenges with this alternative including brine treatment and/or disposal, regulatory uncertainty and public perception, these challenges are offset by the potential reduction in discharge volume and benefit to the City's water supply. Therefore, this alternative is selected for further evaluation.

6.2.8.7 Reuse at the Oxnard WWTP/AWPF

- Reuse at the Oxnard WWTP has the following benefits/disadvantages: Has the potential to result in a in a relatively large reduction in the discharge volume to the SCRE (can take all of the effluent)
- Provides a regional water supply benefit by offsetting the use of other sources in the Oxnard Plain, but does not provide a water supply benefit to the City.
- Relies on the existing VWRF, and has the potential to eliminate tertiary treatment for a portion of the VWRF flow.

While this alternative does not provide a direct benefit to City's water supply system, is does present the opportunity for a relatively large reduction in the discharge to the SCRE without the need for new advanced treatment processes. For these reasons, this alternative is selected for further evaluation.

6.3 GROUNDWATER RECHARGE

This category of alternatives includes several approaches to reduce the discharge volume through various options for groundwater recharge, including:

- Recharge the Mound Basin.
- Recharge the Oxnard Plain Basin.
- Recharge the Oxnard Forebay.
- Recharge at the UWCD Facilities.
- Recharge at the UWCD Facilities with Oxnard Plain Blending Water.

Figure 6.7 shows the location of the groundwater basins the City's water supply wells, water treatment facilities, and United Water Conservation District facilities in the region.

For all groundwater recharge alternatives, reclaimed water from the VWRF would be used to recharge a groundwater basin for the purpose of augmenting the potable groundwater supply, i.e., indirect potable reuse (IPR). As discussed in Chapter 4, the California Department of Public Health has released Draft Groundwater Reuse Regulations governing recharge projects, including requirements for treatment. The draft regulations also provide for two major types of groundwater recharge: subsurface injection and surface spreading. For subsurface injection, full advanced treatment (FAT) is required and consists of RO and advanced oxidation. The brine from the RO process requires treatment and/or disposal. Figure 6.8 shows the required treatment train for subsurface injection.

In this study area, the Oxnard Forebay is the only basin that does not have a confining clay layer where that surface spreading could be possible. The other basins would require subsurface injection. Surface spreading can be accomplished with tertiary treated water and does not require advanced treatment, provided the effluent meets quality requirements.

6.3.1 Recharge the Mound Basin

There are potential opportunities to use the VWRF effluent to augment the City's water supply. The Mound Basin is one of the water sources that the City relies on for potable supply. The City owns and operates groundwater wells in the Mound Basin and the Bailey Conditioning facility. Water extracted from the Mound Basin is treated for iron and manganese, and then blended with water extracted from City's wells located in the Oxnard Plain Basin.

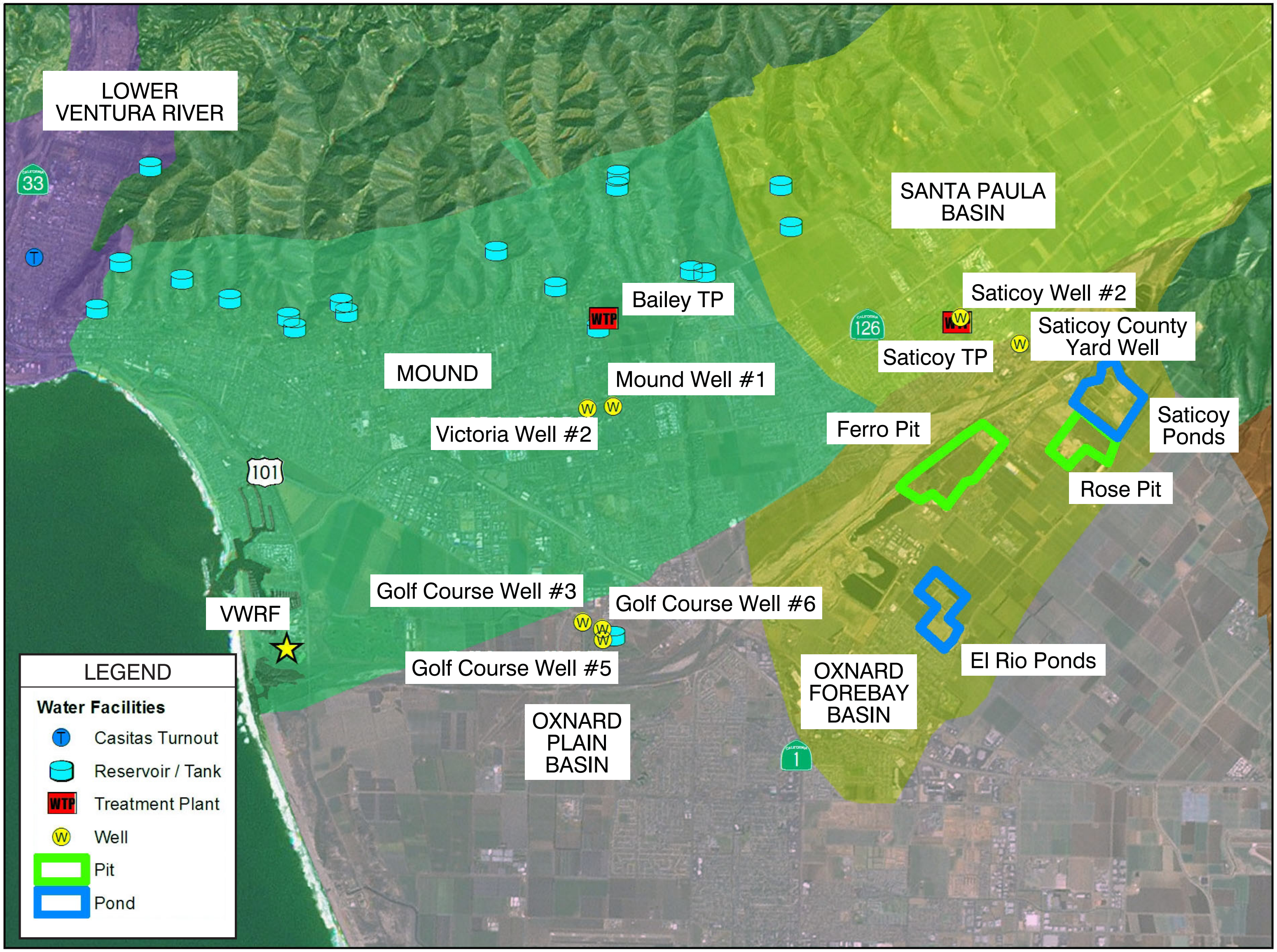

Figure 6.7
VENTURA WATER AND UWCD FACILITIES
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

ven113f14-8144.ai

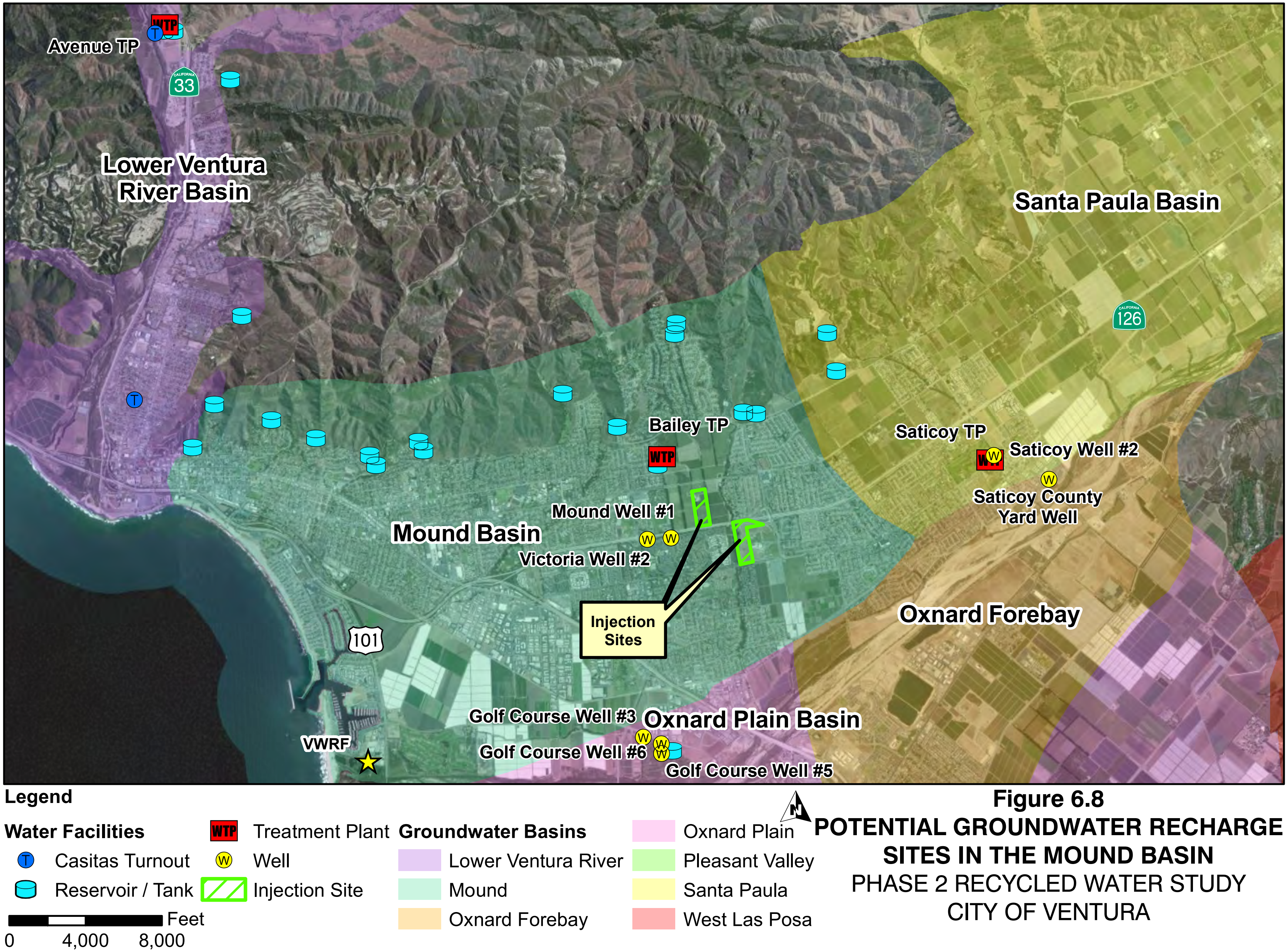

Figure 6.8
POTENTIAL GROUNDWATER RECHARGE SITES IN THE MOUND BASIN
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

In this alternative, reclaimed water from the VWRF would be used to recharge the Mound Groundwater Basin for the purpose of augmenting the potable groundwater supply, i.e. indirect potable reuse (IPR). The confining clay layers in the Upper Aquifer System of the Mound Basin limit the feasibility of surface ponds/spreading and recharge via percolation. The only option for groundwater recharge is subsurface injection and full advanced treatment (FAT) is required and consists of RO and advanced oxidation. The brine from the RO process requires treatment and/or disposal.

There are a couple of factors that contribute to assessing the capacity (or demand) for IPR. Ideally, all of the reclaimed water that is injected should be used, as opposed to allowing this water to migrate across the basin and eventually discharge to the ocean. Therefore, it would be prudent to limit the injection of recycled water to match demands. Average extraction from the Mound basin over the last 10 years by the City is approximately 3.6 mgd (4000 AFY) (RBF, 2011). An alternative approach would be to provide enough recycled water to match the extractions of the entire Mound Basin. Current extractions of the Mound Basin (including the City's extraction volume and agricultural pumper) are approximately 6.3 mgd (7000 AFY) (Personal communication with Curtis Hopkins, 2012).

There are a number of key issues in assessing feasibility of a 3.6 mgd or 6.3 mgd IPR project, including:

- Adequate travel time - The Draft Groundwater Recharge Reuse Regulation requires a two month minimum retention time between injection and any potable water supply well.
- Extraction well capacity – The current and future operational capacities of the existing extraction wells are 4.4 mgd and 7.2 mgd, respectively (reference).
- Land availability – Availability of land for construction of injection wells and extraction wells (if new wells are needed).

A preliminary planning level analysis was conducted to assess the feasibility of an IPR project in the Mound Basin (Hopkins, 2012). The study suggested that recycled water, at both flows) could be injected in a location northeast of the City's existing wells in the Mound Basin (Victoria Well #2), and that there would be greater than 2 months travel time. Figure 6.8 shows the potential locations evaluated for a groundwater recharge project in the Mound basin.

Major components of this alternative include:

- Microfiltration, RO and advanced oxidation treatment facilities.
- Brine treatment/disposal facilities.
- Recycled water pipelines and pump stations to convey recycled water from the VWRF to the groundwater injection wells.
- Groundwater injection wells.

6.3.2 Recharge the Oxnard Plain Basin

There are potential opportunities to use the VWRF effluent to augment the City's water supply. The Oxnard Plain Basin is one of the water sources that the City relies on for potable supply.

The City owns and operates groundwater wells (the Golf Course Wells) in the Oxnard Plain Basin. Water extracted from the Oxnard Plain Basin is blended with water, post-treatment, from the Bailey Conditioning Facility. The reclaimed wastewater would be injected at new injection wells, and be extracted at the Golf Course Wells or at other wells that would be constructed for this purpose.

The key issues associated with feasibility discussed for the Mound Basin apply to the feasibility of an IPR projects in the Oxnard Plain. One additional issue in the Oxnard Plain is that this groundwater basin falls under the management of the Fox Canyon Groundwater Management Agency (FCGMA) The FCGMA has responsibility for groundwater management planning, managing pumping allocations and credits, and developing policies related to groundwater extractions and recharge (FCGMA, 2007).

The City is limited by the Fox Canyon GMA allocation of 4104 AFY (3.7 mgd) (RBF 2011). However, it is possible that this could change as a result of IPR since additional water would be recharging the basin. The operational capacity of the existing Golf Course Wells is currently at 6.0 mgd but with a planned increase to 8.9 mgd.

Major components of this alternative include:

- Microfiltration, RO and advanced oxidation treatment facilities.
- Brine treatment/disposal facilities.
- Recycled water pipelines and pump stations to convey recycled water from the VWRF to the groundwater injection wells.
- Groundwater injection wells.
- Possibly new groundwater extraction wells.
- Coordination and approval from the FCGMA.

6.3.3 Recharge the Oxnard Forebay

Recharge of the Oxnard Forebay Subbasin is a potential opportunity to use reclaimed water from the VWRF to augment the City's water supplies. The Oxnard Forebay is recognized as the primary recharge area for aquifers in the Oxnard Plain (UWCD 2012a). The confining layers present in other aquifers are either absent or discontinuous in the Oxnard Forebay, and therefore recharge to downgradient aquifers occurs (UWCD 2012a). UWCD (2012b) report that the Mound Basin receives recharge from both the Oxnard Forebay and Oxnard

Plain. However, other scientists believe that this is not the case and differences of opinion have yet to be resolved.

In this alternative, VWRF effluent would be conveyed to new groundwater recharge facilities in the Oxnard Forebay. Because of the absence/discontinuities of confining layers in the Oxnard Forebay, surface recharge would be feasible. The Draft Groundwater Reuse Regulation includes requirements for surface recharge of reclaimed water. For surface application, FAT is not required, and this alternative could be implemented without the need for RO and AOP.

However, there are water quality requirements in the Draft Groundwater Reuse Regulation and the Basin Plan that apply to an IPR project in the Oxnard Forebay. The water quality objectives for the Oxnard Forebay include TDS and chloride concentrations of 1200 mg/L and 150 mg/L, respectively. In addition, there is a requirement that the initial recycled water contribution is less than 20 percent and that with demonstration of attainment of other requirements this could be increased to a maximum of 75 percent. Diluent water would be required for the purposes of meeting groundwater quality objectives and meeting the recycled water contribution limitations.

The Santa Clara River (SCR) and groundwater are potential sources of diluent water. Water rights to a surface water diversion or groundwater extractions would need to be obtained. In addition, the quality of the diluent water impacts the amount of recycled water that could be recharged. For example, based on an analysis of SCR water quality, the blend water fraction would need to be a minimum of approximately 40 percent SCR water to meet the chloride limitation of 150 mg/L in the Basin Plan. Under this scenario, where the SCR water is used as the diluent water, the VWRF effluent chloride concentrations would need to be reduced through RO to increase the recycled water contribution beyond 60 percent.

Similar to injection of reclaimed water, the Draft Groundwater Reuse Regulation requires that there is a minimum 2-month travel time between the site of surface recharge and any potable water supplies. Groundwater travel time from potential recharge sites in the Oxnard Forebay to potable supply wells would need to be determined to assess feasibility of this alternative. If the City wanted to extract the recharged groundwater for use, then new extraction facilities would need to be sited and constructed.

For this alternative, the capacity for recycled water depends on the availability of land for siting recharge facilities, the ability to site recharge facilities in a location where travel time to potable wells is at a minimum of 2 months, the availability of diluent water, and the quality of the diluent water to provide dilution of chloride in the VWRF effluent.

Major components of this alternative include:

- Construction of new groundwater recharge facilities (surface ponds, spreading basins, recharge pits).
- Land acquisition for the surface recharge facilities.

- A source of diluent water and facilities to extract/divert water for use.
- Recycled water pipelines and pump stations to convey recycled water from the VWRF to the groundwater recharge facilities.

6.3.4 Recharge the Oxnard Forebay using UWCD Facilities

UWCD owns and operates groundwater recharge facilities located on the south side of the Santa Clara River. The Phase 1 Report includes discussion of the potential opportunity to route reclaimed water from the VWRF to the UWCD facilities for groundwater recharge. The objective of this alternative is to take advantage of the existing facilities at UWCD, and their potential interest in augmenting their supply of recharge water through accepting VWRF effluent.

In this alternative, VWRF effluent would be conveyed to UWCD recharge facilities. Based on discussion with UWCD staff, the most likely location for recharge of VWRF effluent would be the Saticoy Spreading Grounds or the Noble Basins. In this scenario, UWCD would be introducing recycled water into their surface spreading operations, and would be required to meet the requirements of the Draft Groundwater Reuse Regulation.

As discussed previously, the Draft Groundwater Reuse Regulation requires that the initial recycled water contribution is less than 20 percent and that with demonstration of attainment of other requirements this could be increased to a maximum of 75 percent. UWCD extracts SCR water for recharge of their groundwater basins and for direct conveyance (via pipeline) to growers. Agricultural demands peak in the summer months, and during this time period, the first priority for diverted SCR water is to meet these agricultural demands. This alternative would rely on the SCR water extracted/recharged by UWCD as the source of diluent water for recharge of recycled water. UWCD diversion/recharge of SCR water depends on hydrologic conditions and agricultural demands.

UWCD does not want to introduce water quality issues as a result of recharging reclaimed water from the VWRF (personal communication with UWCD, 2012). Groundwater downgradient of UWCD facilities is used for potable supply and agricultural irrigation. The Upper Santa Clara River Chloride TMDL, established a maximum chloride concentration of 117 mg/L to be protective of agricultural beneficial uses (irrigation of salt sensitive crops) (LARWQCB Final Basin Plan Amendment (TMDL), 2008). UWCD has indicated that water (combination of recycled water and surface water) recharged in their spreading basins should not exceed a chloride concentration of 117 mg/L (note that this is lower than the Basin Plan Objective of 150 mg/L chloride).

The amount and quality of SCR water that UWCD uses for recharge impacts the amount of VWRF effluent that could be recharged as the SCR river water is needed to meet the recycled water contribution percentage and to achieve the target chloride concentration of 117 mg/L. While the initial concept of this alternative was to use VWRF tertiary effluent for groundwater recharge (without additional advanced treatment), the current operations of UWCD combined with the chloride water quality target, led to the development of several sub-alternatives, including:

- Partial RO of VWRF effluent to increase the amount of effluent that could be recharged year round at UWCD.
- Conveying VWRF effluent to UWCD for blending with SCR water and conveyance to growers, in the summer months. Recharge of VWRF effluent blended with the SCR water diverted by UWCD in the winter months.
- Partial RO of the VWRF effluent to increase the amount of VWRF effluent that could be used for agricultural irrigation in the summer, combined with groundwater recharge in the winter.

Under the Draft Groundwater Reuse Regulation, a recharge project using the UWCD facilities would need to meet the minimum 2 month travel time between recharge sites and potable water supply wells. Groundwater travel time from the Saticoy Spreading Grounds or the Noble Basins to potable supply wells would need to be determined to assess feasibility of this alternative.

Major components of this alternative/sub-alternatives include:

- Recycled water pipelines and pump stations to convey recycled water from the VWRF to UWCD's facilities.
- Possible advanced treatment processes, UF/MF and RO, to increase the amount of VWRF effluent that could be used by UWCD for recharge or agricultural irrigation.
- Brine treatment/disposal would be required if RO was implemented.

6.3.5 Recharge the Oxnard Forebay using UWCD Facilities with Blending Water from the Oxnard Plain

Similar to the alternative describe previously, this alternative would involve groundwater recharge using the UWCD facilities. However, in this case, water extracted from the Oxnard Plain would be used for diluent water. UWCD has suggested that there is groundwater in the Oxnard Plain that migrates to the Ocean and this alternative is designed to take advantage of that groundwater and use it as diluent water to meet the recycled water contribution requirements and water quality targets.

The feasibility of this alternative depends on the quantity and quality of groundwater available for extraction and use as diluent water. Chloride concentrations in the Oxnard Plain are low, with concentrations generally less than 60 mg/L. To meet a target of 117 mg/L with the blend of VWRF effluent and diluent water, the required diluent water fraction is approximately 55 percent. The quantity of water available for extraction and use as diluent water depends on hydrogeologic conditions in the area.

Similar to the UWCD alternatives presented in Section 6.1.2.4, this alternative would need to comply with the minimum 2 month travel time required by the Draft Groundwater Reuse Regulation.

Major components of this alternative include:

- Recycled water pipelines and pump stations to convey recycled water from the VWRF to UWCD's facilities.
- Extraction wells, pipelines and pump stations to convey Oxnard Plain Groundwater to the UWCD facilities.

6.3.6 Preliminary Screening of Groundwater Recharge Alternatives

The preliminary screening analysis is summarized in Table 6.2 and in the discussion that follows. Where appropriate, a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned to provide a relative scaling of attainment of the criteria.

Table 6.2 Preliminary Screening of Groundwater Recharge Alternatives
Phase 2 Recycled Water Study
City of Ventura

	Criteria					
Alternatives	**Lowers Discharge Volume**	**Improves the Quality of Final Discharge to the SCRE**	**Provides Habitat**	**Provides a Water Supply Benefit**	**Relies on Existing Treatment**	**Selected for Further Evaluation**
Recharge the Mound Basin	1	N	N	1	N	Y
Recharge the Oxnard Plain Basin	1	N	N	2	N	N
Recharge the Oxnard Forebay	2	N	N	2	N	N
Recharge/Irrigation at the UWCD Facilities	1	N	N	-	N	Y
Recharge at the UWCD Facilities with Oxnard Plain Blending Water	1	N	N	-	Y	N

Notes:
Where appropriate a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned in lieu of a Y to provide a relative scaling of attainment of the criteria.
The "-" indicates that it is not known at this time, whether the alternative would meet the criterion, and an explanation is provided in the discussion.

The preliminary evaluation of these alternatives and the rationale for including or excluding the alternatives for more detailed development and evaluation is described below. Note that none of the alternatives improve the water quality of the final discharge to the SCRE and none of the alternatives provide habitat, therefore these criteria are not discussed.

6.3.6.1 Recharge the Mound Basin

Recharging the Mound Basin has the following benefits/disadvantages:

- Potential for a moderate to large reduction in the VWRF discharge volume to the SCRE.
- Provides a potentially significant water supply benefit through augmenting one of the City's existing groundwater supplies. In addition, recharging the Mound Basin may also lead to improving the quality of the groundwater extracted for potable supply.
- Does not rely exclusively on the existing VWRF treatment processes and requires advanced treatment, including MF.RO, UV/AOP, and brine treatment/disposal to meet the Draft Groundwater Reuse Regulation.

The potential for a relatively large reduction of the VWRF discharge volume and the potential direct benefits to the City's potable source waters (quality and supply of groundwater), are significant advantages of this alternative. Therefore, this alternative is considered for further evaluation.

6.3.6.2 Recharge the Oxnard Plain Basin

Recharging the Oxnard Plain Basin has the following benefits/disadvantages:

- Potential for a relatively large reduction in the VWRF discharge volume to the SCRE.
- Potentially provides a water supply benefit through recharge to the Oxnard Plain, which is a source of groundwater for the City. However, the amount of groundwater credits that the City would receive as a result of an IPR project in the Oxnard Plain would require coordination and approval from the FCGMA.
- Does not rely exclusively on the existing VWRF treatment processes and requires advanced treatment, including MF.RO, UV/AOP, and brine treatment/disposal to meet the Draft Groundwater Reuse Regulation.

This alternative is similar to recharge of the Mound Basin, with respect to the potential for a relatively large reduction in the VWRF discharge, and the need for advanced treatment, including brine treatment/disposal. However, compared to the alternative for recharging the Mound Basin, the potential for water supply benefit may be less, as groundwater credits resulting from an IPR project in the Oxnard Plain would fall under the jurisdiction of the FCGMA. In addition, this alternative requires siting new injection and possibly new extraction wells. There is less City owned land in the Oxnard Plain than in the Mound Basin, potential making the siting of injection/extraction facilities more complicated. For these reasons, implementing an IPR project in the Oxnard Plain Basin will likely be more challenging than in the Mound Basin, and therefore this alternative is not selected for further evaluation.

6.3.6.3 Recharge the Oxnard Forebay

Recharging the Oxnard Forebay has the following benefits/disadvantages:

- Potential for a moderate reduction in the VWRF discharge volume to the SCRE since this alternative would require diluent water to meet the recycled water contribution limits in the Draft Groundwater Recharge Regulation and to meet the water quality objective of 150 mg/L chlorine in the Basin Plan.
- Potentially provides a water supply benefit through recharge to the Oxnard Forebay, which is a source of groundwater to surrounding basins. However, the FCGMA would allocate groundwater credits to the City.
- Potentially relies on existing VWRF processes to produce water for groundwater recharge via surface spreading provide that there is sufficient diluent water available.

There is potential for a moderate reduction of the VWRF discharge volume and potential for some water supply benefit through recharge a groundwater source in the region. To meet basin plan objectives, this system would be recharging a maximum of 60 percent VWRF effluent, unless advanced treatment (UF/MF/ and RO) was implemented. However, there are a number of complicating factors with this alternative, including, it requires construction of new recharge facilities, there is limited land available for recharge facilities in the Oxnard Forebay, the amount of recharge that could be implemented would depend on the availability of diluent water from the SCR, and the feasibility of using the SCR for diluent water is limited, as the City does not currently have any water rights for the SCR. For these reasons, this alternative is not considered for further evaluation.

6.3.6.4 Recharge at UWCD Facilities

Recharging at UWCD Facilities has the following benefits/disadvantages:

- Potential for a relatively large reduction in the VWRF discharge volume to the SCRE. The flow that could be diverted to UWCD depends on the amount of flow that undergoes advanced treatment and/or the amount of diluent or blending water from SCR.
- Potentially provides a water supply benefit through agreement/coordination with FCGMA and UWCD.
- Does not rely exclusively on the existing VWRF, and requires advanced treatment, including MF.RO, and brine treatment/disposal.

There is potential for a relatively large reduction of the VWRF discharge volume by taking advantage of UWCD's existing recharge facilities and agricultural water supply distribution system. While preliminary analysis suggests that there is limited opportunity for recharge or agricultural irrigation without partial advanced treatment, there is opportunity for a moderate to large reduction in discharge volume with partial advanced treatment. Additional investigation into the possibility of groundwater credits from the FCGMA and possible other water supply benefits through agreement with UWCD is needed to determine if there is a potential City water supply benefit associated with this alternative. The ability to take advantage of existing recharge and distribution facilities and the potential for a moderate to large reduction in discharge volume with only partial advanced treatment, are benefits of this alternative. For these reasons, this alternative is considered for further evaluation.

6.3.6.5 Recharge at UWCD Facilities with Oxnard Plain Blending Water

Recharging at UWCD Facilities with Oxnard Plain Blending Water has the following benefits/disadvantages:

- Potential for a moderate reduction in the VWRF discharge volume to the SCRE depending on the availability of diluent water from the Oxnard Plain.
- Potentially provides a water supply benefit through agreement/coordination with FCGMA and UWCD.
- Relies on the existing VWRF treatment processes.

There is potential for a moderate reduction of the VWRF discharge volume, but the amount of recharge depends on the availability of diluent water to meet the 117 mg/L chloride target. Based on groundwater quality of the Oxnard Plain, the required diluent water fraction is at a minimum of 55 percent. This large fraction of diluent water means that piping and pumping facilities would need to be very large from the VWRF all the way to the UWCD facilities to carry both the effluent and the diluent water. A significant unknown with this alternative is the amount of groundwater in the Oxnard Plain that would be available for extraction and use as diluent water. UWCD has started to develop a more refined groundwater model that will provide a better to for predicting groundwater elevations and transport in the Oxnard Plain and other basins. At present time, since the availability of diluent water is still a major unknown, this alternative is not considered for further evaluation. However, the City should track the development of this model and upon completion should revisit this question of the availability of diluent water in the Oxnard Plain.

6.4 TREATMENT WETLANDS ALTERNATIVES

The treatment wetlands alternatives include several options for further polishing treatment of the VWRF effluent. In addition, there are a number of other reuse and recharge alternatives that may require RO and therefore will require brine treatment. The potential use of wetlands for brine treatment is included in this grouping of alternatives. The wetlands alternatives include:

- Wetlands at wildlife ponds.
- Wetlands on City-owned property.
- Wetlands on TNC property.
- Wetland on uplands.
- Wetlands combined with perched recharge located East of 101.
- Wetlands combined with perched recharge located West of 101.
- Brine Wetlands.

With the exception of the brine wetlands, the primary objective of the treatment wetlands is to further reduce nitrate concentrations in the VWRF effluent. In general, the greater the wetland area, the greater the amount of flow can be routed to the treatment wetland, while maintaining the residence time required to achieve the targeted effluent nitrate concentration. An overview of the areas considered for wetlands is shown in Figure 6.9.

6.4.1 Wetlands at Wildlife Ponds

The Phase 1 Report includes discussion modifying the existing Wildlife Ponds to function as treatment wetlands. Two of the existing ponds, Pond 1 (Bone) and Pond 2 (Snoopy), would be filled to create a depth less than three feet, and vegetated benches would be constructed. The Phase 1 Report indicates that approximately 12.4 acres of treatment wetlands could be created by modifying Ponds 1 and 2. The existing interties between the ponds would be preserved as would the existing discharge channel that conveys flow into the Santa Clara River Estuary.

The amount of additional nitrate removal that could be achieved in the 12.4 acres of treatment wetland area would depend on the amount of flow that would be routed to the treatment wetlands. Assuming a total inorganic nitrogen concentration of 8 mg/L as N, and a flow into the wetland of 3 mgd, the resulting effluent nitrate concentrations would range from 2 to 6 mg/L as N.

The major components of this alternative include:

- Approximately 12.4 acres of treatment wetlands (replacing existing Wildlife Ponds 1 and 2).
- Existing interties between wetland cells.
- Existing discharge channel into the SCRE.

Figure 6.10 shows the potential modifications of the Wildlife Ponds.

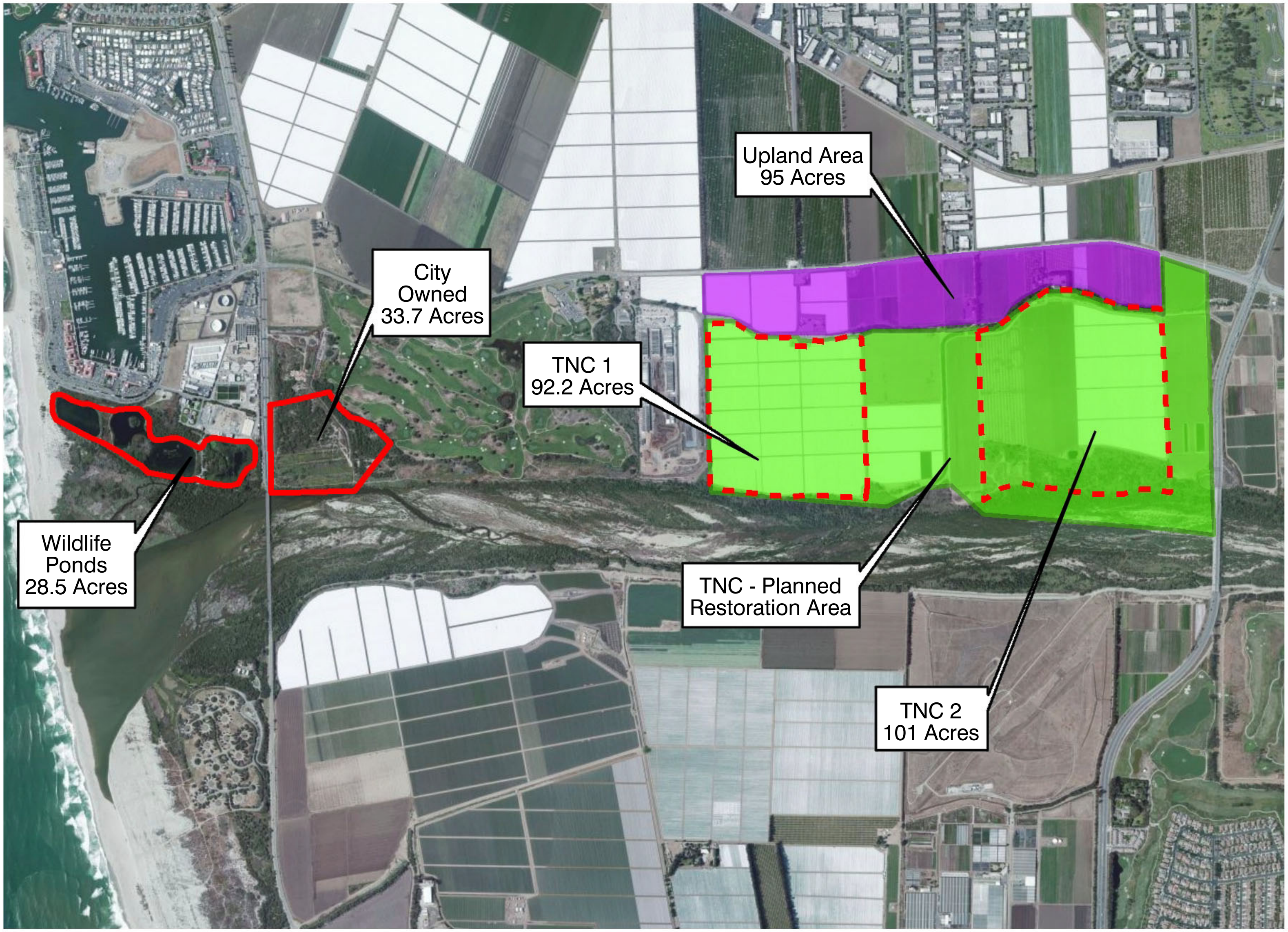

Figure 6.9
POTENTIAL SITES FOR TREATMENT WETLANDS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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Legend

Wildlife Ponds

N

0 125 250 Feet

Figure 6.10
LOCATIONS OF THE BONE AND SNOOPY WILDLIFE PONDS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

6.4.2 Wetlands on City Property

The Phase 1 Report includes discussion of the possibility of using the City owned property, located adjacent to the VWRF, for treatment wetlands. Approximately 29 acres would be available for construction of new treatment wetlands (85 percent of the total available area). In addition, associated infrastructure would need to be constructed. This infrastructure would include pipelines and pump stations required to convey the VWRF effluent to the wetland, and the infrastructure required for discharge of the wetland outflow to the SCRE. There are two alternatives for discharge from new wetlands at the City owned property, including routing the outflow to the existing VWRF effluent discharge channel, or construction a new outfall structure/channel into the SCRE.

The amount of additional nitrate removal that could be achieved in the 29 acres of treatment wetland area would depend on the amount of flow that would be routed to the treatment wetlands. By combining the City owned property and the existing wildlife ponds (modified to be vegetated wetlands), the influent flow can be increased while maintaining the same effluent nitrate concentration target. Assuming an influent total inorganic nitrogen concentration of 8 mg/L as N, and a flow into the wetland (combined city owned property and existing wildlife ponds) of 7 mgd, the resulting effluent nitrate concentrations would range from 3 to 5 mg/L as N.

The major components of this alternative include:

- Approximately 29 acres of treatment wetlands.
- Pipelines and pump stations to route VWRF effluent to the treatment wetlands.
- Infrastructure associated with discharge via the existing effluent channel or an new discharge structure.
- A new point of compliance, if the existing VWRF effluent channel is not used.

6.4.3 Wetlands on TNC Property

The Phase 1 Report describes the potential for using a TNC owned property as the site for new treatment wetlands. Since the completion of the report, the TNC has purchased a parcel located closer to the VWRF. This alternative would involve constructing new treatment wetlands on the TNC parcel closest to the VWRF. If the site were to be used exclusively for treatment wetlands, then approximately 78 acres 85 percent or the total parcel area) would be available. In addition, new pipelines and pump stations would need to be constructed to convey effluent from the VWRF to the treatment wetlands. New infrastructure associated with the discharge of the wetland outflow to the SCR would need to be constructed.

The amount of additional nitrate removal that could be achieved in the 78 acres of treatment wetland area would depend on the amount of flow that would be routed to the treatment wetlands. The proposed wetlands is estimate to reduce the Total inorganic nitrogen (TIN) of 8 mg/L as N to between 3 to 6 mg/L nitrate at a flow of 13 mgd, or better for flows less than 13 mgd.

The use of this parcel would require coordination and agreement with the TNC. The TNC's Santa Clara River Parkway Project involves purchasing parcels along the SCR that are within the 100-year floodplain for the purpose of floodplain restoration. This involves removing the levees, ceasing agricultural activities, and re-establishing riparian vegetation. The removal of the levees would allow more frequent flooding of the parcel. The differences between the objectives of using the parcel for treatment wetlands versus for floodplain restoration would need to be resolved.

The major components of this alternative include:

- Approximately 78 acres of treatment wetlands within the 100-year floodplain, if the site can be used exclusively for treatment wetlands.
- Pipelines and pump stations to route VWRF effluent to the treatment wetlands.
- Infrastructure associated with discharge via the existing VWRF effluent channel or a new discharge structure.
- A new point of compliance for discharge to the SCR, if the existing VWRF effluent channel is not used.

6.4.4 Wetlands on Uplands

This alternative involves construction of new treatment wetlands on upland area on the north side of the SCR, as shown in Figure 6.10. This area is outside of the 100-year floodplain and is currently used for agriculture. The City would need to purchase this upland area. Depending on how many parcels were purchased, up to 95 acres could be available for construction of new treatment wetlands, for 80 acres of wetlands (if 85 percent of acreage is used). In addition, new pipelines and pump stations would need to be constructed to convey effluent from the VWRF to the treatment wetlands. New infrastructure associated with the discharge of the wetland outflow to the SCR would need to be constructed. Since the parcel is not adjacent to the SCR, the discharge of the wetland outflow would need to be conveyed across an adjacent parcel to reach the SCR. Conveyance of the wetland outflow could be achieved by a pipeline. If the outflow were conveyed across TNC owned parcel(s) then it may be possible for the wetland outflow to be routed via overland flow to the SCR.

The amount of additional nitrate removal that could be achieved in the 80 acres of treatment wetland area would depend on the amount of flow that would be routed to the treatment wetlands. The proposed wetlands is estimate to reduce the TIN of 8 mg/L as N to between 3 to 6 mg/L nitrate at a flow of 13 mgd, or better for flows less than 13 mgd.

The major components of this alternative include:

- Approximately 80 acres of new treatment wetlands.

- Pipelines and pump stations to route VWRF effluent to the treatment wetlands.
- Infrastructure associated with a new discharge structure, including the infrastructure to convey the wetland outflow across the parcel(s) between the upland site and the SCR.
- A new point of compliance for discharge to the SCR.

6.4.5 Wetlands with Perched Recharge East of 101

One possibility with treatment wetlands is to site and design it to promote recharge to shallow groundwater, as opposed to a surface water discharge. The crossing of Route 101 and the SCR roughly aligns with the boundary between the Oxnard Forebay Basin and the Oxnard Plain Basin. This alternative involves construction of treatment wetlands combined with perched zone recharge located east of 101. The construction of treatment wetlands combined with perched zone recharge located west of 101 is described in the next section.

This alternative involves routing the VWRF effluent to a treatment wetlands located east of 101. The wetlands would be configured to promote groundwater recharge. As previously described, the Oxnard Forebay Basin readily percolates into the shallow aquifer as well as deeper aquifers. The recharge of the wetlands outflow would be subject to attainment of groundwater quality objectives in the Basin Plan. Oxnard Forebay water quality objectives include TDS of 1200 mg/L and chloride of 150 mg/L. This alternative may also be subject to the Draft Groundwater Recharge Regulations. The wetlands would be recharging a groundwater basin that is designated for municipal supply and is currently used for municipal supply.

The boundary of the Oxnard Forebay Basin, is located north of the SCR, and there is land adjacent to the SCR that could be used to site treatment wetlands with recharge. However, much of the area adjacent to the SCR and within the Oxnard Forebay Basin is currently owned and used for other purposes. In addition, land adjacent to the north side of the SCR is within the 100 year floodplain.

The major components of this alternative include:

- Purchase of land to site a treatment wetlands.
- Pipelines and pump stations to route VWRF effluent to the treatment wetlands.
- Surface water treatment wetlands, that are configured to promote groundwater recharge.

6.4.6 Wetlands with Perched Recharge West of 101

This alternative involves construction of treatment wetlands combined with perched zone recharge located west of 101. VWRF effluent would be routed to treatment wetlands that would be designed to promote the recharge of the wetland outflow to shallow groundwater.

In this case, the recharge would occur by surface recharge to the shallow groundwater of the Oxnard Plain Basin, and would ultimately contribute to the baseflow in the SCR.

The potential area for wetlands within the Oxnard Plain Basin, roughly coincides with the area west of Route 101. Much of the area adjacent to the SCR within the Oxnard Plain Basin are currently owned and used for other purposes. In addition, land are adjacent to the SCR is within the 100 year floodplain.

The recharge of the wetlands outflow would be subject to attainment of groundwater quality objectives in the Basin Plan. The water quality objectives of the shallow groundwater aquifer in the Oxnard Plain Basin include TDS of 3000 mg/L and chloride of 500 mg/L. This alternative may also be subject to the Draft Groundwater Recharge Regulations. The wetlands would be recharging a groundwater basin that is designated for municipal supply. However, while the shallow groundwater is designated as municipal supply, there are no known municipal wells that rely on the shallow groundwater.

- The major components of this alternative include:
- Purchase of land to site a treatment wetlands.
- Pipelines and pump stations to route VWRF effluent to the treatment wetlands.
- Surface water treatment wetlands, that are configured to promote groundwater recharge.

6.4.7 Wetlands for Brine Treatment Disposal

There are a number of alternatives for recharge and irrigation that require RO to meet water quality requirements. The RO process generates a brine waste that requires treatment and/or disposal. This alternative involves the construction of a wetlands for brine treatment and final surface water disposal.

Brine wetlands can provide removal of nutrients, metals and other contaminants. In addition, brine wetlands provide brackish water vegetation and habitat. The brine generated from the RO process would be conveyed to the inflow of a brine wetland, where it would be subject to treatment by natural physical and biochemical processes. The outflow of the brine wetland would be combined with VWRF effluent to provide dilution prior to discharge into the SCRE.

The feasibility of using a brine wetlands is dependent on the ability of the wetlands to reduce metals, nutrients and other pollutants to concentrations, that when combined with the VWRF effluent, would not water quality discharge limitations or cause adverse effects on the SCRE. There has been limited research on the efficacy of brine treatment wetlands. Pilot studies would be required to assess the feasibility of a brine treatment wetlands.

The major components of this alternative include:

- Construction of a new brine treatment wetlands.

- Pipelines and pump stations to route the brine to the treatment wetlands and to convey the treated brine back to the VWRF effluent channel for blending and discharge.
- Infrastructure to blend brine with VWRF effluent.

Figure 6.11 shows the concept of how a brine wetland could be configured.

6.4.8 Preliminary Screening of Wetlands Alternatives

The preliminary screening results are presented in Table 6.3 and discussed in the bullets that follow. Where appropriate a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned to provide a relative scaling of attainment of the criteria.

Table 6.3 Preliminary Screening of Wetlands Alternatives
Phase 2 Recycled Water Study
City of Ventura

Alternatives	Criteria					Selected for Further Evaluation
	Lowers Discharge Volume	Improves the Quality of Final Discharge to the SCRE	Provides Habitat	Provides a Water Supply Benefit	Relies on Existing Treatment	
Wetlands at Wildlife Ponds	3	Y	3	N	Y	Y
Wetlands on City Owned property	3	Y	3	N	Y	Y
Wetlands on TNC property	1	Y	1	N	Y	N
Wetland on uplands	1	Y	1	N	Y	N
Wetlands combined with perched recharge located East of 101	1	Y	3	N	Y	N
Wetlands combined with perched recharge located West of 101	1	Y	3	N	Y	N
Brine Wetlands	NA	NA	Y	NA	NA	Y

Notes:
Where appropriate a relative rating of 1 to 3 (1 highest and 3 lowest) was assigned in lieu of a Y to provide a relative scaling of attainment of the criteria.
NA = Not applicable

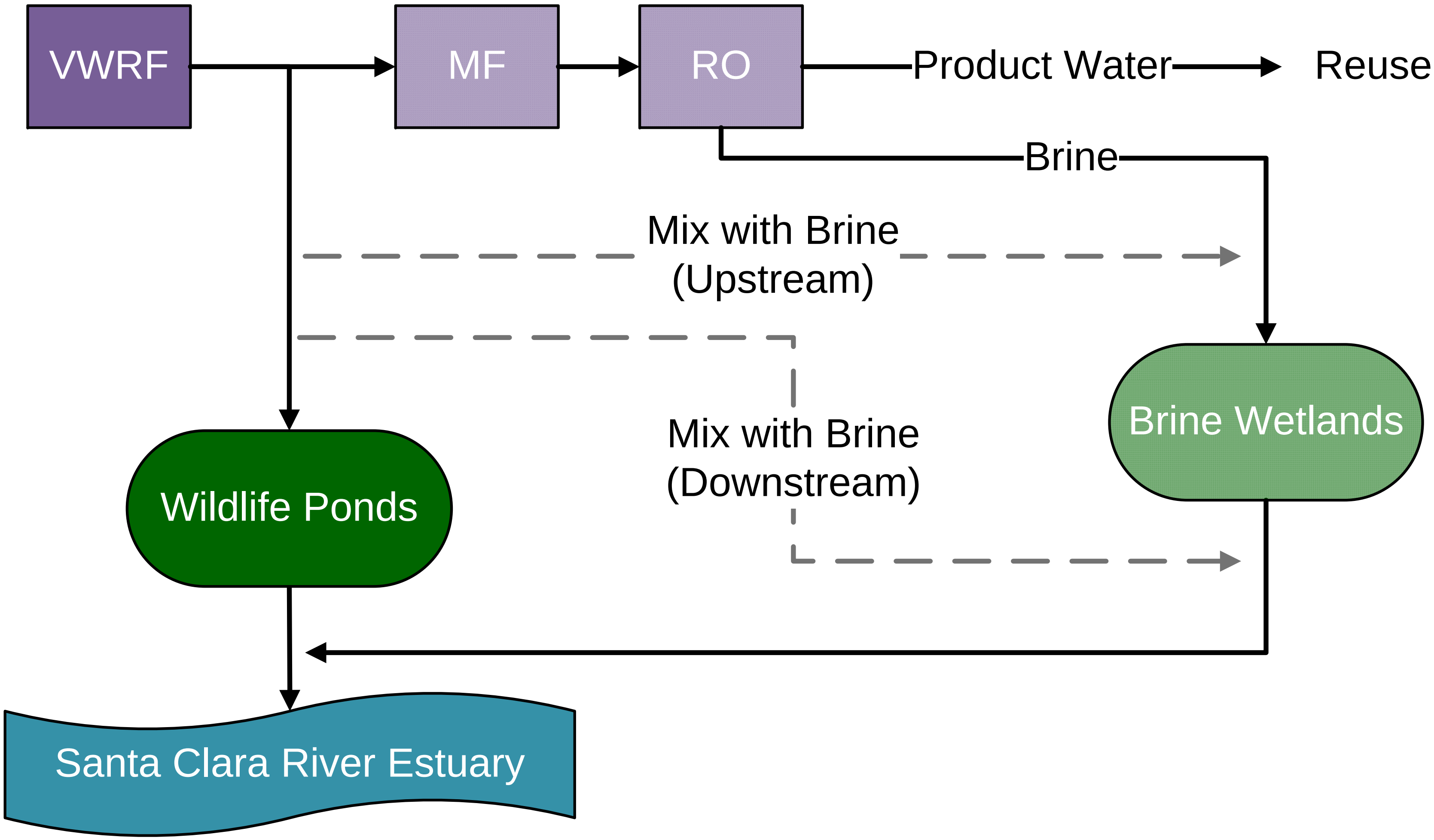


Figure 6.11
SCHEMATIC OF BRINE WETLANDS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

The preliminary evaluation of these alternatives and the rationale for including or excluding the alternatives for more detailed development and evaluation is described below. Note that none of the alternatives provide a benefit to the City's water supply, and all of the alternatives rely on the existing VWRF treatment processes, therefore, these criteria are not discussed.

6.4.8.1 Wetlands at Wildlife Ponds

Wetlands at the Wildlife Ponds have the following benefits/disadvantages:

- There is a low potential for reducing the volume of the discharge through increased evapotranspiration of a wetlands system as compared to the existing Wildlife Ponds.
- There is relatively low potential for improving water quality of the discharge because the land available for treatment wetlands is relatively small. A flow of 3 mgd could be treated to a nitrate concentration of 2 to 6 mg/L as N. Higher flows would achieve less reduction.
- There is relatively low potential for providing habitat because of the limitations on area available for wetlands.

While the relatively small area of the Wildlife Ponds provides capacity for only 3 mgd, there may be combinations of alternatives that would result in an VWRF effluent discharge of 3 mgd or less. In this case, the Wildlife Ponds could be used to provide additional nutrient removal and polishing of the WVRF effluent prior to discharge to the SCRE. In addition, the wetlands would provide some wildlife habitat. For these reason, this alternative is considered for further evaluation.

6.4.8.2 Wetlands at City Owned Property

Wetlands at City Owned Property have the following benefits/disadvantages:

- There is a low potential for reducing the volume of the discharge through evapotranspiration of a wetlands system.
- There is relatively moderate potential for improving water quality of the discharge.
- There is relatively moderate potential for providing habitat.

The City-owned property provides the potential for increasing the capacity of a treatment wetland and increasing habitat. For alternatives that result in a discharge of flow to the SCRE greater than 3 mgd, the treatment wetland area could be expanded to include the Wildlife Ponds and the City-owned parcel. Complicating factors include the infrastructure to convey water to and from the City-owned parcel. However, these challenges are offset by the potential financial benefit of using an existing City owned parcel and the potential to provide additional nitrate removal for a larger flow volume. For these reasons, this alternative is considered for further evaluation.

6.4.8.3 Wetlands at TNC Property

- Wetlands at TNC Property have the following benefits/disadvantages: The volume of the discharge to the SCRE would be reduced because the discharge location would be upstream of the Estuary into the river.
- There is relatively high potential for improving water quality of the discharge.
- There is relatively high potential for providing habitat.

The TNC owned property provides a relatively high the potential for treatment and habitat because it is a relatively large parcel. However, there are a number of challenges with siting treatment wetlands on the TNC parcel. The TNC plans to pull back the levees, allow more frequent flooding, and promote re-establishment of riparian vegetation These objectives are not aligned with a treatment wetlands, consisting of wetland vegetation and would put any investment in wetland infrastructure and vegetation at risk during flood events. In addition, the TNC parcels were purchased with grant funding from several agencies including, the State Coastal Conservancy, the Wildlife Conservation Board, Department of Water Resources and US Fish and Game. The funding agreements include requirements that the land be used for conservation and flood plain restoration. Ultimately, the TNC plans to sell back their parcel to an owner with conditions for maintaining the floodplain and riparian vegetation function of the parcels.

The lack of consistency between TNC objectives for the parcel and the objectives of a treatment wetlands, the risk to the investment in the construction of the treatment wetlands, and the expectation of future land purchase, limits the feasibility of siting treatment wetlands on the TNC property. For these reasons, this alternative is not considered for further evaluation.

6.4.8.4 Wetlands on Uplands

Wetlands on Uplands have the following benefits/disadvantages:

- The volume of the discharge to the SCRE would be reduced because the discharge location would be upstream of the Estuary.
- There is relatively high potential for improving water quality of the discharge.
- There is relatively high potential for providing habitat.

The upland area, outside of the 100 year floodplain, provides a relatively high the potential for treatment and habitat because there is a significant amount of land that could be converted to treatment wetlands. However, there are a number of challenges with siting treatment wetlands on the upland area. The most significant challenges include, that this area is prime agricultural land, changing the land use would be in conflict with local land use policies, the land area is owned by several different entities, there is already an entity interested in purchasing this land, it would require coordination with adjacent land owners to route the wetland outflow to the SCRE or SCR, and the City would need to purchase the land. For these reasons, this alternative is not considered for further evaluation.

6.4.8.5 Wetlands combined with perched recharge located east of 101

Wetlands combined with perched recharge located East of 101 has the following benefits/disadvantages:

- While the discharge would be outside of the SCRE, the amount of available land limits the potential for reducing the discharge volume.
- Due to land constraints there is low potential for improving water quality of the discharge and for providing habitat.

The area on the north side of the river that is within the Oxnard Forebay (East of 101) is either being used for other purposes or is a parcel targeted by the TNC for acquisition and restoration to floodplain, and therefore, space for a treatment wetlands is limited. In addition, the concept of a treatment wetlands would be to improve the VWRF water quality through natural treatment. However, the water quality objectives of the Oxnard Forebay could not be met without RO. For these reasons, this alternative is not considered for further evaluation.

6.4.8.6 Wetlands combined with perched recharge located West of 101

Wetlands combined with perched recharge located West of 101 has the following benefits/disadvantages:

- While the discharge would be outside of the SCRE, the amount of available land limits the potential for reducing the discharge volume.
- Due to land constraints there is low potential for improving water quality of the discharge and for providing habitat.

The area on the north side of the river that is within the Oxnard Plain (West of 101) is either being used for other purposes or is a parcel targeted by the TNC for acquisition and restoration to floodplain, and therefore, space for a treatment wetlands is limited. For these reasons, this alternative is not considered for further evaluation.

6.4.8.7 Brine Wetlands

Brine wetlands has the following benefits/disadvantages:

- Not designed to reduce the VWRF discharge volume or to improve the VWRF effluent quality.
- Moderate potential to provide habitat.

There a number of alternatives that require some portion of the VWRF effluent to be treated by RO, Among the number of alternatives for brine treatment/disposal is a brine treatment wetlands. The analysis of the wetlands alternatives has led to the City-owned property as the most viable site for construction of a wetlands. A brine wetlands on the city-owned property is considered in the context of brine treatment/disposal option. However, as discussed, the feasibility of a brine wetlands would require more investigation and pilot testing to determine the ability of the wetlands to removal nutrient, metals and other pollutants in the concentrated brine stream.

6.5 SUMMARY OF SCREENING ANALYSIS

The preliminary screening analysis led to a number of alternatives that were identified for further consideration, including:

- Northern Decentralized Treatment Plant with urban and agricultural irrigation.
- Direct potable reuse.
- Conveyance to the Oxnard WWTP/AWPF.
- Groundwater recharge of the Mound Basin (IPR).
- Groundwater recharge/irrigation at UWCD Facilities.
- Treatment wetlands on-site and at City-owned property.

In addition, urban irrigation and agricultural irrigation are selected as alternatives that could be combined implemented along with other alternatives. Chapter 7 provides additional information, analysis and evaluation of these alternatives.

VIABLE ALTERNATIVES DEVELOPMENT AND COMPARISON

The preliminary screening of alternatives (presented in Chapter 6) led to a number of alternatives that were selected for further evaluation. This chapter provides additional detail on these alternatives, including cost estimates. This chapter also includes a discussion of environmental considerations associated with these alternatives that focuses on the amount of flow that remains in the discharge and the resulting effects on the SCRE stage and water quality.

7.1 NORTH SIDE DECENTRALIZED TREATMENT PLANT WITH URBAN AND AGRICULTURAL IRRIGATION

7.1.1 Planning and Design Assumptions

This alternative includes the construction of a decentralized treatment plant for the purpose of providing an upstream supply of recycled water located near the Seaside Pump Station. Raw wastewater would be diverted from the collection system for treatment. Figure 7.1 presents the location of the decentralized treatment plant and recycled water distribution system. Year 2050 estimates of sea level rise suggest inundation in this area. If selected as a preferred alternative then addition investigation of alternative sites in the vicinity would be needed.

Based on analysis of collection system flows (Kennedy Jenks, 2010) as well as flow information from the Seaside Pump Station, there is approximately 2.6 million gallons per day (mgd) raw wastewater available at this location in the VWRF collection system.

Potential urban and agricultural demands were estimated using land use/crop information, and City records of potable water demands. The average and maximum month demands in the vicinity of this new distributed treatment plant are presented in Table 7.1.

Table 7.1 Summary of Urban and Agricultural Irrigation Demands near the Proposed Distributed Treatment Plant
Phase 2 Recycled Water Study
City of Ventura

Demand Type	Average (mgd)	Maximum Month (mgd)
Urban Irrigation	0.17	0.24
Agricultural Irrigation	1.1	1.8
Total	1.3	2.0

On a maximum month basis, these demands are similar to the available supply of approximately 2.6 mgd. Agricultural irrigation demands represent the majority of the total demands. The potable average and maximum month demands that would be offset with recycled water are 0.17 mgd and 0.24 mgd, respectively.

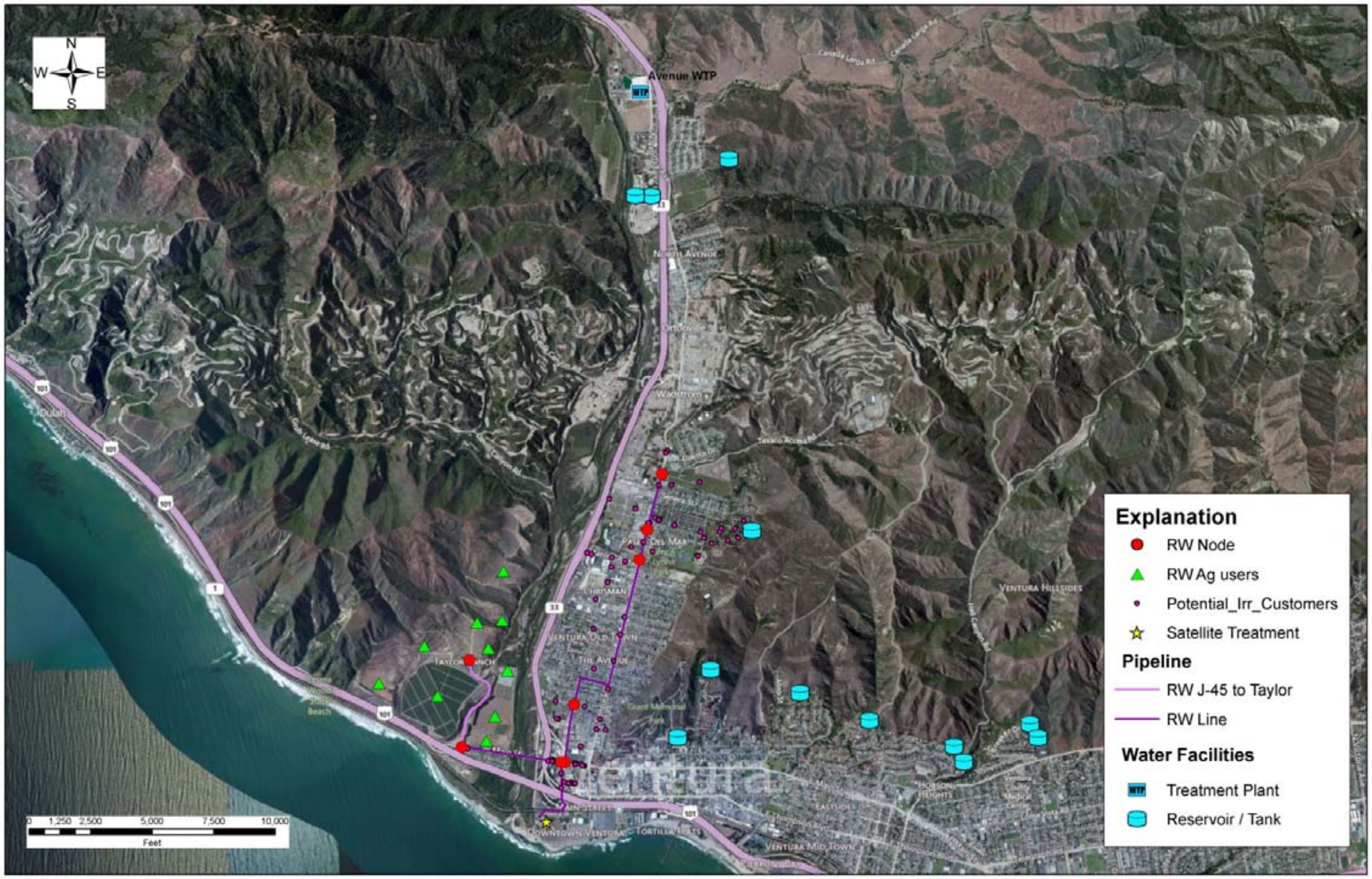


Figure 7.1
NORTH SIDE DECENTRALIZED TREATMENT PLANT AND DISTRIBUTION SYSTEM
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

7.1.2 Treatment

To serve local urban and agricultural demands, the treatment plant would be sized for a maximum month flow of 2 mgd. The treatment plant would be designed to meet Title 22 standards for unrestricted reuse. In addition, the recycled water would need to meet a chloride target of 117 milligrams per liter (mg/L) for the irrigation of crops sensitive to chloride. Raw wastewater samples from this area of the VWRF collection system suggests that this chloride target could be met. Measured TDS and chloride concentrations were 676 mg/L and 68 mg/L, respectively. These TDS and chloride concentrations are acceptable for sensitive crops and no additional treatment beyond treatment required to meet Title 22 would be required.

Small, distributed treatment plants can either be package treatment plants or customized plants. While there are several different approaches to wastewater treatment that could be employed, this analysis considers two treatment approaches, conventional activated sludge and a membrane bioreactor (MBR). Figure 7.2 presents the treatment alternatives. One advantage of a membrane bioreactor is that if there was need or interest in implementing advanced treatment, such as reverse osmosis (RO), at this treatment plant, then the ultra or microfiltration (UF/MF) pretreatment process would not be needed due to the membrane bioreactor process. Upgrading a conventional activated sludge treatment plant to include RO would require the addition of UF/MF. Section 7.2 presents a direct potable reuse alternative that would include implementing advanced treatment (RO) at the distributed treatment plant and conveyance to Casitas Turnout No. 2.

For the conventional and MBR treatment plants, the solids would be conveyed back to the collection system and would be conveyed in the influent wastewater to the VWRF.

7.1.3 Distribution System

As shown in Figure 7.1, the distribution system was designed to convey recycled water to potential urban and agricultural users. The recycled water distribution systems consist of 4-inch and 8-inch PVC pipes.

7.1.4 Summary

The components of this alternative are summarized in the Table 7.2.

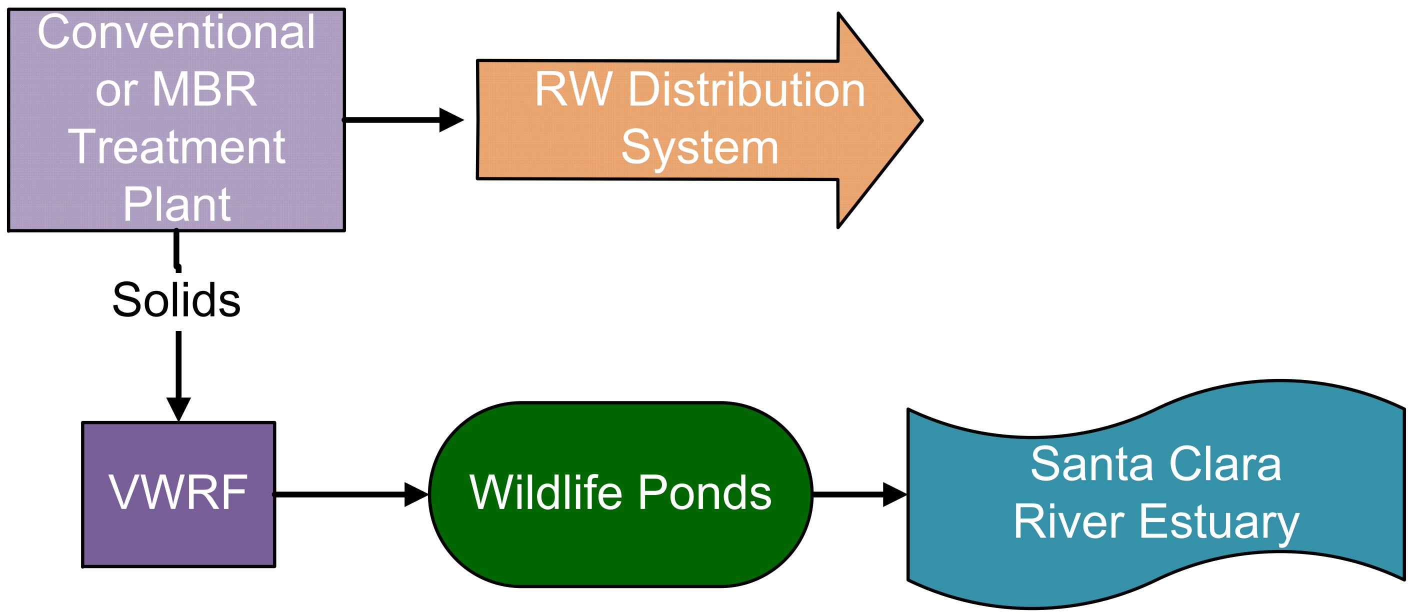


Figure 7.2
DECENTRALIZED TREATMENT PLANT SCHEMATIC
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Table 7.2 Summary of the North Decentralized Treatment Plant Alternative Phase 2 Recycled Water Study City of Ventura	
Recycled Water Demand (average)	1.3 mgd
Recycled Water Demand (max month)	2.0 mgd
Decentralized Treatment Plant Capacity	2 mgd
Volume Diverted from SCRE	2 mgd
Treatment Processes	Conventional Activated Sludge or MBR, designed to meet Title 22 requirements, no solids treatment
Location	Near the Seaside Pump Station
Infrastructure	Recycled water distribution system

7.2 DIRECT POTABLE REUSE

7.2.1 Planning and Design Assumptions

This alternative involves advanced treatment of wastewater and direct reuse in the potable water distribution system. There are two sub-alternatives for direct potable reuse (DPR) that utilize different sources of wastewater for DPR.

The first sub-alternative involves advanced treatment at the VWRF and conveyance to the distribution system that originate from the Bailey Water Conditioning Facility. This alternative would provide approximately 3.6 mgd of reclaimed wastewater to replace the City's current extractions from the Mound Basin.

The second sub-alternative involves advanced treatment at a new north side decentralized treatment facilities. Advanced treatment processes would be located at the north side decentralized treatment plant. The treated water would be conveyed to Casitas Turnout No 2, for use in the potable water distribution system. This alternative would provide approximately 2 mgd of reclaimed wastewater to be used in the City's potable water system.

7.2.2 Treatment

While regulations have not been developed, it is anticipated that the DPR will require RO and advanced oxidation. The treatment train is similar to the indirect potable reuse (IPR) treatment train without the environmental buffer (minimum 2 month groundwater travel time). Additional treatment and monitoring is substituted for the environmental buffer. After RO treatment, the water would be stored for a set period of time, 12 hours, to allow for additional monitoring. The influent to the storage tank would be dosed with free chlorine to provide for an additional measure of disinfection. Storage would be such that treated "potable" water would be diverted for 12 hours at a time to two tanks, "Tank 1" and "Tank 2." After 12 hours of flow to Tank 1, the tank would be sealed and water would be diverted to start filling "Tank 2." Water samples would be taken at constant intervals during the filling process and tested. Upon successful completion of the advanced monitoring, water would be released from the full tank, undergo UV and advanced oxidation, and be delivered into the distribution system. The tank would subsequently be refilled while Tank 2 undergoes advanced monitoring. An equalization basin would be needed to regulate flow into the two tanks. Figure 7.3 presents the DPR treatment train.

The recovery of the RO process is dependent on the influent (to the RO process) water quality. In particular, silica is an important water quality parameter that can adversely affect the RO process. Preliminary analysis of silica concentrations in the VWRF effluent suggests that the silica content could affect the operation of an RO process. However, additional data would need to be collected to confirm the silica concentrations. Additional treatment or operation at a lower recovery are two approaches for addressing issues related to high silica concentrations.

Brine will be generated from the DPR treatment process. For the DPR treatment processes at the VWRF, the brine generated will require treatment and disposal. For the DPR treatment processes at the north side decentralized treatment plant, it is assumed that the small volume of brine (0.5 mgd) would be conveyed back into the VWRF collection system. The impacts of this brine flow on treatment and effluent quality at the VWRF would require further study to assess feasibility of this brine disposal option.

7.2.3 Distribution System

The first sub-alternative requires new infrastructure to convey the water from the DPR treatment train to the Bailey Water Conditioning Facility. This alternative relies on the existing potable water distribution system to convey the water to the City’s potable water supply customers.

Similarly, the second sub-alternative requires new infrastructure from the potential new decentralized treatment plant to Casitas Turnout No. 2. This alternative relies on the existing potable water distribution system between Casitas Turnout No. 2. and the City’s potable water customers.

Figure 7.4 shows the potential pipeline alignments to convey the treated wastewater to the potable water distribution system.

7.2.4 Summary

Table 7.3 summarizes the DPR alternatives. The City participated in a research project on DPR (Evaluation of Risk Reduction Principles for Direct Potable Reuse, WateReuse Research Foundation Project 11-10). This study evaluated the treatment performance of current IPR practices and considers what additional treatment and monitoring and operational issues may be necessary to implement DPR. The City of Ventura Case Study section of the draft report is included in Appendix B.

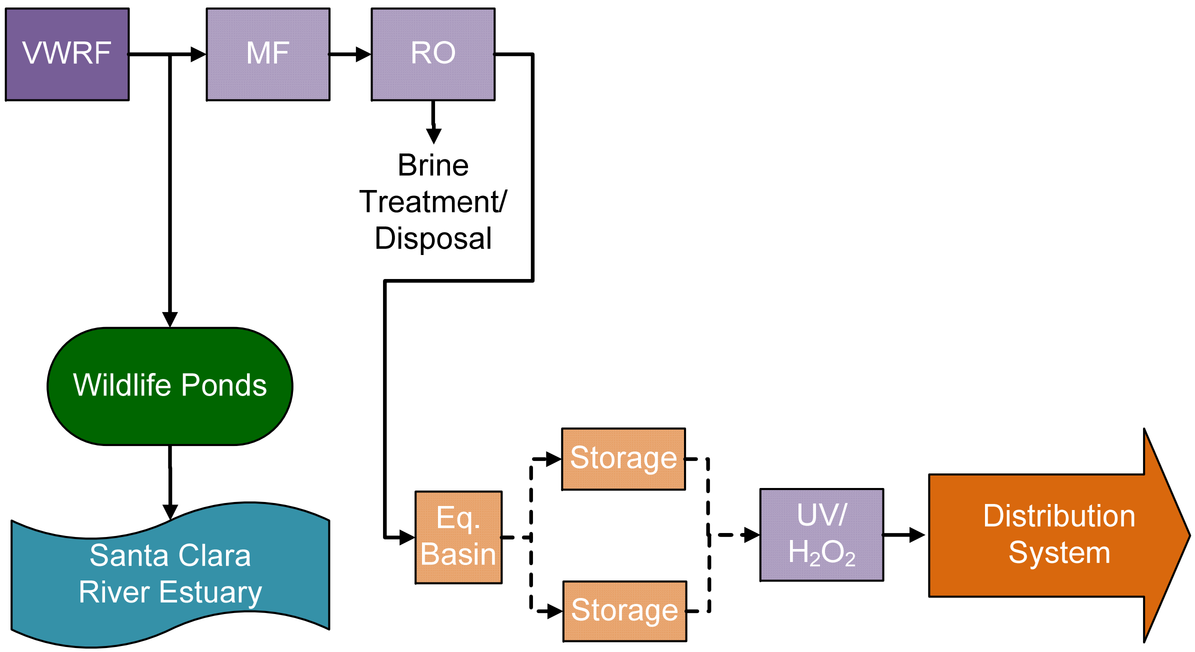


Figure 7.3
DPR TREATMENT PLANT SCHEMATIC
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

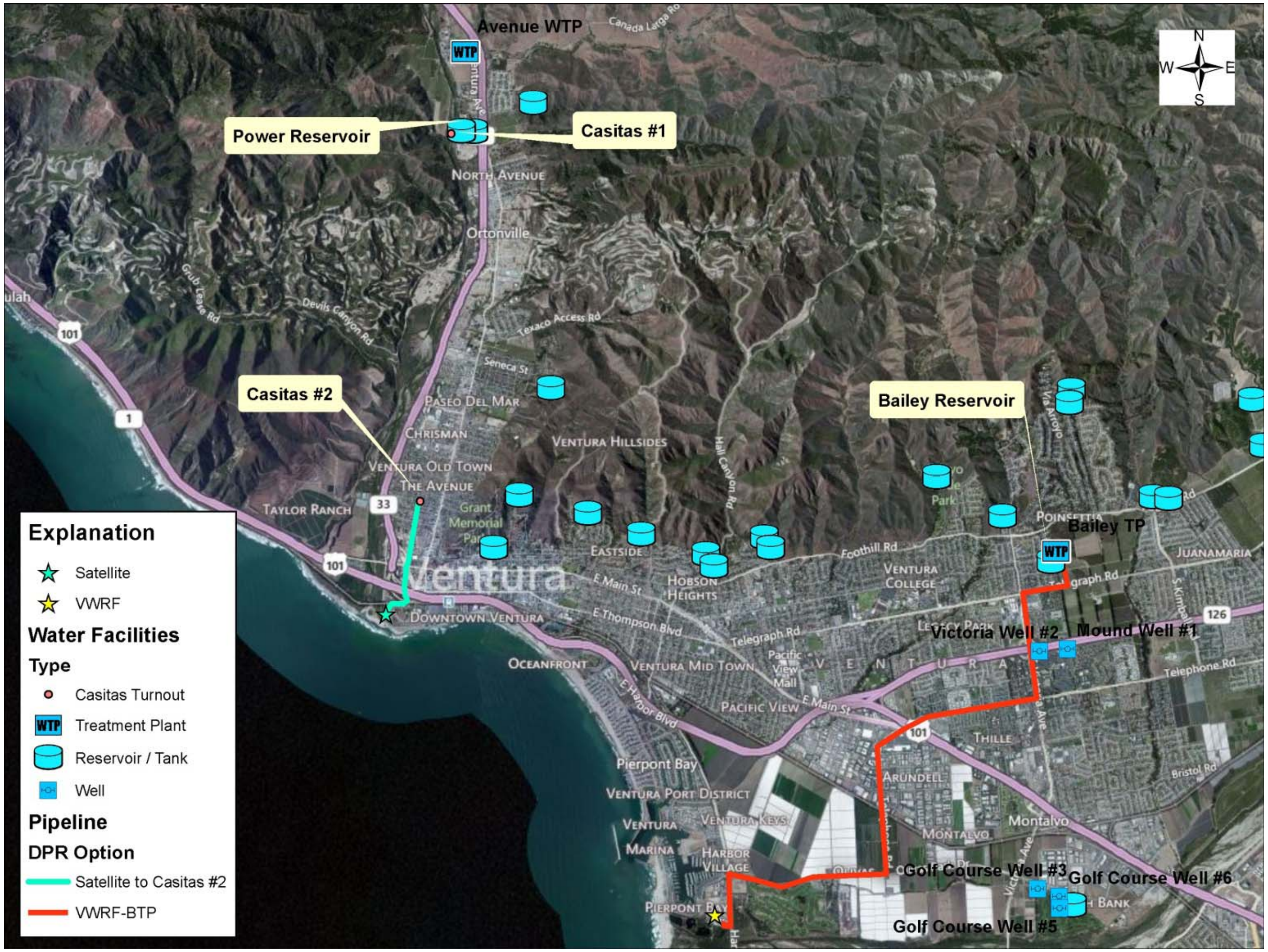


Figure 7.4
POTENTIAL DPR PIPELINE ALIGNMENTS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Table 7.3	Summary of the DPR Alternatives Phase 2 Recycled Water Study City of Ventura
Bailey/Mound Alternative	
Product Water Flow	3.6 mgd
Advanced Treatment Plant Capacity	5 mgd
Volume Diverted from SCRE	4.5 mgd
Brine Flow	0.9 mgd
Advanced Treatment Processes	MF/UF, RO, advanced oxidation
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the VWRF.
Infrastructure	Pipelines and pump stations to convey water from the VWRF to the Bailey Conditioning Facility.
Casitas Turnout No. 2 Alternative	
Product Water Flow	1.8 mgd
Advanced Treatment Plant Capacity	2.5 mgd
Volume Diverted from SCRE	2.5 mgd
Brine Flow	0.5 mgd
Advanced Treatment Processes	MF/UF, RO, advanced oxidation
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the North Decentralized Treatment Plant.
Infrastructure	Pipelines and pump stations to convey water from the North Decentralized Treatment Plant to Casitas No 2.

7.3 CONVEYANCE TO THE OXNARD WWTP/AWPF

7.3.1 Planning and Design Assumptions

The Final Draft Ventura-Oxnard Recycled Water Interconnect Feasibility Study (Kennedy Jenks, 2013) investigates the feasibility of conveying VWRF effluent to the City of Oxnard's Advanced Water Purification Facility (AWPF), and, if treatment capacity is not available or if there is not enough demand, discharging the effluent to either the City of Oxnard's ocean outfall or Calleguas Municipal Water District's (Calleguas) Salinity Management Pipeline. Figure 7.5 shows the potential pipeline routing for conveying VWRF effluent to the AWPF.

Source: Adapted from Kennedy Jenks (2012)

Figure 7.5
POTENTIAL VWRF-AWPF PIPELINE ALIGNMENT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

In the proposed alternative, VWRF effluent is supplied to the AWPF for treatment and utilization as high quality recycled water. The alternative involves using secondary effluent that is disinfected through modified disinfection facilities. At the AWPF, the secondary effluent will undergo MF/UF and RO treatment. The AWPF capacity will need to be increased to accommodate flow from the VWRF. The City and the City of Oxnard would need to develop an agreement on the financing approach and parties responsible for both capital and O&M costs. There are numerous possible arrangements that could be made between the City and the City of Oxnard. Section 7.9.3 includes additional information on two possible financial arrangements between the City and the City of Oxnard. In this study, two possibilities are considered:

- City pays for AWPF expansion – In this scenario, the City would be responsible for the capital investment in the AWPF expansion. In addition, the City would pay the City of Oxnard for O&M associated with treatment of VWRF effluent at the AWPF.
- City of Oxnard pays for AWPF Expansion – In this scenario, the City of Oxnard would be responsible for the capital investment in the AWPF expansion. The City would pay annual fees to the City of Oxnard to cover both treatment costs at the AWPF and an annualized capital costs that would allow the City of Oxnard to recover their capital investment.

As discussed, the silica concentration in the VWRF effluent may present operational problems with the RO process. The acceptability of the VWRF effluent at the AWPF may depend on attainment of water quality limits. If the silica concentrations in the VWRF present a problem for the AWPF, then additional treatment may be required.

7.3.2 Distribution System

This alternative requires a new pipeline to convey VWRF effluent to the AWPF. Once treated at the AWPF, the recycled water will conveyed to users to offset potable demands, irrigate agriculture and recharge local groundwater. (Kennedy Jenks, 2012). The City of Oxnard has constructed a delivery system and is working with existing customers to retrofit sites to accept recycled water (Kennedy Jenks, 2012). If treatment capacity at the AWPF is not available or if there is not enough demand, then the water from the VWRF would not be reused, and would be conveyed to the City of Oxnard's ocean outfall or the Calleguas Salinity Management Pipeline.

7.3.3 Summary

A summary of this alternative is provided in Table 7.4.

Table 7.4 Summary - Conveyance to Oxnard WWTP/AWPF Alternative Phase 2 Recycled Water Study City of Ventura	
Volume Diverted from SCRE	Up to 13 mgd
Treatment	Disinfection Improvements
Infrastructure	Pipelines and pump stations to convey water from the VWRF to the AWPF Oxnard WWTP outfall connection Calleguas SMP discharge station/piping

7.4 GROUNDWATER RECHARGE OF THE MOUND BASIN

7.4.1 Planning and Design Assumptions

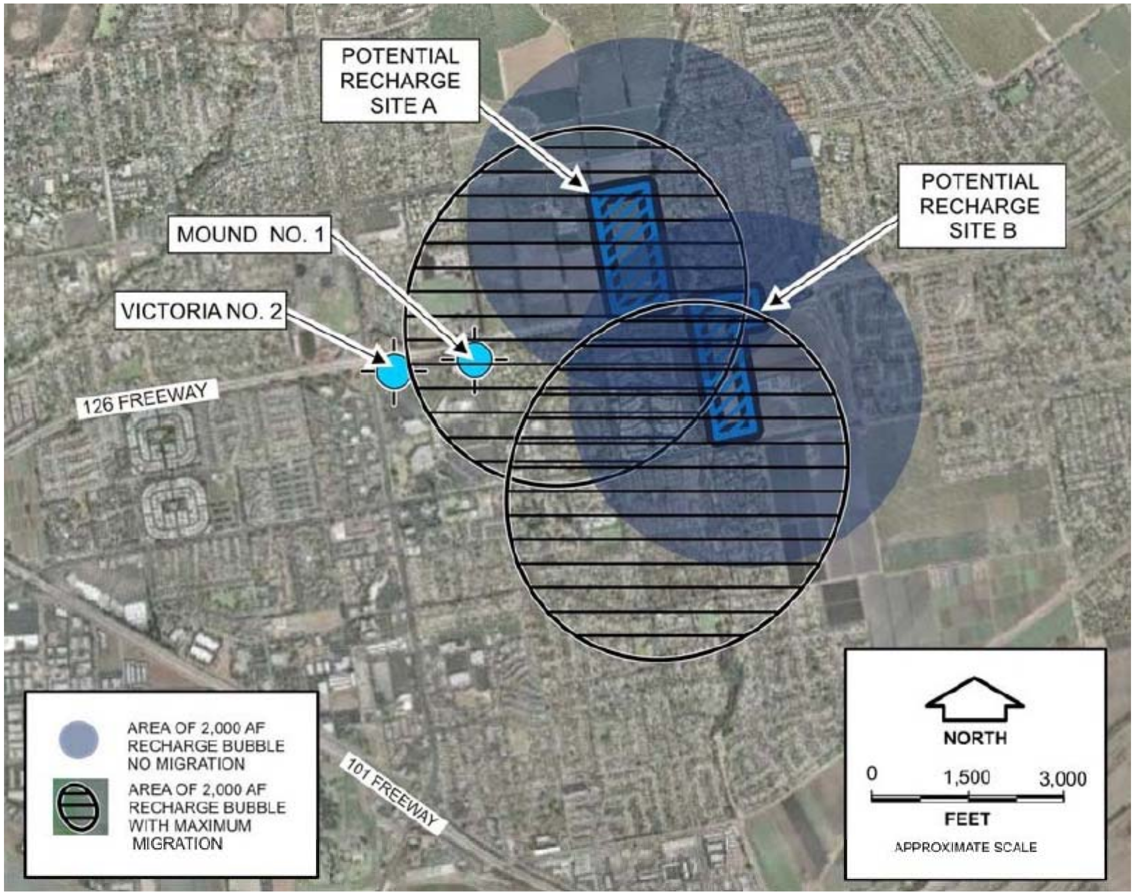
In this alternative, reclaimed water from the VWRF would be used to recharge the Mound Groundwater Basin for the purpose of augmenting the potable groundwater supply, i.e., indirect potable reuse (IPR).

Currently, two wells withdraw water from the Mound Subbasin; Victoria Well No. 2, and Mound Well No. 1. Water from these wells is treated at the Bailey Water Conditioning Facility for iron and manganese. The treated water is then blended with groundwater extracted from the Oxnard Plain basin and conveyed to users through the City's potable water distribution system.

Subsurface characteristics limit the feasibility of groundwater recharge through surface spreading. The only option for groundwater recharge is subsurface injection. IPR projects with capacities of 3.6 mgd and 6.3 mgd are considered in this alternative. A 3.6 mgd flow is consistent with the City's current extractions from the Mound Basin, and a 6.3 mgd flow is consistent with the total extractions from the Mound Basin.

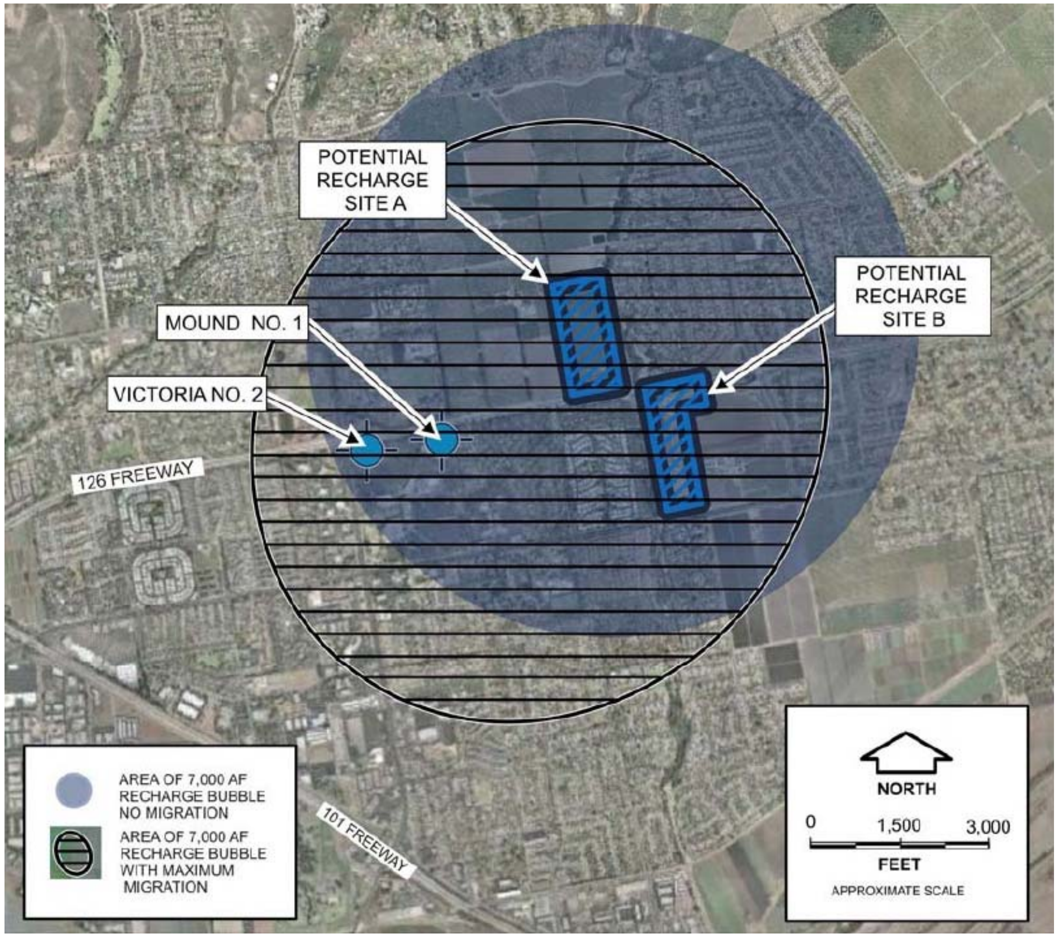
Hopkins (2013) describes the approach to IPR through injection of the Lower Aquifer System (LAS) of the Mound Basin. One of the key requirements in the Draft Groundwater Recharge Reuse Regulation is a minimum 2 month subsurface travel time. A preliminary analysis of groundwater travel time in the LAS was conducted (Hopkins 2013) and is included in Appendix C. The study evaluated the feasibility of a 3.6 and 6.3 mgd IPR project that would use the City's Victoria Well No. 2. Figures 7.6 and 7.7 show the area of recharge without migration and with maximum migration for the 3.6 and 6.3 mgd alternatives, respectively. Well Site A is located on a parcel that is currently used for agriculture. Well Site B is located adjacent to the Ventura Community Park.

Preliminary analysis suggested that the location of Recharge Site A had a higher likelihood of being recaptured at the location of Victoria Well No. 2 and that groundwater travel time would be greater than the 2 month minimum under the 3.6 and 6.3 mgd recharge scenarios



Source: Hopkins Groundwater Consultants (2013)

Figure 7.6
RECHARGE AREAS WITHOUT MIGRATION AND WITH MAXIMUM MIGRATION FOR A 3.6 MGD IPR PROJECT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA



Source: Hopkins Groundwater Consultants (2013)

Figure 7.7
RECHARGE AREAS WITHOUT MIGRATION AND WITH MAXIMUM MIGRATION FOR A 6.3 MGD IPR PROJECT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

(Hopkins 2013). Therefore, it is assumed that this alternative involves injection at Well Site A, and extraction at the location of Victoria Well No. 2.

Injection of the recycled water at Recharge Site A, may require multiple wells capable of injection rates of between 1,000 gallons per minute (gpm) (1.4 mgd) to 2,000 gpm (2.9 gpm). Depending on the injection rate of the wells, a 3.6 mgd IPR project would require 2 to 3 wells, and a 6.3 mgd IPR project would require 3 to 5 wells.

7.4.2 Treatment

The Draft Groundwater Recharge Reuse Regulation requires FAT for injection of recycled wastewater. Figure 7.8 shows the conceptual treatment train to achieve FAT. The existing VWRF effluent undergoes tertiary media filtration. Additional filtration with MF/UF is required as pretreatment for the RO process.

All of the water that would be injected into the Mound Basin would undergo FAT. Assuming an 80 percent recovery of the RO process, the 3.6 and 6.3 mgd IPR alternatives would require treatment of approximately 5 mgd and 9 mgd, respectively. The brine produced by the RO process would require treatment and disposal, which is further described in Section 7.7.

As discussed earlier, the recovery of the RO process is dependent on the influent (to the RO process) water quality. While preliminary analysis of silica concentrations in the VWRF effluent suggests that the silica content could affect the operation of an RO process, additional data would need to be collected. Additional treatment or operation at a lower recovery are two approaches for addressing issues related to high silica concentrations.

While groundwater that is currently extracted from the Mound Basin is treated for iron and manganese at the Bailey Conditioning Facility, it is possible that these treatment processes would not be needed if IPR is implemented. It may be feasible that the IPR project would lead to recover of groundwater that is better quality than is currently extracted from the Mound Basin's lower aquifer system (Hopkins 2013).

7.4.3 Distribution System

The water produced from the advanced treatment processes, located at the VWRF, would be conveyed to injection Recharge Site A. The proposed pipeline alignment is shown in Figure 7.9. This pipe sizing and alignment is the same for the 3.6 mgd and 6.3 mgd alternatives, to allow for a potentially phased approach where the lower capacity IPR project is implemented initially and then expanded in the future.

As discussed, the injected water would be extracted at a location near Victoria Well No. 2. Hopkins (2013) concluded that recharge of the Mound Basin would require construction of additional downgradient production wells. Additional investigation into the feasibility of using Victoria Well No. 2 and/or additional new extraction wells near Victoria Well No. 2 or other locations, would need to be conducted. Distribution of the extracted water would be

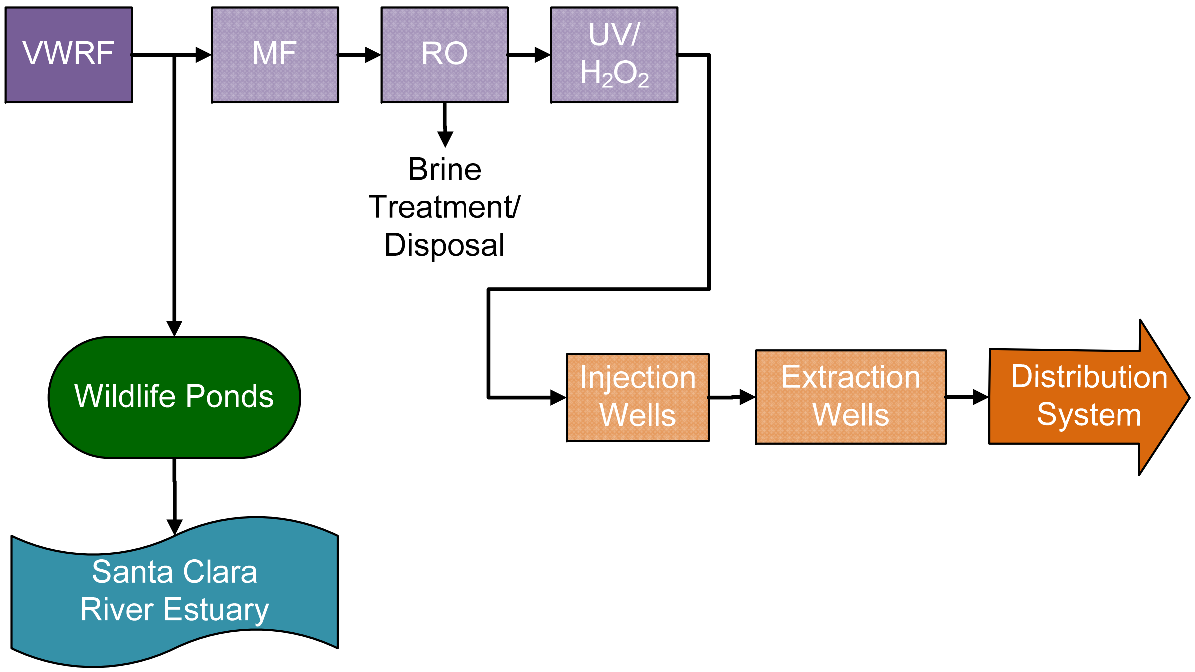


Figure 7.8
IPR TREATMENT PLANT SCHEMATIC
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

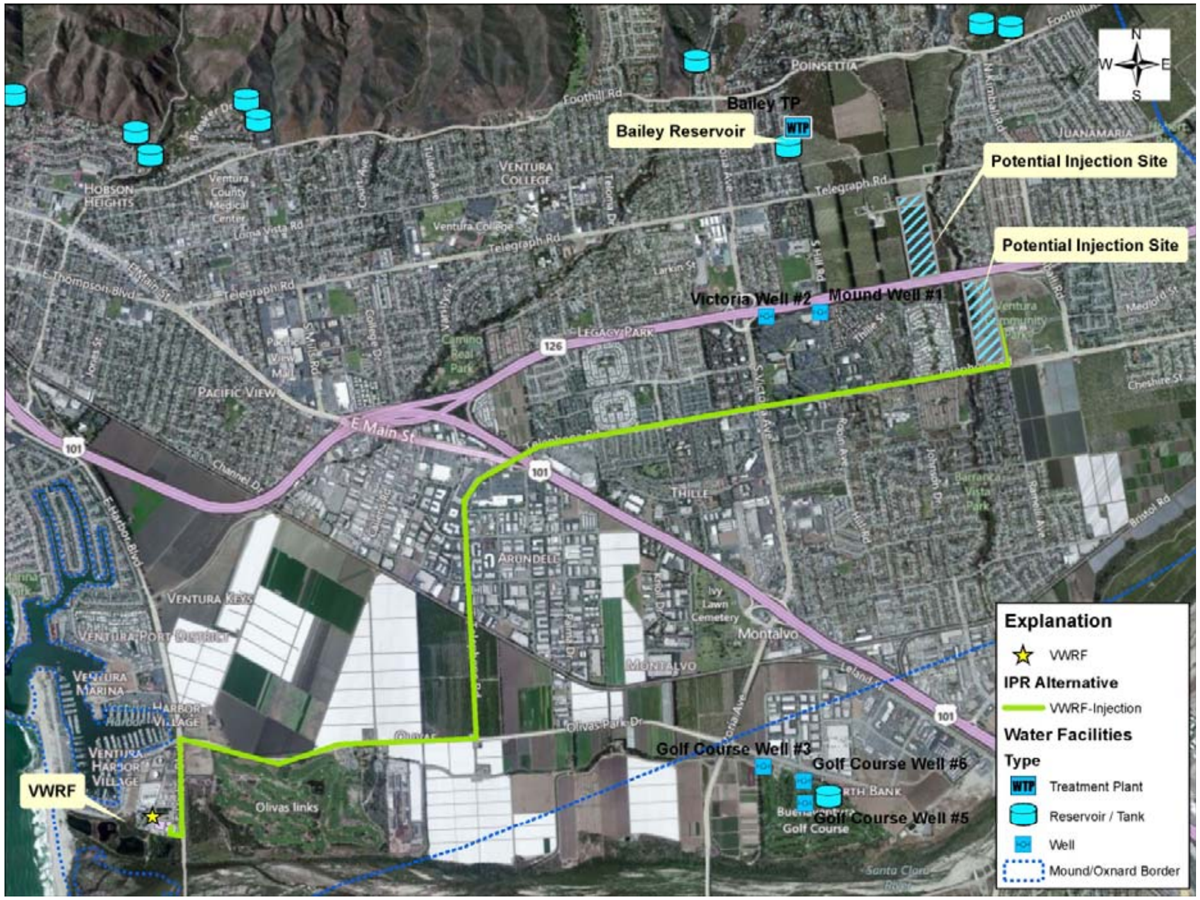


Figure 7.9
POTENTIAL IPR PIPELINE ALIGNMENT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

achieved through the existing potable water distribution system that originates from the Bailey Water Conditioning Facility.

7.4.4 Summary

The components of this alternative are summarized in Table 7.5.

Table 7.5 Summary of the Mound Basin Groundwater Recharge Alternatives Phase 2 Recycled Water Study City of Ventura

3.6 mgd IPR Alternative	
Product Water Flow	3.6 mgd
Advanced Treatment Plant Capacity	5 mgd
Volume Diverted from SCRE	4.5 mgd
Brine Flow	1 mgd
Advanced Treatment Processes	MF/UF, RO, advanced oxidation
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the VWRF. Injection wells at Recharge Site A. Extraction at Victoria No 2/additional nearby wells/ other wells.
Land Requirements	Recharge Site A, and possibly for new extraction wells if needed.
Infrastructure	Pipelines and pump stations to convey water from the VWRF to Recharge Site A. 2-3 Injection Wells. New Extraction Wells
6.3 mgd IPR Alternative	
Product Water Flow	6.3 mgd
Advanced Treatment Plant Capacity	9 mgd
Volume Diverted from SCRE	7.9 mgd
Brine Flow	1.6 mgd
Advanced Treatment Processes	MF/UF, RO, advanced oxidation
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the VWRF. Recharge Site A. Extraction at Victoria No 2/additional nearby wells/ other wells.
Land Requirements	Recharge Site A, and possibly for new extraction wells if needed.
Infrastructure	Pipelines and pump stations to convey water from the VWRF to Recharge Site A. 3-5 Injection Wells. New Extraction Wells

7.5 GROUNDWATER RECHARGE/IRRIGATION AT UWCD FACILITIES

7.5.1 Planning and Design Assumptions

The groundwater recharge/agricultural irrigation alternatives are designed to take advantage of UWCD's existing facilities and their existing practices of diverting SCR water for groundwater recharge and irrigation.

The availability of diluent water is the key factor in assessing the feasibility of groundwater recharge or agricultural irrigation. In both cases, the limiting criterion is target chloride concentration of 117 mg/L. The variability of SCR water depends on hydrologic conditions and is highly variable. During periods of low flow in the SCR, commonly the summer months of dry and average years, UWCD may route all diverted water to growers for agricultural irrigation, Therefore, during summer low flow periods in the SCR, there may be limited to no water available for dilution of recycled wastewater for the purposes of groundwater recharge. Given these constraints, several sub-alternatives were investigated, including:

- Summer agricultural irrigation and winter recharge without advanced treatment
- Summer agricultural irrigation and winter recharge with partial advanced treatment
- Year round agricultural irrigation/recharge with partial advanced treatment

The additional investigation of these alternatives is discussed, as the results form the basis of the planning and design assumptions, specifically the end use, total flow, and advanced treatment flow required to meet regulatory and water quality limitations.

The first sub-alternative, summer agricultural irrigation and winter recharge, relies on the SCR water to provide sufficient dilution to meet a 117 mg/L chloride target. The VWRF effluent chloride concentration is about 290 mg/L. The SCR chloride concentration varies with hydrologic condition, and is inversely proportional to SCR flow. Therefore, during the summer low flow conditions, the SCR chloride concentrations are the greatest. Based on data collected every 1 to 2 weeks since 2010, the 95th percentile chloride concentrations in May through September, range from 68 mg/L to 85 mg/L. Based on UWCD agricultural diversion flows from 1997 through 2011, and assuming a summer SCR chloride concentration of 85 mg/L, the VWRF flow that could be blended with SCR water for irrigation was estimated. The estimated median VWRF flow that could be diverted for agricultural irrigation via UWCD is 2.5 mgd. By definition, 50 percent of the monthly VWRF flow that could be diverted for agricultural irrigation would be less than 2.5 mgd. The primary limitation of this sub-alternative is that the amount of flow that could be diverted from the VWRF would be not be a reliable diversion due to the dependence on the flow and quality of the SCR water diverted by UWCD. Due to the limited reliability of this alternative, it was not considered further. The following discussion addresses alternatives that incorporate some level of advanced treatment, and thereby increase the flow potential and reliability of the diversion,

The second sub alternative involves summer agricultural irrigation and winter recharge, with partial advanced treatment of the VWRF effluent. Figure 7.10 presents a schematic of this scenario. This alternative relies on the combination of dilution of the effluent using SCR water and partial advanced treatment to reduce the chloride concentration in the reclaimed water that is conveyed to UWCD. Using this approach, the amount of VWRF effluent that could be used for UWCD for agricultural irrigation can be increased, while still meeting the chloride target. A VWRF flow of 7.7 mgd with 33 percent treated by RO will result in a blended VWRF effluent (partial RO) of approximately 7.3 mgd. Assuming 33 percent of the effluent is treated by RO, the median VWRF flow that could be used at UWCD for conveyance to agricultural users is approximately 7.3 mgd. There is a significant amount of variability in the amount of VWRF effluent (with partial RO) that could be used due the variability in the amount of water that UWCD can divert from the SCR in the summer months. For example, 25 percent of the months, the VWRF effluent (with partial RO) that could be used by UWCD would be less than 5 mgd. In the non-summer months, the VWRF effluent with partial RO. could be used for groundwater recharge, although the volume that VWRF that could be recharged is dependent on the volume of SCR water diverted for recharge.

The third sub-alternative involves maximizing the use of VWRF effluent for agricultural irrigation/recharge at UWCD facilities. In this sub-alternative, the priority would be to maximize recharge based on the availability of diluent water. In the low flow SCR conditions, commonly the summer months, where diluent water may be limited, the treated VWRF water could be used for agricultural irrigation. Approximately 62 percent of the VWRF effluent needs to be treated by RO to meet the chloride concentration of 117 mg/l in the blended water (combination of the water treated by RO and bypassed effluent). Following the Draft Groundwater Reuse Regulations, if we assume the maximum recycled water contribution for surface spreading is 75 percent, a 25 percent contribution of diluent water from the SCR would be needed. A VWRF flow of 12 mgd with 62 percent treated by RO will result in a blended VWRF effluent (partial RO) of approximately 10.7 mgd. To achieve a recycled water contribution of 75 percent, approximately 3.3 mgd of SCR water is needed. The SCR water diverted for recharge was greater than 3.3 mgd in approximately 35 percent of the summer months, and 80 percent of winter months. When the SCR flow diverted for recharge is less than 3.3 mgd in the summer months, then the VWRF effluent (with partial RO) could be conveyed by UWCD to meet irrigation demands. Because the VWRF effluent (with partial RO) meets the 117 mg/L chloride standard, no dilution from SCR water would be needed. This scenario results in year-round use of 10.7 mgd of VWRF effluent that has undergone partial (62 percent) RO treatment.

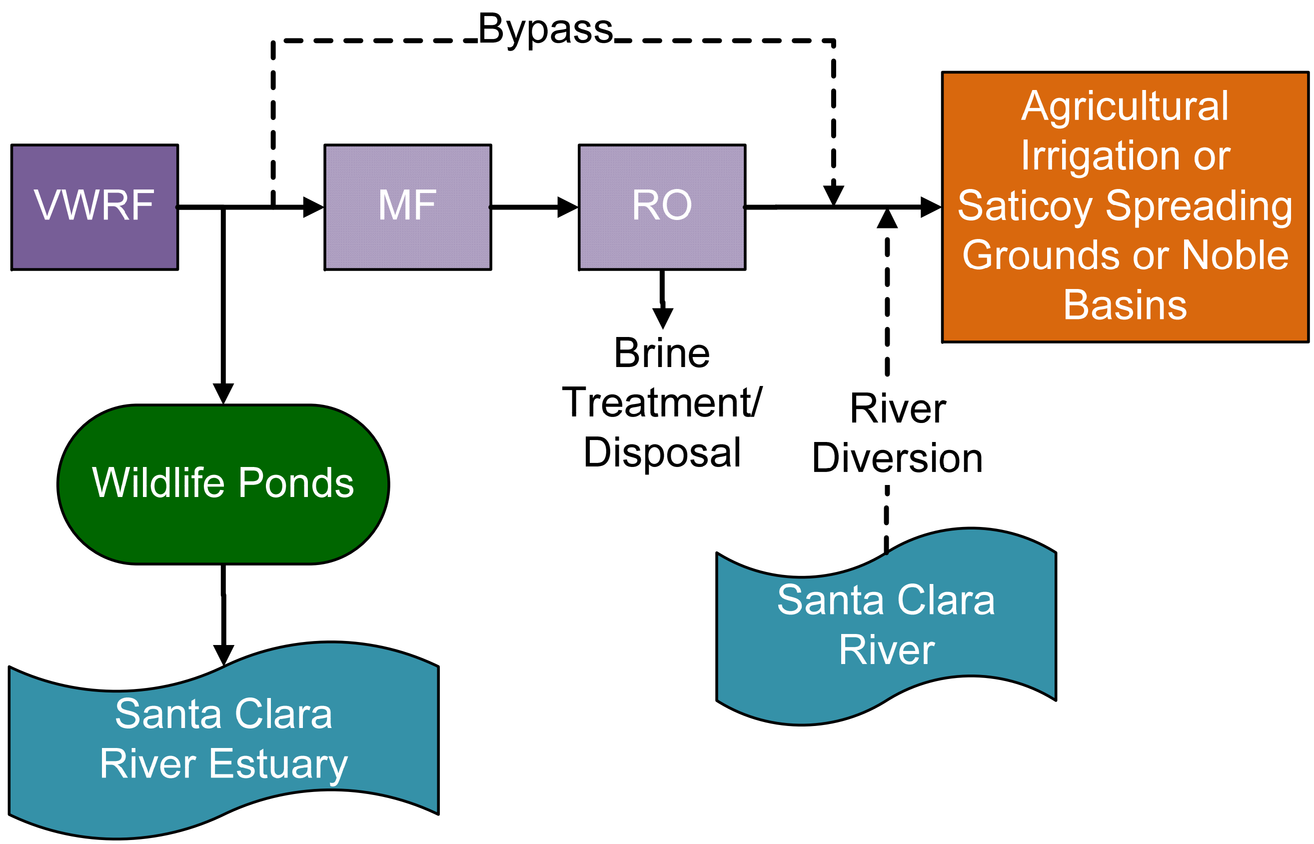


Figure 7.10
PARTIAL RO TREATMENT APPROACH FOR UWCD ALTERNATIVES
PHASE 2 RECYCLED WATER STUDY
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Any alternative that involves groundwater recharge of recycled water at the UWCD facilities would be subject to the minimum travel time of 2 months between recharge sites and potable water supply wells. Groundwater travel time from the Saticoy Spreading Grounds or the Noble Basins to potable supply wells would need to be determined to assess feasibility of this alternative.

7.5.2 Treatment

As discussed previously, the alternative requires a portion of the VWRF effluent to be treated by RO to reduce the chloride concentrations in the VWRF effluent. The additional treatment processes include MF, RO, and brine treatment/disposal (see Section 7.7). Approximately 95 percent of the chloride concentration can be removed through the RO process. As shown in Figure 7.10, a portion of the VWRF effluent would bypass MF and RO, and the bypass flow depends on the alternative.

As discussed earlier, the recovery of the RO process is dependent on the influent (to the RO process) water quality. While preliminary analysis of silica concentrations in the VWRF effluent suggests that the silica content could affect the operation of an RO process, additional data would need to be collected. Additional treatment or operation at a lower recovery are two approaches for addressing issues related to high silica concentrations.

7.5.3 Distribution System

The recycled water from the VWRF would be conveyed to UWCD facilities. Figure 7.11 shows the proposed pipeline alignment. The UWCD's existing distribution systems would provide recycled wastewater to growers for agricultural irrigation. When conditions allow groundwater recharge, the recycled wastewater would be recharged via UWCD’s existing facilities (Saticoy Spreading Grounds or Noble Basins).

7.5.4 Summary

The components of this alternative are summarized in Table 7.6.

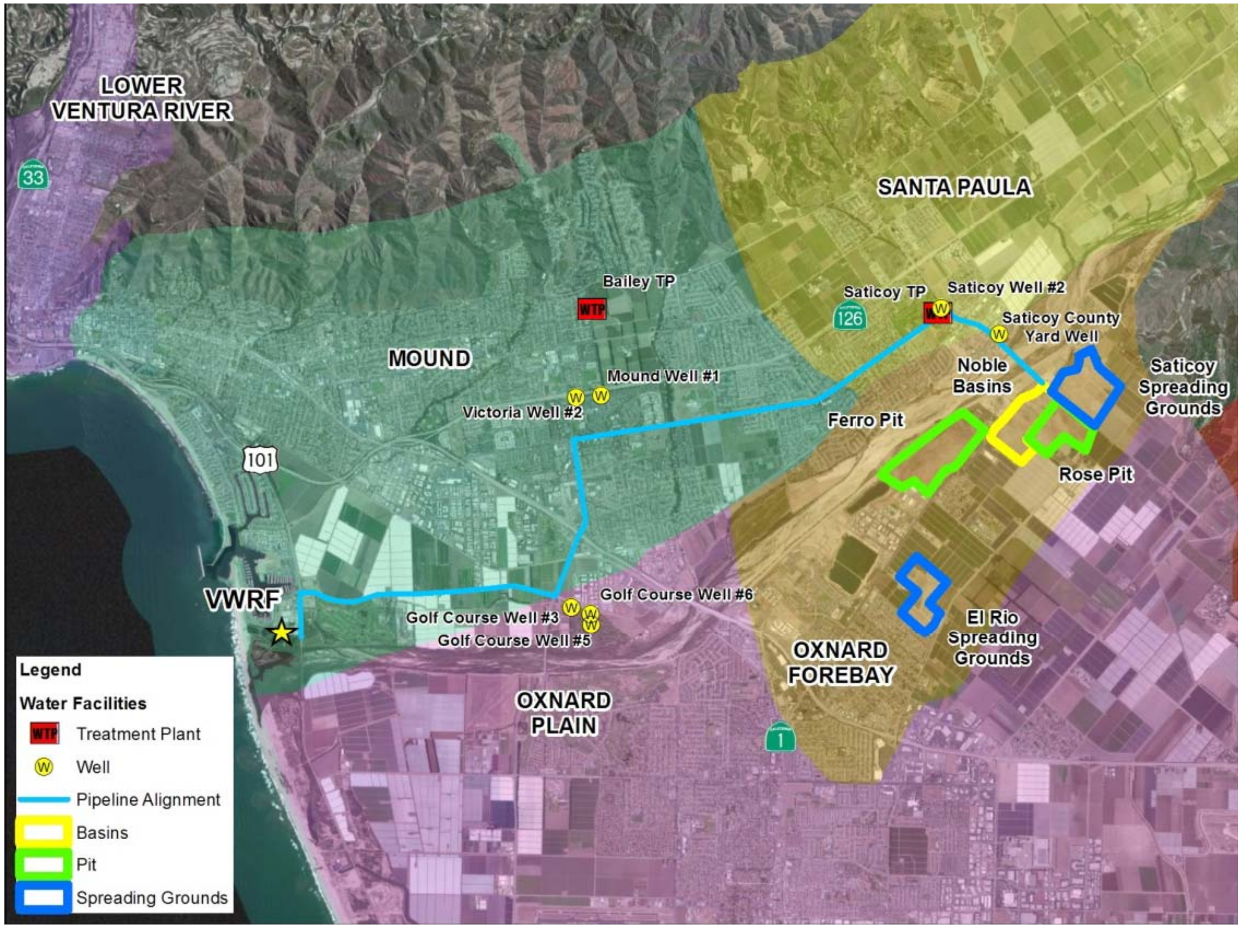


Figure 7.11
POTENTIAL IPR PIPELINE ALIGNMENT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Table 7.6 Summary of the UWCD Groundwater Recharge and Agricultural Irrigation Alternatives Phase 2 Recycled Water Study City of Ventura	
8 mgd Alternative	
Volume Diverted from SCRE	7.7 mgd
Advanced Treatment Processes	MF/UF, RO
RO Flow Percentage	33%
Blended Water (RO and bypass) flow	7.3 mgd
MF/UF and RO Process Capacity	3 mgd
Brine Flow	0.5 mgd
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the VWRF.
Infrastructure	Pipelines and pump stations to convey water from the VWRF to UWCD facilities
12 mgd Alternative	
Volume Diverted from SCRE	12 mgd
Advanced Treatment Processes	MF/UF, RO
RO Flow Percentage	62%
Blended Water (RO and bypass) flow	10.7 mgd
MF/UF and RO Process Capacity	8 mgd
Brine Flow	1.5 mgd
Brine Treatment/Disposal	Required
Siting	Advanced treatment processes located at the VWRF.
Infrastructure	Pipelines and pump stations to convey water from the VWRF to UWCD facilities

7.6 TREATMENT WETLANDS

The treatment wetlands alternative being considered for further evaluation is a hybrid alternative combining both the Wildlife Ponds and City-Owned Property alternatives. In general, the greater the wetland area, the greater the amount of flow that can be routed through the treatment wetlands while maintaining the residence time required to achieve the targeted effluent nitrate concentration (i.e., 3 to 5 mg/L during the critical summer months).

7.6.1 Planning and Design Assumptions

This alternative requires modification of the existing Wildlife Ponds (Pond 1 (Bone) and Pond 2 (Snoopy)), as well as modifying the City-Owned Property located east of and adjacent to the VWRF, to function as treatment wetlands. Ponds 1 and 2 must be filled to reduce the depth to approximately 2.5 feet and vegetated benches need to be constructed creating a total area of approximately 12.4 acres of treatment wetlands. In addition, approximately 29 acres (i.e., 85 percent of the total area) are available for construction of new treatment wetlands on the City-Owned Property. The combined area available for treatment wetlands is approximately 41.4 acres for nitrate reduction and wildlife habitat.

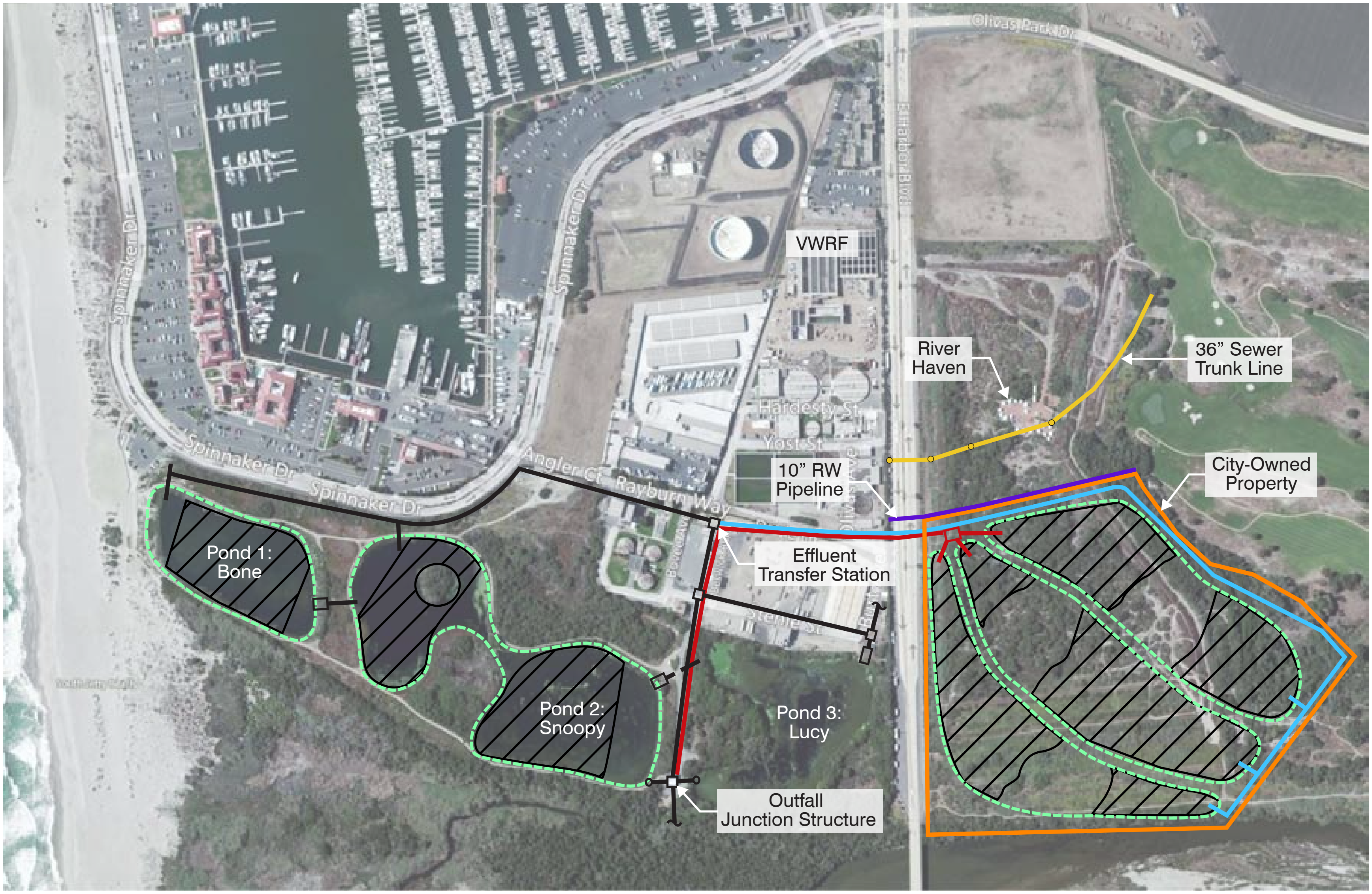
While infrastructure is already in place for the Wildlife Ponds, for the additional wetlands at the City-Owned Property new infrastructure is required to convey the VWRF effluent from the effluent transfer station (ETS) to the wetland, including pump stations and pipelines. New infrastructure is also required to convey the wetland effluent to the SCRE. Discharge from the new wetlands at the City-Owned Property will be routed to the existing VWRF effluent discharge channel via the outfall junction structure (OJS) to eliminate the need for considering a new point of compliance. Figure 7.12 shows an aerial view of the potential layout of the alternative.

7.6.2 Treatment

The primary objective of the treatment wetlands is to further reduce nitrate concentrations in the VWRF effluent to improve water quality in the estuary. The VWRF effluent is currently meeting levels of total inorganic nitrogen of 8 mg/L. Modifying the area of the Wildlife Ponds to be vegetated wetlands provides capacity for up to 3 mgd to be able to meet summer nitrate levels of 3 to 5 mg/L. Combining the existing Wildlife Ponds and the City-Owned Property effluent nitrate concentration levels can be reduced to 3 to 5 mg/L up to the projected future VWRF summer effluent flow of 11.2 mgd. The removal of nitrate in a wetland is variable, and is dependent on detention time (which is a function of area, depth and flow) temperature and vegetation conditions. A range of effluent nitrate concentrations is shown to reflect the variability that can be expected in a natural system and due to the flow variability that may occur.

7.6.3 Distribution

An advantage of this alternative is that the existing interties between the Wildlife Ponds can be preserved, as can the existing discharge channel that conveys effluent into the SCRE. A challenge of this alternative includes the infrastructure (pump stations and pipelines) required to route VWRF effluent from the ETS to the City-owned treatment wetlands and back to the existing OJS. However, this challenge is offset by the potential financial benefit of using an existing City-owned parcel and the potential to provide additional nitrate removal for a larger flow volume. Figure 7.13 shows a process flow schematic for the potential routing required for the treatment wetlands.



LEGEND
Existing
Planned Wetland Influent
Planned Wetland Effluent
Polishing Wetland
Vegetated Zone

Figure 7.12
AERIAL VIEW OF THE TREATMENT WETLANDS ALTERNATIVE
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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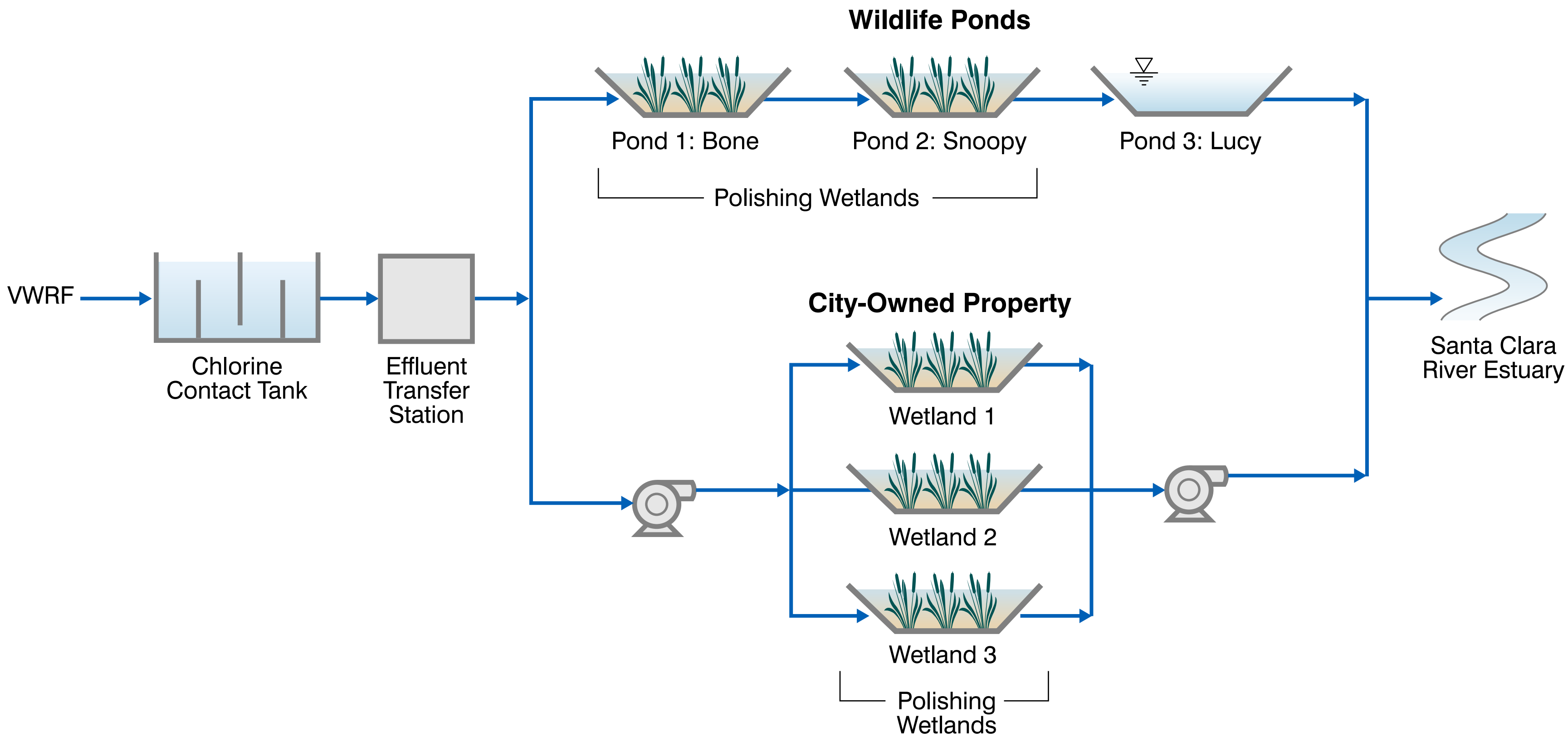

Figure 7.13
PROCESS FLOW SCHEMATIC OF THE TREATMENT WETLANDS ALTERNATIVE
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

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7.7 BRINE TREATMENT AND DISPOSAL

Several of the alternatives discussed in sections 7.1 through 7.5 require partial or full RO treatment. These alternatives include:

- Mound Basin IPR
- DPR
- Groundwater Recharge/Agricultural Irrigation at UWCD

The brine generated from these alternatives requires treatment and/or disposal. Brine flows from these alternatives range from 0.5 mgd to 1.6 mgd.

AECOM (2011) conducted a groundwater treatment study that evaluated treatment options for the City's potable supply. The study includes an evaluation of RO for groundwater treated at the Bailey Conditioning Facility and the Saticoy Conditioning Facility. Approximately 1.4 mgd of brine would be generated from RO of these two water supplies.

The AECOM (2011) study evaluated a number of brine disposal alternatives, including discharge to the SCRE, evaporation ponds, deep well injection, ocean outfalls, and a wetland discharge. The evaluation of discharge to an ocean outfall included investigation of a number of discharge points, including (1) Calleguas SMP; (2) Reliant Power Plant, Ormond (3) Reliant Power Plant, Mandalay (4) City of Port Hueneme WWTP; (5) Oxnard WWTP (6) Ventura WRP ; (7) Fairgrounds outfall; (8) Crimson Pipeline; (9) beach wells or reverse Ranney collectors. The results of this analysis are summarized in Table 7.7.

As shown in Table 7.7 there are a number of alternative brine disposal alternatives that may be possible, pending further investigation of technical, regulatory, and inter-agency issues. The Calleguas SMP is an existing brine line and is therefore one of the more promising alternatives. Section 7.7.1 presents additional information on conveying brine generated at the VWRF to the Calleguas SMP.

With the exception of evaporation ponds, the AECOM (2011) report did not evaluate zero liquid discharge alternatives. Section 7.7.2 includes a discussion of a zero liquid discharge (ZLD) alternative.

7.7.1 Brine Pipeline to Calleguas SMP

The brine pipeline to the Calleguas SMP would follow the same alignment as discussed in the alternative where VWRF effluent would be conveyed to the Oxnard AWPF. Figure 7.5 presents this alignment. The brine pipeline consists of approximately 10 miles of 8-inch PVC pipe. The size of the pipeline was designed to convey approximately 1.6 mgd, the greatest brine flow that would be generated from the various alternatives.

Table 7.7 Summary of Brine Disposal Alternatives Presented in AECOM (2011) Phase 2 Recycled Water Study City of Ventura		
Alternative	**Further Investigation (Y/N)**	**Comments (per AECOM, 2012)**
Discharge to the SCRE	N	Permit challenges. Opposition from organizations and stakeholders.
Evaporation Ponds	N	Limited by climate and land availability. Thousands of acres would be required for evaporation ponds.
Deep Well Injection	Y	The logistics of deep well injection in the Ventura Oil Field would require additional study
Santa Clara Valley Regional Brine Line	Y	Potential new regional brine line. Requires interest and agreement between participating municipalities
Ocean Outfalls		
Calleguas SMP	Y	Existing brine line with capacity for brine from the VWRF
Reliant Power Plant Ormond	Y	Permitting challenges. Technical issues related to the "dilution ratio", due to the intermittent operation of the power plant. Additional study is needed to determine whether this outfall could be used.
Reliant Power Plant Mandalay	N	Existing permitting challenges and issues similar to the Ormond alternative limit feasibility.
City of Port Hueneme WWTP	N	Abandoned outfall removed as a condition of the permit process of the Calleguas SMP
Fairgrounds outfall	Y	Condition of pipeline requires additional study
Beach wells or reverse Ranney collectors	N	Coastline is not well suited for production of seawater or disposal of brine because of the poor transmissivity of the soil.

7.7.2 Zero Liquid Discharge

For a ZLD process, RO recovery should be maximized prior to downstream brine minimization processes to minimize capital and operating costs. In order to maximize recovery of the primary RO process, soluble salts are removed from the wastewater effluent through a softening process.

Using the wastewater effluent water quality and RO performance projections, brine quality was established. The brine quality is the basis for developing the ZLD system. The brine quality is presented in Table 7.8. Based on this analysis, a treatment process that utilizes chemical softening (upstream of the MF), filtration, reverse osmosis, was developed to achieve a zero liquid discharge brine management system. The proposed process is presented in Figure 7.14.

**Table 7.8 Projected Primary RO Brine Quality
Phase 2 Recycled Water Study
City of Ventura**

Parameter	Units	Value
pH	units	9.7
Total Dissolved Solids	mg/L	15,800
Total Hardness	mg/L as $CaCO_3$	4,570
Total Organic Carbon	mg/L	
Total Alkalinity	mg/L as $CaCO_3$	10
Ammonia	mg/L as N	9.6
Barium	mg/L	0.11
Bicarbonate	mg/L as $CaCO_3$	12
Calcium	mg/L	632
Chloride	mg/L	3,080
Fluoride	mg/L	1.4
Magnesium	mg/L	727
Nitrate	mg/L	225
Phosphate	mg/L	44
Potassium	mg/L	284
Silica (Total)	mg/L as SiO_2	336
Sodium	mg/L	3,280
Strontium	mg/L	11.9
Sulfate	mg/L	7,262

Notes:
(1) Design water based on softened wastewater effluent treated with RO at a recovery of 92%. Quality projected using Hydranautics IMSDesign (R) software, ESPA 2 membranes, and a 3-yr membrane age.

In this system, the recovery rate of the RO is approximately 99.3 percent. The resulting brine flows range from 0.4 to 0.8 mgd. The brine flow is further reduced (via a thermal process) and the conveyed to evaporation ponds. The required evaporation pond areas range from 17 to 37 acres.

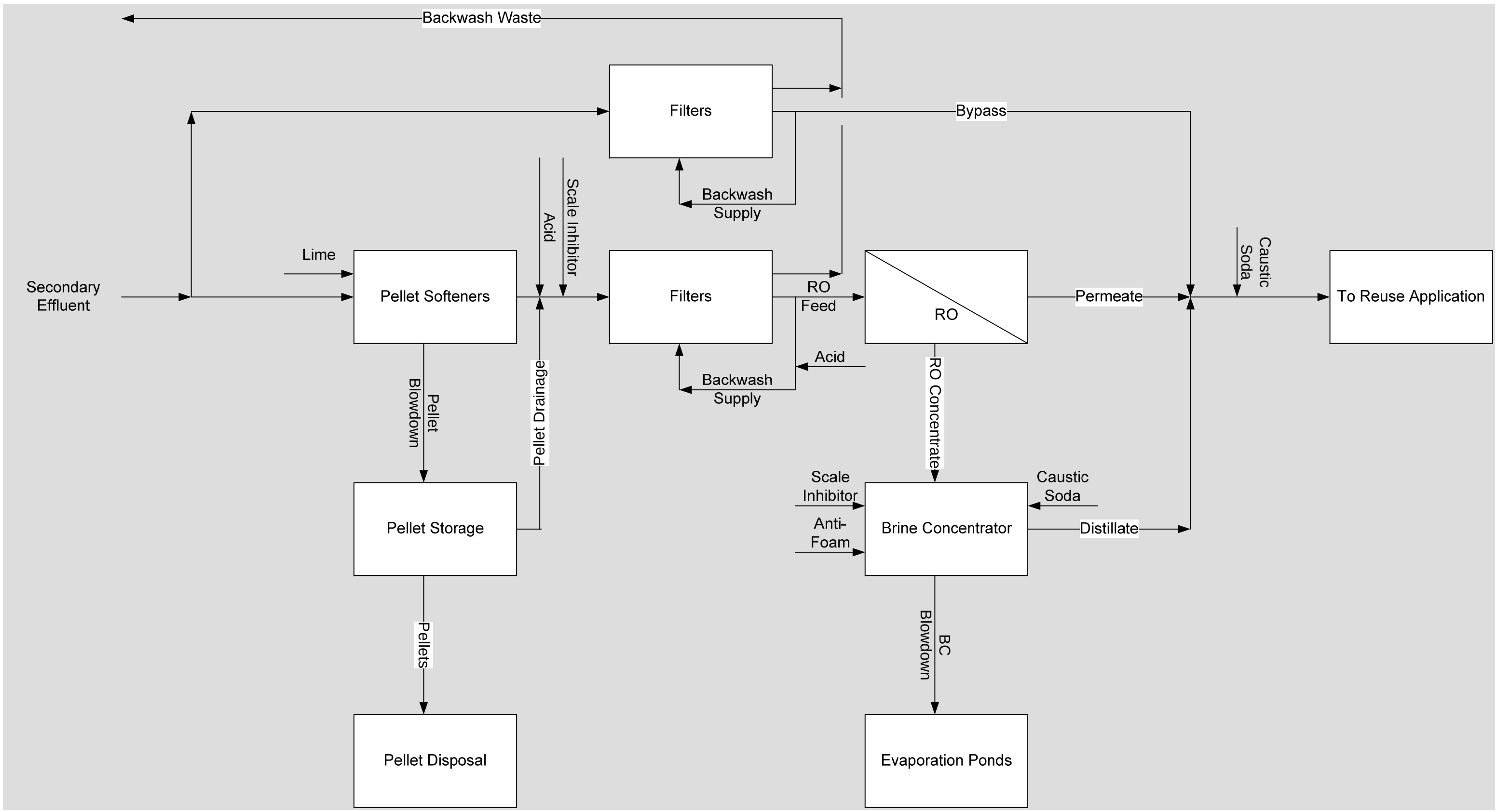

Figure 7.14
ZLD TREATMENT PROCESS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

7.8 ENVIRONMENTAL CONSIDERATIONS

There are both short and long-term environmental considerations associated with implementing any of the alternatives discussed in this report. The primary long-term environmental considerations include:

- Creation of new wetland habitat
- Impacts on SCRE habitat and ecosystem functions
- The short term environmental impact and primarily associated with construction activities, and will be described in subsequent studies when the proposed project is defined.

7.8.1 Creation of New Wetland Habitat

Throughout the stakeholder involvement process, many stakeholders have expressed interest in implementing alternatives that will lead to creation of new wetland habitat. This study evaluated a number of wetland treatment alternatives that would provide polishing treatment for the VWRF effluent prior to discharge into the SCRE, and would create

additional wetland habitat adjacent to the SCRE. The preliminary screening analysis (Chapter 6) of the wetland treatment alternatives led to the conclusion that the most feasible treatment wetland alternative involved reconfiguration of the existing Wildlife Ponds, in combination with the new treatment wetlands on the City-owned property. The Phase 1 Treatment Wetlands Feasibility Study describes the habitat that would be created as a result of implementing treatment wetlands at the Wildlife Ponds and adjacent city-owned property.

While treatment wetlands provide additional habitat, they do not achieve the objective of reducing the VWRF effluent discharge volume to the Estuary. All of the other alternatives discussed in this chapter provide some degree of reduction in the VWRF discharge flow to the SCRE. To achieve both effluent reduction and habitat creation, the alternatives have been combined. It is assumed that for each alternative (described in sections 7.1 through 7.5), the remaining effluent flow to the SCRE would be routed to a treatment wetlands. The benefits of this approach include additional polishing treatment of the VWRF effluent prior to discharge to the SCRE, and the creation of wetland habitat.

As discussed in Section 7.6, the area of the Wildlife Ponds (modified to be vegetated wetlands) provides capacity for up to 3 mgd. The combined area of the Wildlife Ponds (modified to be vegetated wetlands) and the City-Owned Property would be needed to meet nitrate concentration levels of 3 to 5 mg/L for higher flows.

7.8.2 Impacts on SCRE Habitat and Ecosystem Function

The Phase 1 Estuary Study assessed habitat/ecosystem function affected by each alternative during the dry season (June through September) by using the SCRE water balance, nutrient balance, and SCRE stage modeling tools. These tools developed during Phase 1 predicted future SCRE focal species habitat conditions while accounting for climate change and various alternatives for modifications to VWRF effluent discharges. Habitat conditions were assessed as a function of modeled SCRE stage, water depth, and associated mouth breaching timing, modeled average nitrogen levels, and habitat areas (as a function of SCRE stage) and habitat needs of for each listed focal species (Steelhead, Tidewater goby, California least tern, and Western snowy plover) associated with each VWRF discharge alternative. Stillwater Sciences (2011) includes a comprehensive analysis of the habitat/area relationship and water quality conditions to support the focal species. In the Phase 2 studies, these established conditions were used as the basis for evaluating the impacts of alternatives on SCRE beneficial uses related to habitat and ecosystem function.

Based on Stakeholder feedback received following the Phase 1 alternatives assessment, additional data was collected for Phase 2 and used to update both the water balance and nutrient balance tools. The additional data collected for Phase 2 led to several modifications to the water and nutrient balances, as described in Stillwater Sciences (2013) (provided in Appendix D) Key changes to the water and nutrient balances include:

- A SCRE berm breaching elevation of 12.5 feet.
- Total inorganic nitrogen (TIN) concentration of 8 mg-N/L in the VWRF effluent.
- Groundwater data from new wells on the north side of the SCRE provided groundwater quality information (TIN concentrations as high as 15 mg-N-L).

The Phase 2 alternatives assessment included developing SCRE stage/depth estimates for both dry and wet water year types as a means of elucidating the anticipated minimum and maximum values associated with each alternative. The Stillwater Sciences (2013) technical memo (Appendix D) describes the analysis of the effects of the alternatives on SCRE beneficial uses based upon impacts to the focal species' habitat and ecosystem function.

As described in Stillwater Sciences (2013), available habitat was assessed as a function of modeled SCRE stage and associated mouth breaching timing, modeled average nitrogen levels, and focal species habitat area (as a function of SCRE stage) associated with each VWRF discharge alternative. Detailed discussion on the SCRE stage-the focal species habitat area versus SCRE stage relationships can be found in Stillwater Sciences (2011). Because spatial variations in substrate, water temperature, salinity, and dissolved oxygen were considered to be relatively minor, focal fish species habitat use was related only to variations in depth and vegetative cover. For Central Coast steelhead, area versus stage curves were limited to shallow water areas (0.15–1 m [0.5–3.0 ft]) adjacent and within flooded vegetation for juvenile rearing, and considered all open water habitats deeper than 1 m (> 3.3 ft) suitable for adult upmigrants. For tidewater goby, understanding that most seining efforts were concentrated along the SCRE margin, potential habitat was mapped within a depth range of 0.3–1.5 m (1.0–4.9 ft)(Stillwater Sciences 2011). For focal bird species, habitat area curves were related to unvegetated areas potentially used for nesting (western snowy plover and California least tern), as well as foraging (western snowy plover). For western snowy plover, the amount of open water areas potentially available for foraging was also included in the habitat area versus stage relationships (Stillwater Sciences 2011).

The bird watching recreational benefit of the SCRE remains an important evaluation criterion and is incorporated into the analysis through evaluation of the foraging and nesting habitat of the focal species. The impacts of the alternatives on recreational camping opportunities at McGrath State Park are noted, however, due to uncertainty associated with future closure and/or relocation, the impacts to recreational camping opportunities were not used as an evaluation criterion.

The effects of the remaining discharge on the SCRE were evaluated for each alternative for both the existing and future VWRF flow conditions. The discharge to the SCRE under current and future conditions was calculated based on a water balance for the treatment plant and existing Wildlife Ponds. Figure 3.2 presented a treatment plant schematic. The effluent flow meter is located at the ETS. Flow is diverted for the existing recycled water system upstream of the ETS. There are internal plant recycled water streams that are also diverted upstream of the ETS. The influent flow meter measures the raw influent wastewater to the treatment plant and the internal plant recycled water streams. The Wastewater Master Plan projected the influent ADWF to be 13 mgd, for the buildout condition. The calculations of existing and future VWRF effluent flow into the proposed treatment wetland are summarized in Table 7.9.

Table 7.9 Historic and Projected Flows
Phase 2 Recycled Water Study
City of Ventura

Development Condition	Existing (mgd)(1)	Projected at Build-out(2) (mgd)
Influent Treatment Plant Flow (June through September)	-	13.0 (3)
Existing Recycled Water System Diversion (Summer)	-	1.0
Internal Treatment Plant Recycle Flow	-	0.8
VWRF Effluent Flow (June through September)	7.3	11.2

Notes:
(1) Effluent flow data from the ETS was used to estimate the average June through September flows.
(2) The projected VWRF (June through September) effluent flow was calculated using the projected ADWF for the influent and the approximate flows diverted for recycled water use and for internal plant recycled streams.
(3) The projected ADWF of 13.0 mgd from the Master Plan is a good estimate of the average June through September influent flow, based on analysis of historical data.

The amount of flow that would be routed to the treatment wetlands and subsequently discharge to the SCRE was calculated for each alternative under existing and future conditions. The loss of water through evaporation and percolation through the wetlands was estimated based on the observed losses from the existing Wildlife Ponds. Based on the influent flow to the treatment wetlands, the effluent nitrate concentrations were estimated based on estimates of hydraulic residence time, water temperature, and denitrification rate constants, as well as other inputs and parameters. A range of nitrate concentrations was estimated for each of the alternatives and the upper end of this range was used as input to the nutrient balance for the SCRE. The flow and water quality conditions for the alternatives are summarized in Table 7.10. In addition, Table 7.10 also includes the results of a “no action” alternative, which represents the existing VWRF discharge flow and quality to the SCRE.

In each of these alternatives where there is flow into the treatment wetlands, the outflow of the wetlands results in a discharge to the SCRE. The discharge flows from the treatment wetlands to the SCRE range from 0 to 8 mgd, and the nitrate concentrations of the discharges range from 4 mg-N/L to 5 mg-N/L. For each of the alternatives with remaining VWRF effluent flow, the effluent would be conveyed to a treatment wetland to further improve water quality, Depending on the remaining VWRF effluent flow, the wetlands would be the “onsite” Wildlife Ponds with modifications and/or the modified Wildlife Ponds in combination with the offsite City-owned property. The “no action” alternative represents the discharge from the Wildlife Ponds and existing flows. Each of the existing and future conditions for the alternatives, dry and wet year hydrologic conditions were evaluated. The analysis is limited to the critical summer period, June through September, when the SCRE mouth is typically closed. Alternatives with the same discharge conditions have be grouped to simplify Table 7.10.

The analysis included an assessment of SCRE hydrology and stage, water quality, and SCRE habitat. The results are summarized as follows.

Estuary hydrology and stage

- For zero effluent discharge alternatives (i.e., those alternatives with zero VWRF discharge into the SCRE), the maximum modeled equilibrium stage range for dry and wet water year conditions was the lowest of all the alternatives considered (~2.5–3 ft lower than the No Action alternative) and the average unmeasured groundwater inflow range (which is driven by SCRE stage) was the highest (~1.9–2.6 MGD lower than the No Action alternative).
- Increasing the effluent discharge rate resulted in a progressive increase in SCRE equilibrium stage and associated decrease in unmeasured groundwater flow rate.

**Table 7.10 Estimated Average Dry Season (June - September) Flows and Nitrate Concentration for Each Alternative
Phase 2 Recycled Water Study
City of Ventura**

Alternative	Treatment Wetland	Flow Components (mgd)					Discharge to SCRE (from Treatment Wetlands) Nitrate Concentration (mg-N/L)
		VWRF Effluent	Diverted Effluent Capacity	Influent to Treatment Wetland	Evaporation/Percolation Estimate (2)	Approximate Discharge to SCRE from the Treatment Wetlands	
Existing Flows							
No Action	None	7.3	-	-	1	6.3 (5)	8 (6)
North decentralized plant (Irrigation or DPR)	Onsite + City-Owned	7.3	2.0(4)	5.3	1.3	4	4
Conveyance to Oxnard or Recharge/Ag supply for UWCD	Onsite	7.3	>7.3 (1)	0	-	0	0
Ag supply for UWCD	Onsite	7.3	>7.3 (1)(3)	0	-	0	0
Mound Basin IPR & DPR (3.6 mgd)3	Onsite	7.3	4.5	2.8	1	2	4
Mound Basin (6.3 mgd)	Onsite	7.3	>7.3 (1)	0	-	0	0
Future Flows							
North decentralized plant (Irrigation or DPR)	Onsite + City-Owned	11.2	2.0(4)	9.2	1.3	8	5
Conveyance to Oxnard or Recharge/Ag supply for UWCD	Onsite	11.2	>11.2	0	-	0	0
Ag supply for UWCD	Onsite + City-Owned	11.2	7.7(3)	3.2	1.3	2	4
Mound Basin IPR & DPR (3.6 mgd)3	Onsite + City-Owned	11.2	4.5	6.7	1.3	5	4
Mound Basin IPR (6.3 mgd)	Onsite + City-Owned	11.2	7.9	3.3	1.3	2	4

Notes:
(1) Capacity for the diverted flow is greater than the VWRF effluent flow. The VWRF effluent flow was used for the calculations.
(2) Estimated as 1 mgd for the onsite wetlands (modified Wildlife Ponds) and 1.3 mgd for the combination of the Modified Wildlife Ponds and the City-Owned Property Wetlands.
(3) There is significant variability in the diverted capacity since the diverted flow depends on the diverted SCR flow.
(4) The effluent flow diverted for Irrigation and DPR are 2 mgd and 2.5 mgd respectively. The lower value of 2 mgd was used.
(5) In this alternative treatment wetlands would not be constructed and therefore approximately 6.3 mgd would discharge from the Wildlife Ponds to the SCRE.
(6) For this alternative, treatment wetlands would not be constructed and therefore, the VWRF effluent nitrate concentration is assumed for the discharge into the SCRE.

- In addition, increasing the effluent discharge resulted in a decreasing difference in dry and wet water year stage and unmeasured groundwater inflow for individual discharge alternatives, suggesting that SCRE stage/depth and subsequent habitat area is more sensitive to water year type at lower VWRF discharge rates than higher rates.
- The maximum equilibrium stage for the 8 MGD discharge alternative was 11.5 ft NAVD88 (~0.5 ft higher than the No Action alternative), which is considered to be below the current breaching threshold indicated by summer/fall 2012 SCRE stage data but is above the breaching threshold during the Phase 1 alternatives assessment. Although the SCRE mouth berm can currently remain closed at a stage up to approximately 12.5 ft NAVD88 during dry season, low-flow conditions, it should be noted that there is the possibility that this is a temporary condition and the breaching stage may be lower in the near future.
- At a discharge volume between 2 mgd and 4 mgd, the SCRE stage to rise above 9.5 ft NAVD88 during extended dry season, closed-mouth periods, thereby causing flooding at the McGrath State Beach campground.

Estuary water quality

- As discussed for the development of the nutrient balance (Stillwater Sciences 2011), future TIN levels will rapidly approach the largest flow and thus load contribution to the SCRE under the future discharge conditions.
- Because recent water quality monitoring results show relatively high TIN levels in shallow groundwater along the north side of the SCRE that were previously un-identified and also show low TIN levels in the VWRF discharge due to the future improvement in water quality (shown as wetlands in all alternatives), the current modeling results suggest the projected lower TIN levels in VWRF discharges as compared to groundwater inflows may improve conditions in the SCRE affected by excess nutrients such as biostimulation of nuisance algae as well as any interrelationship with adverse dissolved oxygen conditions.
- Alternatives with no discharge to the SCRE result in the greatest SCRE nitrate concentrations.
- The lowest TIN levels in the SCRE were achieved for alternatives that resulted in discharges to the SCRE of 4 to 8 mgd with nitrate concentrations ranging from approximately 3 mg-N/L to 5 mg-N/L.

Assessment of Impacts to Estuary Habitat Conditions

- The highest VWRF discharge (8 mgd) resulted in the highest average depth and wetted area (with values being ~10% higher than for the No Action alternative discharge average dry season flow of 6.3 MGD).

- Steelhead habitat area increased with increasing VWRF discharge, reaching the maximum value of approximately 157 acres for all alternatives under the 8 mgd discharge scenario (which was ~6% higher than the No Action alternative stage).
- Because of the relatively high stage and inundated area of the SCRE, California least tern foraging habitat area remained fairly static at approximately 130 acres for all alternatives.
- Tidewater goby and habitat was essentially static at approximately 110 acres for the zero through 5 mgd alternatives then dropped considerably to approximately 85 acres for alternatives with a discharge of 8 mgd to the SCRE.
- California least tern/western snowy plover nesting habitat was essentially static at approximately 180 acres for the zero through 5 mgd alternatives then dropped considerably to approximately 160 acres for alternatives with a discharge of 8 mgd to the SCRE.

The alternatives result in five different combinations of SCRE discharge flow and nitrate concentration. Table 7.11 presents the results of the analysis for these conditions, as well as the no action alternative, and therefore brackets the range of results that would occur as a result of implementing the alternatives. The color gradations in Table 7.11 represent a relative comparison of the results with the lightest shades representing the lowest water quality/habitat and the darkest shades representing the highest quality and habitat. California least tern foraging habitat is not included in Table 7.11 because the results were constant across the discharge flow and nitrate concentrations. Table 7.11 suggests that a discharge flow into the SCRE of 4 to 5 mgd, and a nitrate concentration of 4 mg-N/L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide a the greatest (or near greatest) habitat for the four focal species.

As stated in the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011), because significant levels of TIN are present in local groundwater and the Santa Clara River, it should be noted that reductions in nitrate levels under one or more alternatives may not result in substantially reduced algal levels and continued algal bloom episodes are likely to occur under all alternatives. Historically measured dissolved oxygen levels in some locations within the SCRE were periodically found below Basin Plan objectives (Stillwater Sciences 2011). Nevertheless, it is expected that the frequency and duration of algal blooms and any related dissolved oxygen impacts should decrease with reduced TIN levels. As discussed in Stillwater Sciences (2011), however, measurable reductions of algal biomass in the SCRE may not occur until the TIN:PO4 ratio approaches 4.5:1 by mass, with TIN approximately below 1.5–4.5 mg-N/L under current conditions.

Table 7.11	**Estimated Average Dry Season (June through September) Flows and Nitrate Concentration for each Alternative Phase 2 Recycled Water Study City of Ventura**				
Discharge to SCRE – Flow and Water Quality			**Predicted Habitat, acres**		
Flow (mgd)	**Nitrate Concentration from treatment wetlands (mg-N/L)**	**Predicted SCRE Nitrate Concentration Range (mg-N/L) (1)(3)**	**Steelhead**	**Tidewater Goby**	**CLT and WSP nesting (2)(3)**
No Action (6.3)	8	6.2 – 7.7	148	101	167
0	0	9.6 – 12.5	58	107	183
2	4	4.5 - 8	78	110	183
4	4	3 – 5.2	115	111	182
5	4	2.8 – 4.7	132	110	177
8	5	3.5 – 4.9	157	85	160

Notes

(1) Concentration range is based on range of denitrification rates and wet and dry hydrologic conditions.

(2) CLT = California least tern; WSP = Western snowy plover

(3) Color gradations for SCRE nitrate concentrations and habitat area show lowest quality/habitat in the light shades and the highest quality/habitat in the darkest shades. For similar numbers the same color shading was applied.

As discussed in Stillwater Sciences (2011), unseasonal breaching of the SCRE mouth has potential adverse impacts on tidewater goby and steelhead. Estimated stages for a discharge into the SCRE of 4 mgd and 5 mgd are 9.5 feet NAVD88 and 10.5 feet NAVD88 respectively. Both of these stage estimates are below both the Phase 1 and Phase 2 estimates of breaching stage (11.0 feet NAVD88 and 12.5 feet NAVD88, respectively). The alternatives with discharges into the SCRE of 4 mgd to 5 mgd will result in increased breaching potential relative to alternatives with lower discharges in to the SCRE, but reduced breaching potential relative to alternatives with greater discharge into the SCRE.

It is important to understand that the alternatives do not need to be implemented at their full diversion capacity shown in this study. Several alternatives could be implemented at a capacity for diversion that would lead to increased water recycling, and local supply benefits, while continuing a discharge to the SCRE of between 4 to 5 mgd. At these flow levels, the combination of the modified Wildlife Ponds and the City-Owned Property would be used for treatment wetlands to achieve a nitrate concentration of approximately 4 mg-N/L (outflow from the treatment wetlands to the SCRE).

The findings, based on the additional data collected on Phase 2, are different than the results of the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011), which suggested that a lower VWRF discharge into the SCRE would provide better water quality conditions. The difference in these findings is in large part due to the north side groundwater data that were obtained during Phase 2. However, the estimated groundwater flow and quality from the north side is based on a limited data set. The results and evaluation of alternatives that follows is based on findings of the Phase 2 study, which suggests that a discharge flow into the SCRE of 4 to 5 mgd, and a nitrate concentration of 4 mg-N/L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide a the greatest (or near greatest) habitat for the four focal species. However, as noted in Chapter 8, the City plans on conducting further groundwater studies to confirm the Phase 2 data and water quality analysis.

7.9 COST ESTIMATES

7.9.1 Basis of Costs

Capital costs are Class 5 estimates as outlined by the Association for the Advancement of Cost Engineering International. Class 5 estimates are typically used for conceptual and screening purposes and are based on a project definition of 0 to 2 percent. A contingency is often used to compensate for lack of detailed engineering data and oversights (–20 percent to -50 percent on the low side, and +30 percent to +100 percent on the high side) depending on the technological complexity of the project, availability and accuracy of appropriate reference information, and the inclusion of an appropriate contingency determination.

The costs presented are based on preliminary layouts, preliminary unit process sizes, and conceptual alternative configurations. Construction costs are estimated from unit costs developed from estimating guides, equipment manufacturers' information, unit prices, and construction costs of similar facilities and configurations at other locations.

The total installed equipment costs are inclusive of the equipment, and associated installation costs and ancillary equipment. The total construction costs include the total installed equipment costs, and additional costs to account for sales tax, general conditions, contractor overhead and profit margin, and a construction estimating contingency. The project costs include an additional cost to account for engineering, legal, administration, and project contingencies (ELAC). Table 7.12 presents a summary of the percentages applied to account for these costs.

Table 7.12 Summary of the Total Project Cost Components Phase 2 Recycled Water Study City of Ventura		
Description	**Percentage**	**Subtotal Calculation**
Installed Equipment Cost	-	A
Construction and Estimating Contingency	30%	B=A*30%
Contractor Overhead and Profit Margin	10%	D=C*10%+C
Sales Tax Rate	7.5%	E=7.5%*B*0.5+D
Total Construction Cost		E
ELAC	30%	F=E*30%+E
Total Project Cost		F

7.9.2 Costs Common to Alternatives

7.9.2.1 Treatment Wetlands

Common to all of the alternatives, is the additional cost of treatment wetlands, as the approach is to combine each of the alternatives with treatment wetland for any remaining flow that the alternative does not provide the capacity to divert for reuse. Considering the additional cost of treatment wetlands as common to all alternatives also assures that additional water quality treatment and habitat benefits associated with the treatment wetlands are provided should it be determined appropriate to implement one or more alternatives at less than full diversion capacity for purposes of assuring some continued discharge to the SCRE to control TIN values. Costs are included to construct vegetated zones in the existing Wildlife Ponds as well as constructing new treatment wetlands at the City-Owned Property adjacent to the VWRF.

The planning level estimates of total project costs and annual O&M costs are provided in Table 7.13. The total project cost estimates include treatment wetland construction as well as pumping and pipeline costs as separate line items. The Wildlife Ponds treatment wetland construction cost estimate includes only fill, earthwork, plants, and planting, since the remaining items were already performed or were in place. The City-Owned Property treatment wetland construction cost estimate includes clearing and grubbing the site, earthwork, plants and planting, control structures, and plumbing. The pump cost estimates are based on the average annual flow and the distance the pump will convey the treated effluent from the Wildlife Ponds to the City-Owned property (accounting for the total dynamic head). The pipeline cost estimates are based on the total length, diameter, and material of the pipe determined to be appropriate for conveying the treated effluent. The annual O&M costs are based on *Constructed Wetlands Treatment of Municipal Wastewater Manual* range of costs ($2,000 to $4000 per hectare) of treatment wetlands (U.S. EPA, 2000). Costs from this manual were adjusted to November 2012 dollars using the ENR index for Los Angeles.

Table 7.13 Summary of Treatment Wetland Planning Level Estimates of Total Project Costs in 2013 Phase 2 Recycled Water Study City of Ventura		
	Wildlife Ponds 1 & 2	**City-Owned Property**
Approximate Area (acres)[1]	12.4	29
Pipe Length from VWRF (feet)	N/A	5,200
Wetland Construction ($)	$670,000	$3,000,000
Pump and Pipeline Costs ($)	N/A	$3,100,000
Total Project Costs ($)	$670,000	$6,100,000
Annual O&M Costs ($)[2]	$30,000	$120,000

Notes:
(1) Area provided in table is 85 percent of the total area available for the constructed treatment wetland.
(2) Based on *Constructed Wetlands Treatment of Municipal Wastewater Manual* range of costs for operations and maintenance ($2,000 to $4000 per hectare) of treatment wetlands (U.S. EPA, 2000). Costs from this manual were adjusted to November 2012 dollars using the ENR index for Los Angeles.

7.9.2.2 Brine Treatment/Disposal

As discussed in Section 7.7, there are a number of brine treatment and disposal alternatives that could be considered. Constructing pipeline to the Calleguas SMP is one of the more promising alternatives since the Calleguas SMP is an existing pipeline. The estimated cost for the pipeline between the VWRF and the Calleguas SMP is approximately $22 million.

Additional investigation of brine treatment alternatives for this study included an analysis of zero liquid discharge systems. The resulting project cost estimates for the range of flows that require brine treatment range from $59 million to $120 million.

These costs far exceed the estimated cost of $22 million to construct a pipeline to convey brine from the VWRF to the Calleguas SMP. Therefore, the costs for the alternatives that require brine disposal include the cost ($22 million) of the pipeline to convey the brine from the VWRF to the Calleguas SMP.

7.9.3 Alternatives Cost Estimates

The project cost estimates, capital and O&M, for the alternatives are summarized in Tables 7.14 and 7.15 and Appendix G provides the detailed estimates. The project cost components include all treatment and infrastructure costs associated with each alternative. Based on the complexity of the alternative and the potential permitting challenges, the CEQA and permitting costs were estimated for each alternative. The total project costs are therefore the sum of the project components and the CEQA/permitting costs. The project cost estimates in Tables 7.14 and 7.15 do not reflect any potential financial offsets associated with existing water and wastewater system operating costs or future capital investments that may be avoided through implementation of the alternatives. Potential financial offsets are listed in Table 7.16.

For the alternative where VWRF effluent is conveyed to the City of Oxnard for treatment and reuse, two cost options are presented in Tables 7.14 and 7.15. The City and the City of Oxnard do not have an agreement as to the financial approach and parties responsible for the both capital and O&M costs. While there are numerous possible arrangements that could be made between the City and the City of Oxnard, the following two possibilities are considered in this study:

- City pays for AWPF expansion – In this scenario, the City would be responsible for the capital investment in the AWPF expansion. In addition, the City would pay the City of Oxnard for O&M associated with treatment of VWRF effluent at the AWPF.
- City of Oxnard pays for AWPF Expansion – In this scenario, the City of Oxnard would be responsible for the capital investment in the AWPF expansion. The City would pay annual fees to the City of Oxnard to cover both treatment costs at the AWPF and an annualized capital costs that would allow the City of Oxnard to recover their capital investment.

The total project costs excluding the treatment wetlands, are presented in Table 7.14 and these costs are carried over into Table 7.15, which presents life cycle costs for the alternatives. The project costs without the treatment wetlands are presented because the treatment wetlands are not explicitly needed to produce recycled water, and therefore are not relevant to comparing the alternatives with respect to the costs for treating and distributing recycled water.

The life cycle costs, presented in Table 7.15, include capital and O&M costs for a project term of 30 years and an interest rate of 3%. The alternatives have different effluent diversion capacities, therefore, unit life cycle costs were calculated to provide a normalized basis for comparing the costs. The unit life cycle costs on a diverted flow basis, is the total project life cycle cost divided by the effluent diversion capacity. The unit life cycle costs on a water supply benefit flow basis, is the total project life cycle cost divided by the flow that would provide a water supply benefit to the City. The flows that provide a water supply benefit to the City are based recycled water flows that be used directly for water supply or to offset potable uses. In addition, the water supply flows account for losses in treatment processes, such as MF and RO.

Table 7.14 Alternatives Comparison Summary Capital and O&M Costs
Phase 2 Recycled Water Study
City of Ventura

Alternative	Effluent Diversion Capacity (AFY)	Water Supply Flow (AFY)	Treatment Processes	Project Cost Components ($M)					CEQA and Permitting ($M)	With Wetlands		Without Wetlands	
				Wastewater Treatment	Brine Disposal [1]	Conveyance/ Storage/Injection	Recycled Water Distribution System	Wetlands		Total Project Cost ($M)	O&M Cost ($M/yr)	Total Project Cost ($M)	O&M Cost ($M/yr)
North decentralized plant - Irrigation	2,240	270	MBR Plant	21			3.5	6.8	1.5	33	0.90	26	0.70
Conveyance to Oxnard[2]	14,560	None	Disinfection Improvements	5		41		6.8	2.0	54	16.20	48	16.00
Conveyance to Oxnard[3]	14,560	None	AWPF Expansion and Disinfection Improvements	45		41		6.8	2.0	95	5.20	88	5.00
Full Flow Recharge/Ag supply for UWCD	14,560	Possible [4]	MF/UF and RO	41	22	27		6.8	2.5	100	5.60	93	5.50
Partial Flow Recharge/Ag supply for UWCD	8,960	Possible [4]	MF/UF and RO	16	22	27		6.8	2.5	74	2.10	67	2.00
Mound Basin IPR (3.6 mgd)	5,040	4,030	MF/UF, RO, advanced oxidation	32	22	30		6.8	2.5	94	3.20	87	3.00
Mound Basin IPR (6.3 mgd)	8,870	7,100	MF/UF, RO, advanced oxidation	52	22	39		6.8	2.5	122	5.30	115	5.10
North decentralized plant - DPR	2,520	2,020	MBR, RO, advanced oxidation	38		4		6.8	3.0	52	2.10	45	1.00
DPR (3.6 mgd)	5,040	4,030	MF/UF, RO, advanced oxidation	32	22	16		6.8	3.0	80	3.00	74	2.90

Notes:

(1) For alternatives with brine treatment, the cost of disposal at the SMP is included.

(2) City of Oxnard pays for the AWPF expansion. Treatment and conveyance capital costs, and O&M costs are from Kennedy Jenks (2013).

(3) City of Ventura pays for the AWPF expansion. Treatment and conveyance capital costs, are from Kennedy Jenks (2013). O&M costs estimated as part of this study.

(4) Potential water supply flow undefined at this point as it would be based on negotiations with Fox Canyon GMA.

Table 7.15 Alternatives Comparison Summary Life Cycle Costs (Without Wetlands)
Phase 2 Recycled Water Study
City of Ventura

			Costs without Wetlands					
							Effluent Diversion Basis	Water Supply Basis
Alternative	Effluent Diversion Capacity (AFY)	Water Supply Flow (AFY)	Total Project Cost ($M)	Annualized Project Cost ($M/year)	Total O&M Cost ($M/year)	Life Cycle Cost ($M/year)	Unit Life Cycle Cost ($/AF)	Unit Life Cycle Cost ($/AF)
North decentralized plant - Irrigation	2,240	270	26	1.3	0.70	2.0	900	7,460
Conveyance to Oxnard(1)	14,560	None	48	2.4	16.00	18.4	1,270	NA (4)
Conveyance to Oxnard(2)	14,560	None	88	4.5	5.00	9.5	650	NA (4)
Full Flow Recharge/Ag supply for UWCD	14,560	Possible (3)	93	4.7	5.50	10.2	700	NA (4)
Partial Flow Recharge/Ag supply for UWCD	8,960	Possible (3)	67	3.4	2.00	5.4	610	NA (4)
Mound Basin IPR (3.6 mgd)	5,040	4,030	87	4.5	3.00	7.5	1,480	1,850
Mound Basin IPR (6.3 mgd)	8,870	7,100	115	5.9	5.10	11.0	1,240	1,550
North decentralized plant - DPR	2,520	2,020	45	2.3	1.00	3.3	1,310	1,630
DPR (3.6 mgd)	5,040	4,030	74	3.8	2.90	6.7	1,320	1,650

Notes:

(1) City of Oxnard pays for the AWPF expansion. Treatment and conveyance capital costs, and O&M costs are from Kennedy Jenks (2013).

(2) City of Ventura pays for the AWPF expansion. Treatment and conveyance capital costs, are from Kennedy Jenks (2013). O&M costs estimated as part of this study.

(3) Potential water supply flow undefined at this point as it would be based on negotiations with Fox Canyon GMA.

(4) Not Applicable (NA) because the there is no water supply flow or the water supply flow is undefined.

Table 7.16 Potential Financial Offsets of the Alternatives Phase 2 Recycled Water Study City of Ventura		
Alternative	**Potential Offset**	**Description**
North decentralized plant - Irrigation	Not quantified	A small offset of potable water and potentially resale value of recycled water for agricultural use.
Conveyance to Oxnard	$14.7 M per year (1)	For the scenario where the AWPF expansion is paid for by the City of Oxnard, there may be reductions in the annual fee to receive, treat and dispose of the secondary effluent. These offsets include the resale, incentive and allocation value of the VWRF effluent. These offsets would potentially reduce the annual fees. In addition, depending on the point of diversion from the VWRF, some wastewater treatment costs may be avoided (upgrading the existing VWRF tertiary filters and associated operating costs). Note that these costs associated with the VWRF filtration process were not quantified.
Full flow Recharge/Ag supply for UWCD	Possibly	UWCD would possibly pay for VWRF recycled water. Agreement on the terms and conditions for payment would need to be negotiated.
Partial flow Recharge/Ag supply for UWCD	Possibly	UWCD would possibly pay for VWRF recycled water. Agreement on the terms and conditions for payment would need to be negotiated.
Mound Basin IPR (3.6 mgd and 6.3 mgd)	$16.8 M capital, and $860,000 per year O&M(2)	Future investment in advanced treatment (RO) of water extracted from the Mound Basin for potable supply may be offset. However, the potential to eliminate the need for RO of the Mound basin groundwater depends on the quality of the groundwater that is realized after implementation of the IPR project. Depending on whether secondary or tertiary effluent is used as the feed to the MF/UF the need for upgrading the existing VWRF tertiary filters and associated operating costs, may be eliminated. Note that these costs associated with the VWRF filtration process were not quantified.

Table 7.16 Potential Financial Offsets of the Alternatives Phase 2 Recycled Water Study City of Ventura		
Alternative	**Potential Offset**	**Description**
North decentralized plant - DPR	Not quantified	Provides an additional source of potable water and therefore potentially eliminates the need for investing in new water supplies. Note that this alternative provides approximately 1.8 mgd of treated water. In addition, from Casitas turnout #2, the treated water could be used in an area of the City's potable water supply system that is currently served with water from the Mound Basin. Therefore, this alternative could partially offset the investment in RO treatment of the Mound Basin groundwater.
DPR (3.6 mgd)	$16.8 M capital, and $860,000 per year O&M(2)	Provides an additional source of potable water and therefore potentially eliminates the need for investing in new water supplies. Treated water could be used directly as an additional water supply to the system (i.e. groundwater from the Mound Basin would continue to be extracted and treated). However, given the water quality issues with the Mound Basin potable supply, the reclaimed wastewater could be blended with groundwater to achieve water quality targets. The capital investment associated with RO of Mound Basin potable groundwater supply could potentially be offset. In addition, depending on whether secondary or tertiary effluent is used as the feed to the MF/UF the need for upgrading the existing VWRF tertiary filters and associated operating costs, may be eliminated. Note that these costs associated with the VWRF filtration process were not quantified

Note:
(1) Calculations based on Kennedy Jenks (2013)
(2) If the City implemented RO for the Mound Basin groundwater supply, it is anticipated that it would not be acceptable to convey the brine to the VWRF. Any alternative that involved RO, of either water or wastewater, would require capital investment in brine disposal. In addition, this capital cost excludes the cost of land acquisition, and conveyance. Cost estimate based on AECOM (2011)

For the conveyance to Oxnard alternative, it is not anticipated that a water supply benefit for the City would be realized. Therefore, "none" is shown for the water supply flow and "Not Applicable" for the total project life cycle unit costs (water supply benefit flow basis).

For the UWCD alternatives, "possible" is shown for the water supply flow and "Not Applicable" for the total project life cycle unit costs (water supply benefit flow basis). There are currently differing professional opinions regarding whether UWCDs recharge operations in the Oxnard Forebay benefit the City's Golf Course wells. UWCD maintains that the City's Golf Course wells benefit from UWCD's recharge activities in the Oxnard Forebay. If this premise was accepted by the City and FCGMA, then it is possible that the City could negotiate with FCGMA for an increased pumping allocation for the Golf Course wells if the City routed reclaimed water of acceptable quality to the Oxnard Forebay for groundwater recharge or agricultural supply. The possibility of a City water supply benefit associated with the UWCD alternatives is dependent on additional studies and interagency agreements.

7.10 COMPARISON OF ALTERNATIVES

7.10.1 Stakeholder Criteria

The alternatives were compared based on criteria established throughout the stakeholder process. In particular, in the October 31, 2012 stakeholder meeting, the stakeholders provided input on the criteria that should be used to evaluate the alternatives. These criteria included several that were used as the basis for the preliminary screening of the alternatives, as well as other criteria. The list of suggested criteria includes:

- Improves discharge quality
- Reduces discharge flow
- Provides a potable source water benefit to the City
- Provides a reliable effluent diversion
- Creates wetland habitat (some stakeholders recognized this criteria was less important that others)
- Capital and operating costs, including rate payer impacts
- Provides multiple benefits (appealing to various stakeholders), in particular, habitat creation and water supply benefit

Since the development of this list of criteria, the alternatives have been further developed and the analysis of impacts of SCRE habitat and ecosystem function has been conducted. There are a number of key developments and findings that frame the criteria and basis for comparing the alternatives.

The criteria of reducing the discharge flow and improving the quality were developed based on the Phase 1 estuary study analysis that suggested that there may be an optimized condition for the SCRE that would result from a lower discharge flow and improve discharge quality. The results of the Phase 2 SCRE habitat and ecosystem function analysis suggests that a discharge flow of 4 to 5 mgd to the SCRE, with a nitrate concentration of 4 mg-N/L (or less) would result in the lowest concentrations of nitrate in the SCRE and would provide a the greatest (or near greatest) habitat for the four focal species. Therefore, the discharge flow criteria are related to whether the alternative can be designed to achieve the target flow range of 4 to 5 mgd.

By adopting the approach that any remaining discharge to the SCRE would be routed through treatment wetlands, all of the alternatives result in improved discharge quality. The creation of new wetland habitat is also achieved by all alternatives. For any alternative that provides a water supply benefit, the criteria of providing multiple (habitat creation and water supply) benefits is achieved.

These key developments and findings, discussed above, lead to a list of criteria that are inclusive of the stakeholder criteria, but are structured to highlight the differentiating features of the alternatives. These criteria include:

- Can the alternative be operated to result in a remaining discharge flow of 4 to 5 mgd to the SCRE, with a nitrate concentration of 4 mg-N/L (or less)?
- Does the alternative provide a potable water benefit to the City?
- Does the alternative provide a reliable diversion of VWRF effluent?
- What is the relative cost compared to other alternatives?

The attainment of these criteria, with exception of costs, is presented in Table 7.17. A summary of the alternatives comparison is included in Table 7.18. The costs for these alternatives are presented in Tables 7.14. and 7.15.

The alternatives that attain the most criteria are the Mound Basin IPR project (3.6 mgd) and the DPR project (3.6). In both cases, the IPR or DPR project would be coupled with treatment wetlands that would provide additional nutrient removal and provide wetland habitat.

7.10.2 Energy Demand Criterion

In addition to the criteria developed by the stakeholders, the estimated energy demand is an important consideration in the evaluation of alternatives. For comparison across the alternatives, the specific energy demand (kWh/kgal) were qualitatively estimated for each alternative. The qualitative estimates include the energy demand associated with additional treatment processes, brine conveyance, and conveyance. The energy demand associated with the treatment wetlands was not included as wetlands are included in all alternatives. The qualitative estimates are summarized in Table 7.19.

As discussed in section 7.10.1, the alternatives that attain the most criteria are the Mound Basin IPR project (3.6 mgd) and the DPR project (3.6). Table 7.19 shows that these alternatives fall in the mid-range of unit energy demands, as compared to the other alternatives.

Table 7.17 Alternatives Comparison Discussion
Phase 2 Recycled Water Study
City of Ventura

Alternative	Evaluation Criteria: Operated to Meet Target Discharge Flow and Quality?	Evaluation Criteria: Provides a Potable Source Water Benefit for the City?	Evaluation Criteria: Provides a Reliable Diversion of VWRF Effluent?
North Decentralized Plant - Irrigation	This alternative is limited by the available raw wastewater and the local irrigation demands. The estimated diversion capacity is approximately 2 mgd. Under existing conditions the remaining discharge to the SCRE would be 4 mgd, but in the future buildout conditions the remaining discharge would be 8 mgd.	This alternative provides a potable source water benefit to the City by offsetting the potable water demand used for irrigation through conversion to recycled water. However, the potable water demand that would be offset by this alternative is very low (0.17 mgd average, and 0.24 mgd maximum month).	This alternative provides a reliable diversion of VWRF effluent in the summer months. For non-summer months the irrigation demands would be very low.
Conveyance to Oxnard	This alternative would be designed for 13 mgd, but could be operated at flows that would result in the target discharge flow of 4 to 5 mgd.	This alternative does not provide a potable source water benefit to the City.	The pipeline to Oxnard provides a reliable means of diverting the VWRF effluent.
Full Flow Recharge/Ag Supply for UWCD	This alternative would be designed for a diversion of 13 mgd but the treatment processes could be constructed in phases and the system could operate at flows that would result in the target discharge of 4 to 5 mgd.	In this alternative, the City could potentially benefit from credits that would be granted from the FCGMA in return from recharging the groundwater basin and offsetting agricultural extractions. There is current conflict over water rights credits for other cities with similar project benefits, and therefore it is reasonable to assume that there is low potential that the City would be able to negotiate a favorable agreement on water credits.	In this alternative, all of the water that would be conveyed to UWCD would meet the water quality targets, and would not rely on the dilution capacity of SCR water. Therefore, this alternative provides a reliable means for diverting the VWRF effluent.

Table 7.17 Alternatives Comparison Discussion
Phase 2 Recycled Water Study
City of Ventura

Alternative	Evaluation Criteria		
	Operated to Meet Target Discharge Flow and Quality?	**Provides a Potable Source Water Benefit for the City?**	**Provides a Reliable Diversion of VWRF Effluent?**
Partial Flow Recharge/Ag Supply for UWCD	This alternative would be designed for a diversion of 8 mgd but the treatment processes could be constructed in phases and the system could operate at flows that would result in the target discharge of 4 to 5 mgd.	In this alternative, the City could potentially benefit from credits that would be granted from the FCGMA in return from recharging the groundwater basin and offsetting agricultural extractions. There is current conflict over water rights credits for other cities with similar project benefits, and therefore it is reasonable to assume that there is low potential that the City would be able to negotiate a favorable agreement on water credits.	This alternative relies on the availability of SCR water to provide dilution of chloride levels.
Mound Basin IPR (3.6 mgd)	This alternative results in about a 5 mgd discharge of effluent to the SCRE.	This alternative directly benefits the Mound Basin. It is anticipated that the IPR project would lead to improved groundwater quality.	An IPR project is a reliable means of diverting VWRF effluent
Mound Basin IPR (6.3 mgd AFY)	This alternative does not result in the target discharge to the SCRE for existing and future conditions	This alternative directly benefits the Mound Basin. It is anticipated that the IPR project would lead to improved groundwater quality.	An IPR project is a reliable means of diverting VWRF effluent
North Decentralized Plant - DPR	This alternative is limited by the available raw wastewater and the local irrigation demands. The estimated diversion capacity is approximately 2 mgd. Under existing conditions the remaining discharge to the SCRE would be 4 mgd, but in the future buildout conditions the remaining discharge would be 8 mgd.	In this alternative, the recycled water is conveyed directly into the City potable system and would therefore provide a benefit.	A DPR project is a reliable means of diverting VWRF effluent
DPR (3.6 mgd)	This alternative results in about a 5 mgd discharge of effluent to the SCRE.	In this alternative, the recycled water is conveyed directly into the City potable system and would therefore provide a benefit.	A DPR project is a reliable means of diverting VWRF effluent

Table 7.18 Alternatives Comparison Summary
Phase 2 Recycled Water Study
City of Ventura

Alternative	Evaluation Criteria		
	Operated to Meet Target Discharge Flow and Quality?	**Provides a Potable Source Water Benefit for the City?**	**Provides a Reliable Diversion of VWRF Effluent?**
North decentralized plant - Irrigation	N	Y (low)	Y
Conveyance to Oxnard	Y	None	Y
Full Flow Recharge/Ag supply for UWCD	Y	Possibly	Y
Partial Flow Recharge/Ag supply for UWCD	Y	Possibly	N
Mound Basin IPR (3.6 mgd)	Y	Y	Y
Mound Basin IPR (6.3 mgd)	N	Y	Y
North decentralized plant - DPR	N	Y	Y
DPR (3.6 mgd)	Y	Y	Y

Note:
(1) Project unit costs based on the effluent diversion capacity of the alternative, and do not include the wetland costs

Table 7.19 Energy Demand Comparison Summary
Phase 2 Recycled Water Study
City of Ventura

Alternative	Diversion Flow (mgd)	Treatment Processes				Infrastructure/ Conveyance		Relative Unit Energy Demand
		Satellite MBR Plant	MF/UF	RO	AOP	Brine	Recycled Water	
North decentralized plant - Irrigation	2	√					√	Medium
Conveyance to Oxnard	13						√	Low
Full Flow Recharge/Ag supply for UWCD	13		√	√		√	√	Medium
Partial Flow Recharge/Ag supply for UWCD	8		√	√		√	√	Medium
Mound Basin IPR (3.6 mgd)	4.5		√	√	√	√	√	Medium
Mound Basin IPR (6.3 mgd)	7.9		√	√	√	√	√	Medium
North decentralized plant - DPR	2.3	√		√	√		√	High
DPR (3.6 mgd)	4.5		√	√	√	√	√	Medium

STAKEHOLDER INPUT AND RECOMMENDATIONS

8.1 STAKEHOLDER INPUT

The City of Ventura (City) has actively sought stakeholder input throughout the Special Studies process and has held ten (10) publicly-announced stakeholder meetings on this subject since December 2008. Phase 1 reports, stakeholder presentation material and meeting minutes were posted on the City's website (http://www.cityofventura.net/rivers), discussed at workshops and stakeholder comments were incorporated into final versions of the reports.

For this Phase 2 report, a total of three stakeholder workshops have been conducted where the alternatives under consideration were presented along with the data collected in the estuary. The draft version of this report was posted on the City's website on February 14, 2013 and a workshop was held on February 21, 2013 to solicit stakeholder input (oral and written comments). This workshop included a review of the alternatives identification and evaluation, as well as an overview of the Stillwater Sciences' technical memorandum (City of Ventura Special Studies Phase 2 – Ventura Wastewater Reclamation Facility [VWRF] Discharge Alternatives Assessment [2013]), which is Appendix D of this report. The workshop minutes are included in Appendix E of this report.

The stakeholders were asked to provide input on several key questions associated with the outcomes of this report. Table 8.1 presents these questions and a summary of stakeholder input.

In addition to responding to these key questions, the stakeholders provided input throughout the workshop. One noteworthy comment, that was supported by several stakeholders, was that the east decentralized treatment plant should not have been eliminated in the screening analysis. Stakeholders suggested revisiting this alternative and investigating potential recycled water uses for the flow from an east side decentralized treatment plant.

Stakeholders also were given colored "dots" with which they could indicate which alternatives presented they preferred, as well as how much flow they felt needed to remain in the Santa Clara River Estuary (SCRE). Graphical representations of the outcome of the use of these dots are shown in Figures 8.1 and 8.2. It is important to note, however, that at least one stakeholder (and potentially others as well) refrained from using their dots as they felt there was not enough information to make a decision.

Table 8.1 Summary of Input on Key Questions in Stakeholder Meeting
Phase 2 Recycled Water Study
City of Ventura

Question	Summary of Response
Based on the Phase 2 data presented, how much flow should be left in the estuary?	Based on the Phase 2 data presented, there were a number of stakeholders that thought that a discharge from the VWRF, via new treatment wetlands, to the SCRE was appropriate. However, other stakeholders felt that based on the Phase 2 data presented, there should be discharge flows either greater or less than the 4 mgd to 5 mgd range identified in the report.
Which alternatives best meet the needs of the estuary and put the valuable resource (water) to its best and highest use?	Many stakeholders supported the IPR and DPR alternatives. Other alternatives with support of at least one stakeholder included, conveyance to Oxnard and the north decentralized treatment plant for agricultural and urban irrigation.
What additional data/studies are needed to confirm flow to remain in estuary and which reuse alternative to implement? (1)	(1) Evaluation of optimal berm height and stability relative to breaching risk. This would include additional stage and discharge data collection in comparison to mouth closure status and berm height. (2) Collection of additional groundwater quality data at existing and potentially new locations. (3) Collection of additional flow, water quality and species monitoring data corresponding to SCRE sources under seasonal and mouth berm conditions not encountered during monitoring conducted pursuant to the Current Term Estuary Special Studies. (4) Evaluation of SCRE habitat use data for endangered species, and in comparison to stage-habitat relationships and water quality. (5) Collection of data regarding presence of constituents of emerging concern in support of potential future evaluations of biological effects upon tidewater goby, Southern California steelhead, or selected sentinel species determined by the SWRCB. (6) Public outreach and education on recycled water use (for non-potable and potable uses) and integrated water management approaches. (7) Development of an integrated water management plan clearly defining local water needs for current and future uses, how new water supplies would be utilized, costs for different water supply options, and the larger benefits of reuse and habitat for in-stream uses. (8) Consideration of other infrastructure alternatives that would improve, consistent with the integrated water management approach, water reclamation and conservation, as well as habitat in the Santa Clara River and SCRE.

Note:
(1) Comments provided in the February 21, 2013 stakeholder workshop and written comments from the stakeholders were used to develop the list of additional studies.

Discharge to SCRE – Flow and Water Quality		Predicted SCRE Nitrate Concentration Range (mg-N/L) (2)(4)	Predicted Habitat, acres (4)		
Flow (mgd)	Nitrate Concentration from treatment wetlands (mg-N/L)		Steelhead	Tidewater Goby	CLT and WSP nesting (3)
● (1) No Action (6.3)	8 (no wetlands)	6.2 – 7.7	148	101	167
●●● 0 ●	0	9.6 – 12.5	58	107	183
●● 2	4	4.5 - 8	78	110	183
●●● 4 ●●●●●	4	3 – 5.2	115	111	182
●●● 5 ●●●●	4	2.8 – 4.7	132	110	177
8 ●	5	3.5 – 4.9	157	85	160

(1) Red circles represent the selections of the stakeholders

(2) Concentration range is based on range of denitrification rates and wet and dry hydrologic conditions.

(3) CLT = California least tern; WSP = Western snowy plover

(4) Color gradations for SCRE nitrate concentrations and habitat area show lowest quality/habitat in the light shades and the highest quality/habitat in the darkest shades. For similar numbers the same color shading was applied.

Figure 8.1
GRAPHICAL REPRESENTATION OF STAKEHOLDER PREFERENCE FOR EFFLUENT DISCHARGE FLOW (FROM THE TREATMENT WETLANDS TO THE SCRE)
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

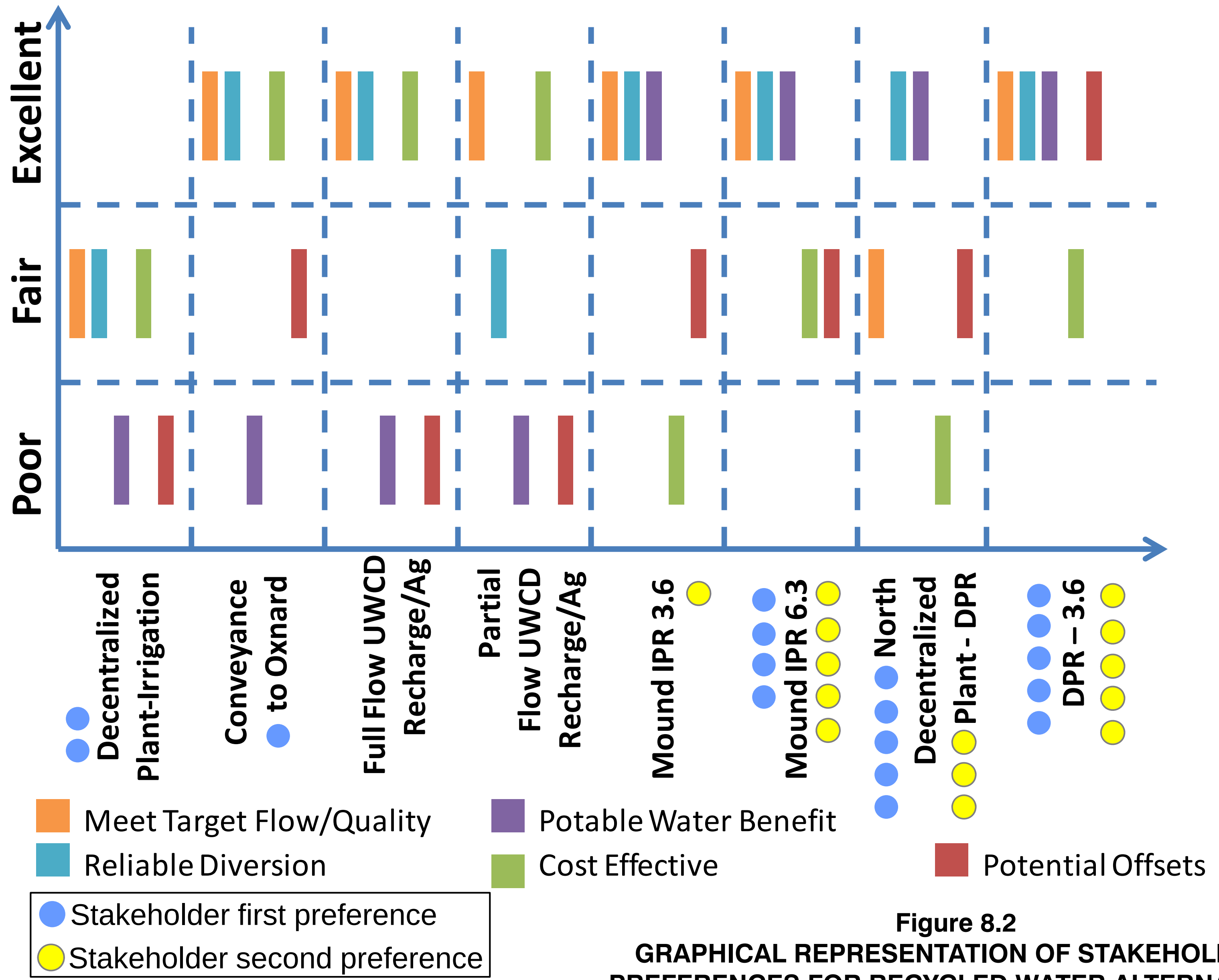

Figure 8.2
GRAPHICAL REPRESENTATION OF STAKEHOLDER PREFERENCES FOR RECYCLED WATER ALTERNATIVES
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Following the stakeholder workshop, stakeholders were given until February 28, 2013 to submit written comments on this report for consideration in preparing the submittal to the Regional Water Quality Control Board (RWQCB) by March 6, 2013, in compliance with the National Pollutant Discharge Elimination System (NPDES) permit. These comment letters are posted on the City's website and have been used as much as possible to guide minor revisions to this report and to outline next steps. The recommended studies outlined in the written comment letters are included in Table 8.1.

RWQCB staff have actively participated in this project through review of the March 6 version of this Phase 2 report, participation in the stakeholder workshops, and review of the written stakeholder comments. The 2013 NPDES permit for the VWRF, approved by the RWQCB in November 2013, includes requirements for additional studies. In response to the anticipated permit requirements, the City will prepare a Workplan for the studies.

8.2 PHASED IMPLEMENTATION APPROACH

At this time, there is some agreement among stakeholders and the City that the best uses of the reclaimed wastewater are those that will provide benefits to the City's potable water supply system. As discussed, the indirect potable reuse (IPR) and direct potable reuse (DPR) alternatives have the potential to provide the most benefit to the City's water supplies. There are several unknowns and issues that need to be resolved before final selection and refinement of an IPR or DPR alternative. The resulting recommendation is to implement an IPR or DPR project in a phased approach, where common components of these alternatives would be implemented first. This would allow the City to potentially take advantage of near term funding opportunities and to allow time for consensus on the project components and capacity.

A number of issues were considered in the development of this phased approach, including:

- Determination of the capacity of a recycled water alternative.
- Stakeholder input related to preferred uses for recycled water.
- Development of DPR Regulations.
- Assessment of the City's water supply needs.
- Public acceptance of IPR and DPR alternatives.
- Common components of the IPR and DPR alternatives.

8.2.1 Capacity of Recycled Water Alternatives

There is currently a lack of consensus on the VWRF effluent flow that should remain as discharge to the SCRE to be protective of beneficial uses. As outlined in Section 8.1, several stakeholders commented that additional data collection and analyses need to be conducted to support a determination of this effluent flow.

The 2013 VWRF NPDES permit includes requirements for several additional studies that will support determination of the discharge flow to the SCRE. The VWRF NPDES permit also recognizes the legal settlement amongst the City, and Heal the Bay and Ventura Coastkeeper. The final Memorandum of Settlement in December 2012 defines the maximum environmentally protective diversion volume (MEPDV) as the flow that will be diverted away from the SCRE to achieve the optimal discharge. The settlement agreement outlines a schedule where the MEPDV must be determined by August 2018. However, the settlement agreement does not preclude the parties of the agreement from determining the MEPDV prior to August 2018. The phased approach includes early implementation of common components of the alternatives that are less dependent on the recycled water system capacity. This approach provides time for the City and stakeholders to determine the MEPDV, which dictates the capacity of the recycled water alternative.

8.2.2 Stakeholder Input on Preferred Recycled Water Use

While there was not consensus on the amount of flow that should be diverted from the SCRE for recycled water use, there was more consensus on the preferred use of the recycled water. Most stakeholders agreed that the best uses of recycled water are those that will provide a benefit to the City's water supply system. Implementation of either an IPR or DPR project would provide the most benefit to the City's water supply system in terms of volume of potential potable offset/use. The stakeholders showed preference for the following alternatives that would provide a benefit to the City's water supply system:

- IPR in the Mound Basin.
- DPR with advanced treatment at the VWRF and conveyance to the Bailey Reservoir.
- DPR with advanced treatment at a new satellite treatment plant located on the north side of the City with conveyance to Casitas turnout #2.

Therefore, the phased recommendation focuses on the IPR and DPR alternatives.

8.2.3 Development of DPR Regulations

Regulations for DPR do not currently exist at the federal or state level, although there are numerous projects under consideration or implementation in other states and under consideration in California.

A new bill (SB 918) was signed into law on September 30, 2012 that provides the CDPH with funding and deadlines to complete regulations for indirect potable reuse projects and to evaluate direct potable reuse. The law requires the DPH to develop and adopt uniform water recycling criteria for surface water augmentation by December 31, 2016, if an expert panel convened pursuant to the bill finds that the criteria would adequately protect public health. The bill also requires DPH to investigate the feasibility of developing uniform water recycling criteria for direct potable reuse and to provide a final report on that investigation to the legislature by December 31, 2016.

Until there are further developments in a DPR regulatory framework, the treatment and storage requirements for implementing DPR will remain unknown. The phased approach provides time for the development of DPR regulations and final decision on the ultimate use of the reclaimed wastewater (i.e., for IPR or DPR).

8.2.4 Water Supply System Needs

The City is currently working on assessing their potable water system needs, which includes evaluating both the ability to meet demands and water quality standards.

The City's available supply (i.e., allocations of groundwater and surface water) are subject to several ongoing regulatory activities as well as interagency negotiations. The quality of the City's supplies also varies considerably by source. As discussed in Chapter 2, secondary drinking water standards for total dissolved solids (TDS) and sulfate have been exceeded in some of the City's groundwater supplies. AECOM (2011) conducted a groundwater treatment study that focused on treatment of groundwater from the Mound and Santa Paula Basins. For the Mound Basin, AECOM (2011) recommends further investigation and refinement of the reverse osmosis (RO) treatment alternative for Mound Basin groundwater, as other alternatives do not achieve compliance with secondary drinking water standards.

As part of this study, several stakeholders suggested that the City needs to develop an integrated water management plan. The objective of the plan will be to conduct a comprehensive evaluation of the City's water supplies, including reclaimed wastewater, to determine the best approach to meeting demands and water quality standards. This study would help further identify how recycled water could be incorporated into the City's water supply portfolio, and would provide the basis for selection and refinement of an IPR or DPR alternative.

A key component to assessing the potential use and benefits of an IPR project is the understanding of how an IPR project would affect groundwater quality in the Mound Basin. The City is planning to conduct a hydrogeologic study of the Mound Basin. This study should include solute transport modeling or other technical analyses to assess the potential water quality benefits of injecting reclaimed wastewater into the Mound Basin.

The phased approach provides time for the City to develop an integrated water management plan and to conduct a hydrogeologic study of the Mound Basin.

While more study is needed to understand the potential Mound Basin groundwater quality benefits of an IPR project, there is potential that the IPR could offset the need for RO on the City's Mound Basin potable water supply. Implementation of a DPR project could offset the need for RO on the City's Mound Basin potable water supply by either replacing the groundwater supply or using the recycled water in a blending configuration with the Mound groundwater supply to meet secondary standards. This approach would require assessing the feasibility of blending a groundwater and recycled water, as there can be complications with blending waters with different water chemistry.

In absence of an IPR or DPR alternative that improves Mound Basin water quality, augments this supply, or replaces this supply, the City will likely need to implement RO on the Mound Basin supply to meet secondary potable water standards. Therefore, RO for the Mound Basin Supply is considered the "no project alternative" and is described in more detail in Section 8.3.

8.2.5 Public Perception

While implementation of an IPR or DPR alternative may not occur for many years, the public acceptance of an IPR or DPR alternative may be challenging. It is anticipated that DPR would have more public resistance than IPR. Public outreach and assessment of public opinion is needed to determine the extent of public support and resistance to IPR and DPR.

The phased approach provides time for the City to develop and implement a public outreach program on the use of reclaimed wastewater as part of the City's water supply portfolio.

8.2.6 Common Components of IPR and DPR Alternatives

As discussed in Section 8.2.2, the stakeholders showed preference for the IPR and DPR alternatives. While this study evaluated alternatives that involved DPR and IPR with water treated at the VWRF, and DPR with water treated at a new satellite treatment plant, there are many different configurations of IPR and DPR alternatives. The integrated water management plan will help define the location and type of project (IPR or DPR) that would provide the most benefit to the City. At this time, it is important for the City to be flexible on the exact configuration of an IPR or DPR project. Regardless of the configuration of an IPR or DPR project, there are common components, including:

- Treatment wetlands.
- Advanced treatment processes (MF, RO and AOP).
- Brine disposal.

Figure 8.3 shows the required components for both a DPR and IPR project. The treatment wetlands are common to the DPR and IPR alternatives, and would provide additional polishing treatment of any future effluent that is not diverted for reuse. Early implementation

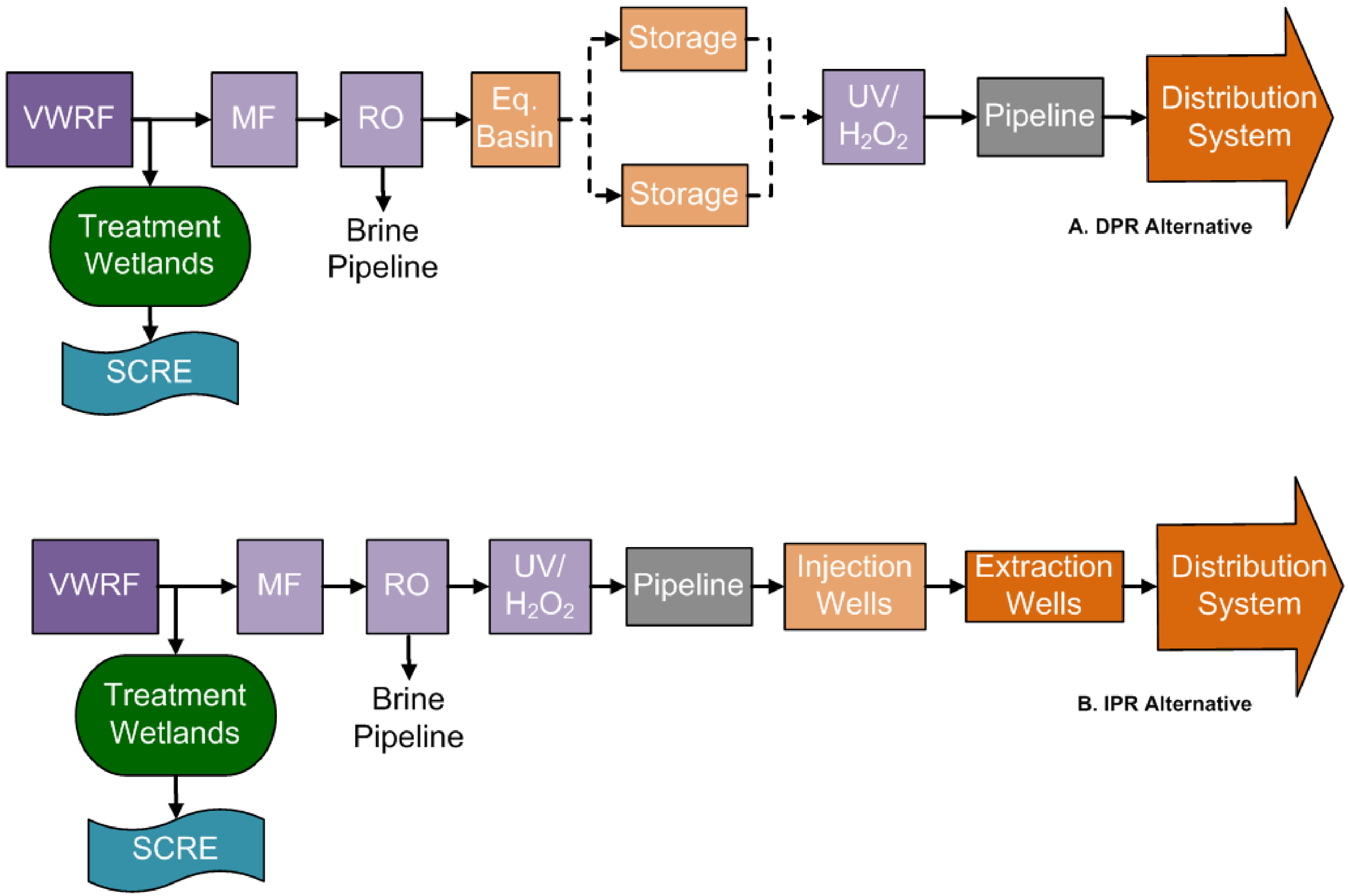

Figure 8.3
IPR AND DPR ALTERNATIVES
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

of the treatment wetlands would also provide further nutrient removal for the discharge to the SCRE between the time when the wetlands are constructed and the implementation of a recycled water project.

As described in Chapter 7, to achieve a nitrate concentration of 4 mg-N/L, the available area of both the existing Wildlife Ponds and the City-owned parcel are required unless the flow into the wetlands is less than 3 million gallons per day (mgd). Developing treatment wetlands on the City-owned parcel provides the City with flexibility for the future, where the remaining discharge to the SCRE could be greater or less than 3 mgd (pending determination of the MEPDV). Development of the City-owned parcel provides more treatment wetlands area than converting the Wildlife Ponds and, as such, would achieve a greater level of nitrate removal in the interim period between construction of the treatment wetlands and construction of a recycled water alternative. For these reasons, the phased recommendation includes early implementation of treatment wetlands on the City-owned parcel. Pending the outcome of the MEPDV determination, there may be a need for more treatment wetlands area. Therefore, creating treatment wetland area through modification of the Wildlife Ponds is included after the MEPDV determination.

The advanced treatment processes for the IPR and DPR alternatives include MF, RO and AOP. While the capacity and location of these treatment processes is yet to be determined, further refinement on RO treatment feasibility and costs is needed. Based on the results from a single sample of VWRF effluent, the silica concentration may potentially affect the sizing and costs of RO treatment. Additional silica data and analysis is required to further assess treatment feasibility and costs. The phased recommendation includes an evaluation of RO treatment feasibility, pilot testing and refinement of the cost estimates.

The analysis of brine treatment and disposal alternatives showed that a brine pipeline to the Calleguas SMP would be the most cost effective approach for brine disposal. However, other brine disposal alternatives have not been fully developed or evaluated. While the exact location and capacity of the RO process is yet to be determined, there is a need to further evaluate brine disposal alternatives that are closer to the City than the Calleguas SMP, may be able to take advantage of existing infrastructure, and may be supported by other agencies that are in need of an ocean discharge. Therefore, the phased recommended alternative includes a more detailed evaluation of brine disposal alternatives.

8.2.7 Phased Recommendations and Additional Studies

The phased approach will allow the City to move forward with some of the common elements of the IPR and DPR alternatives, while simultaneously providing time for additional studies and resolution of outstanding issues. The phased recommended alternative is summarized in Table 8.2.

8.3 NO PROJECT ALTERNATIVE

This project is unique in the sense that the primary driver is the need to provide reuse opportunities to reduce the discharge flow to the SCRE. Per the Settlement Agreement , the City has agreed to reduce the amount of water entering the SCRE by 50 percent to 100 percent by diverting it to other recycled and reclaimed water uses. Therefore, a "no project" alternative does not exist with respect to the primary driver of diverting water from the SCRE. Consequently, this study does not include full consideration of a "no project alternative."

Table 8.2 Phased Recommendations
Phase 2 Recycled Water Study
City of Ventura

Phase	Components	Description
A	Additional Studies	• Studies associated with determination of the MEPDV (Phase 3 Estuary study). • Integrated water management plan. • Hydrogeologic study of the Mound Basin. • Public outreach program. • RO treatment feasibility study and pilot testing. • Brine disposal study.
B	Treatment Wetlands	• Modification of existing ponds and/or new treatment wetlands (offsite City-owned parcel).
C	Reclaimed Water Structure	• Advanced treatment at the VWRF. • Brine disposal to be determined.
D	Diversion Pipeline	• Conveyance pipeline and associated infrastructure for IPR or DPR.

However, as mentioned previously, groundwater quality in the Mound Basin is compromised, and previous studies (AECOM, 2011) recommended further investigation of RO to meet potable water secondary standards. The recommended IPR/DPR project has the potential to improve Mound Basin groundwater quality or provide an alternative water supply and may offset the need for implementing RO at the Bailey Water Conditioning Facility. In absence of the IPR/DPR project, implementation of RO at the Bailey Water Conditioning Facility is the likely alternative for addressing the continued use and water quality of the Mound Basin as a potable supply.

The project involves constructing RO facilities at the Bailey Water Conditioning Facility to reduce the mineral concentration of groundwater extracted from the Mound Basin. The estimate cost of implementing RO treatment at the Bailey Water Conditioning Facility is $16.8 M, excluding the costs for land acquisition, conveyance pipelines, and brine treatment or disposal (AECOM, 2011). Per the AECOM (2011) report, the anticipated RO product water quality would meet secondary standards, with TDS concentrations of approximately 790 milligrams per liter (mg/L). This project provides the benefit of continued use of the City's ground water supply. In addition, with the concurrent reduction of hardness as a result of RO treatment, the need for residential water softeners may be reduced. The reduction in water softener use in the area served by the Mound Basin has the potential to improve chloride concentrations in VWRF effluent. However, it is important to note that this potential reduction in chloride concentration has not been quantified.

8.4 RECOMMENDED PROJECT

The recommended project includes IPR or DPR and treatment wetlands. As described in Section 8.2, there are additional information and decisions that need to be made in order to further refine the capacity and infrastructure needs of the recommended alternative. The phased approach, presented in Table 8.2, provides the City with time to complete additional analyses necessary to support refinement of the recycled water alternative. The recommended project is therefore based on the best information currently available, and is subject to change pending the findings of the additional studies outline in Table 8.2. Several key assumptions are described as follows.

8.4.1 Recommended Project Capacity Assumption

One of the most significant assumptions is the amount of VWRF effluent that will need to be diverted for reuse to reduce the discharge to the SCRE. However, there are outstanding regulatory and legal approvals/agreements that still need to be obtained before there is final determination of the amount of VWRF effluent that is available for water reuse. These approvals and agreements include:

- RWQCB finding that the remaining discharge, via a treatment wetlands, provides an enhancement to the SCRE.
- Agreement on the MEPDV per the conditions of the Settlement Agreement

Since both the regulatory and legal provisions need to be satisfied, it is reasonable to use the MEPDV determination as the context of the discussion on the reuse project capacity.

While the Estuary studies to date suggest that 4 to 5 mgd of VWRF effluent should remain as discharge, via a treatment wetlands, to SCRE, and that the remaining effluent flow is the MEPDV, a final determination (i.e., regulatory and legal agreement) has not yet been made. However, since this is the best available information to date, the analysis is based on the assumption that 4 to 5 mgd of VWRF effluent will be routed through a treatment wetlands and discharged to the SCRE. The following discussion considers the potential MEPDV range, the existing and future effluent flows to the SCRE, and a estimation of a reasonable reuse project capacity. Per the Settlement Agreement, the MEPDV may be up to 100 percent of the VWRF effluent. The existing and future VWRF effluent flows to the SCRE are 7.3 mgd and 11.2 mgd respectively. Table 8.3 presents the range of capacity for

Table 8.3 Recommended Project Capacity Range
Phase 2 Recycled Water Study
City of Ventura

Flow Components	Existing Conditions		Future Conditions	
	Low MEPDV (mgd)	High MEPDV (mgd)	Low MEPDV (mgd)	High MEPDV (mgd)
VWRF effluent flow during summer	7.3	7.3	11.2	11.2
Losses in ponds/treatment wetlands	1.3	0	1.3	0
Discharge to SCRE from treatment wetlands	4	0	4	0
MEPDV	2	7.3	5.9	11.2
Recommended reuse project capacity[(1)]	1.7	6.1	4.9	9.3

Note:
(1) Reuse project capacity is the volume of actual recycled water used and is less than the MEPDV due to brine diversion.

the recommended project, pending the determination of the discharge volume that should remain to the SCRE and the corresponding determination of the MEPDV.

The potential range of the recommended project ranges from 1.7 to 9.3 mgd, depending on the determination of the MEPDV. The 3.6 mgd IPR/DPR alternatives (see Chapter 7) have the capacity to offset the City's existing withdrawals from the Mound Basin. In an IPR scenario, the 3.6 mgd of recycled water would improve water quality in the Mound Basin, and therefore allow the City to continue this withdrawal and improve their groundwater supply quality. In a DPR scenario the 3.6 mgd of recycled water could be used to augment or replace the City's withdrawals from the Mound Basin. Assuming that the discharge from a treatment wetlands to the SCRE is 4 mgd (see table 8.3), then the resulting recommended project capacity ranges from 1.7 mgd for existing conditions to 4.9 mgd in future conditions. Using the same approach, if it is assumed that the discharge from the treatment wetlands to the SCRE is 5 mgd, then the resulting recommended project capacity ranges from 0.8 mgd for existing conditions to 4.1 mgd in future conditions. A recommended project capacity of 3.6 mgd is therefore a reasonable capacity increment. It is important to recognize that this analysis is subject to agreement on how much VWRF effluent should remain as discharge to the SCRE and the corresponding MEPDV.

8.4.2 Recommended Project Recycled Water Use and Location

As discussed previously, the is a need for the City to have some flexibility in the end use of the recycled water as IPR or DPR, and location as to where the IPR or DRP alternative would be integrated into the City's water supply system. At this time, a reasonable assumption is to target offsetting or augmenting the City's use of the Mound Basin. Both IPR and DPR alternatives are included as options for the recommended project.

Pending the outcome of the integrated water management plan, and more detailed investigation of the City's water supply infrastructure and other options for IPR, the end use and configuration of an IPR or DPR alternative may change.

8.4.3 Supply Reliability

The IPR and DPR recycled water alternatives rely on a single source of supply. Therefore, the VWRF represents a point of failure in the IPR and DPR recycled water alternatives.

However, the Mound Basin groundwater is an existing water supply that contributes to supply reliability of both the IPR and DPR recycled water alternatives. While IPR may improve water quality in the Mound Basin, there are other sources of water to this basin and therefore in absence of reclaimed water for injection, there is groundwater available at the Mound and Victoria wells that provide a potable water supply.

8.4.4 Recommended Project Components

Based on the findings of this study and the assumptions described in the previous sections, the recommended alternative provides approximately 3.6 mgd of recycled water, with use for IPR or DPR. The recommended project components are summarized in Tables 8.4a. and 8.4b. Table 8.4a summarizes the treatment and infrastructure associated with implementing IPR or DPR. Table 8.4b summarizes the onsite and offsite portions of the treatment wetlands. A treatment wetlands that combines both the onsite and offsite areas is included as a component of both the IPR and DPR alternatives. Figure 8.4 and 8.5 present the IPR and DPR recycled alternatives, respectively, and include the approximate locations of treatment facilities, the treatment wetlands, and associated infrastructure. As described in Chapter 7, Full Advanced Treatment per the Draft Groundwater Recharge Reuse Regulations, includes UF or MF, followed by RO and AOP. Table 8.5 includes additional detail on these processes. For this project, the proposed advanced treatment processes are MF, RO and UV/peroxide. For the purposes of assessing environmental considerations (See Section 8.6), Table 8.5 includes a description of chemicals that are used as part of treatment or O&M.

For the IPR and DPR alternatives, the brine from the RO process will be conveyed to the Calleguas SMP. Table 8.4 includes information on the brine pipeline and Figure 8.6 shows the proposed alignment.

8.4.5 Preliminary Cost Estimate

Preliminary cost estimates for the recycled water alternatives and treatment wetlands were presented in Chapter 7. Additional detail on the preliminary cost estimates for the IPR and DPR alternatives is provided in this section. The costs for the recommended project components are detailed in Table 8.6. The estimated cost for the no project alternative is included in Table 8.6. The cost for the no project alternative is lower than the IPR and DPR alternatives. However, as mentioned previously, the Mound Basin RO project addresses the issue of compliance with secondary potable water standards but does not address the need for a reduction in the VWRF discharge to the SCRE.

Table 8.4a Recommended IPR and DPR Project Components
Phase 2 Recycled Water Study
City of Ventura

Treatment and Infrastructure Components	IPR Alternative	DPR Alternative
Advanced Treatment Processes	MF, RO, AOP	MF, RO, AOP
Advanced Treatment Capacity	3.6 mgd	3.6 mgd
Advanced Treatment Footprint	1 acre	1 acre
Storage and Equalization	NA	Three 2 MG tanks
Storage and Equalization Footprint	NA	30,000 sq ft
Injection Wells	2 – 3 wells (depending on injection rate, 1.4 mgd to 2.9 mgd)	NA
Injection Well Pumps	2-3 pumps with capacity for 1.4 to 2.9 mgd (depending on injection rate)	NA
Injection Wells/Pumps Footprint	35 acres	NA
Treated Water Pump Station	3.6 mgd	3.6 mgd
Pipeline	16” diameter 5.6 miles	16” diameter 5.8 miles
Extraction Wells	Capacity to be determined	NA
Brine pipeline	2.5 mgd 16” diameter 10 miles	2.5 mgd 16” diameter 10 miles

Table 8.4b Recommended Treatment Wetland Project Components
Phase 2 Recycled Water Study
City of Ventura

Treatment Wetlands Components	Wetlands Location	
	City-Owned Parcel	Wildlife Ponds
Vegetated Wetlands Area	29 acres	12.5
Pump Station	9 mgd	-(1)
Submersible Pumps	9 mgd	NA
Pipeline to Wetlands	24” diameter 2,500 feet	NA
Pipeline to Outfall	24” diameter 2,700 feet	NA
Wetland Effluent Junction Structure	9 mgd	NA
Flow Split Structure	9 mgd	NA

NA = not applicable
Notes:
(1) Included in the construction components of the offsite treatment wetlands

Table 8.5 Treatment Process Descriptions Phase 2 Recycled Water Study City of Ventura		
Process	**Process Description**	**Operational Considerations**
MF	Microfiltration is a membrane filtration process. Membrane filtration is a pressure driven process that achieves solid-liquid separation by using semipermeable membranes to selectively block the passage of various contaminants. As part of the full advanced treatment train, the use of membranes following secondary treatment serves two key purposes; being the improvement of water quality leading to further treatment and being part of a multiple barrier for treatment of pathogens and pollutants (see DPR Case Study – Appendix B). With nominal pore sizes of 0.1 micrometer, MF membranes are designed to remove particulate matter such as turbidity and microorganisms via a sieving mechanism, yielding effluent water quality that is independent from influent water quality. This physical property makes MF/UF the pretreatment of choice for RO membranes that may be easily compromised with particles.	As part of normal operation. Solids can accumulate on membrane fiber surface, Cleaning methods can include physical cleaning methods, such as air agitation. In addition, when necessary, membranes are typically cleaned with hypochlorite and citric acid. This process would be operated by treatment plant staff with the required operator grade certification. This certification process includes training on the safe handling and use of process chemicals.
RO	RO is a pressure-driven membrane separation process by which dissolved constituents are removed from water through a semi-permeable membrane (see DPR Case Study – Appendix B). RO is a diffusion-controlled process in which many species in the feed water will diffuse through the membrane at different rates. Water passes through the membrane at a higher rate than the constituents in the water (including dissolved solids or salts). The rejected constituents are concentrated into a small percentage of the flow and exit the system as waste (brine). The RO process is easily compromised by the presence of particulate matter. Particulate matter can be caught within the interstitial spaces of membrane channels and cause colloidal fouling. To prevent colloidal fouling, feed water is required to have a turbidity value below 0.5 NTU, and/or a silt density index of less than three. To prevent colloidal fouling, feed water is required to have a turbidity value below 0.5 NTU, and/or a	When the concentration of a sparingly soluble salt on the membrane exceeds its solubility, membrane scaling can occur. This is typically mitigated by dosing scale inhibitors into the feed water and also addressed by membrane cleaning using high or low pH cleaners. This process would be operated by treatment plant staff with the required operator grade certification. This certification process includes training on the safe handling and use of process chemicals.

Table 8.5	Treatment Process Descriptions Phase 2 Recycled Water Study City of Ventura	
Process	**Process Description**	**Operational Considerations**
	silt density index of less than three.	
UV/ Peroxide	The conventional AOP following RO is ultraviolet light (UV) combined with hydrogen peroxide (H_2O_2). The UV light provides disinfection, photolysis, and advanced oxidation when combined with H_2O_2. There are two common forms of UV disinfection, both using mercury-based lamps. The low-pressure high output (LPHO) UV lamp emits primarily monochromatic UV light at a wavelength of 254 nanometers, while medium-pressure (MP) UV lamps emit polychromatic UV light over a wide range of wavelengths. For post RO applications, typical operation involves a high UV dose coupled with a low H_2O_2 dose	The UV/Peroxide process involves continual use of hydrogen peroxide. The sleeves that surround the UV lamps are typically cleaned with mechanical wipers or a system that combines mechanical wiping with chemical addition. Sleeves may also be removed from the UV reactors and cleaned manually. Acidic solutions (pH<2) are typically used to clean UV lamp sleeves. This process would be operated by treatment plant staff with the required operator grade certification. This certification process includes training on the safe handling and use of process chemicals.
NA = not applicable Notes:		

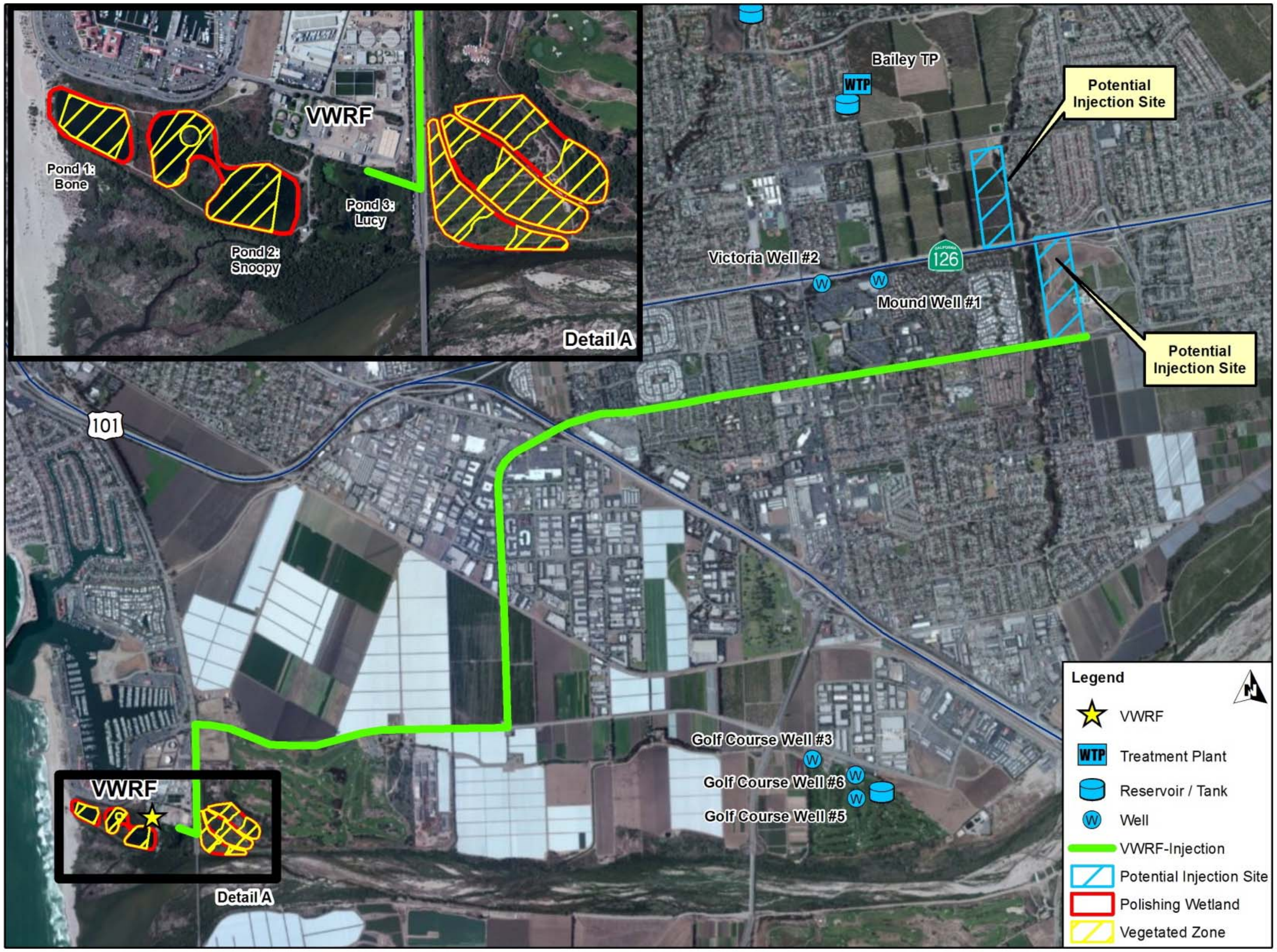

Figure 8.4
IPR ALTERNATIVE COMPONENTS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

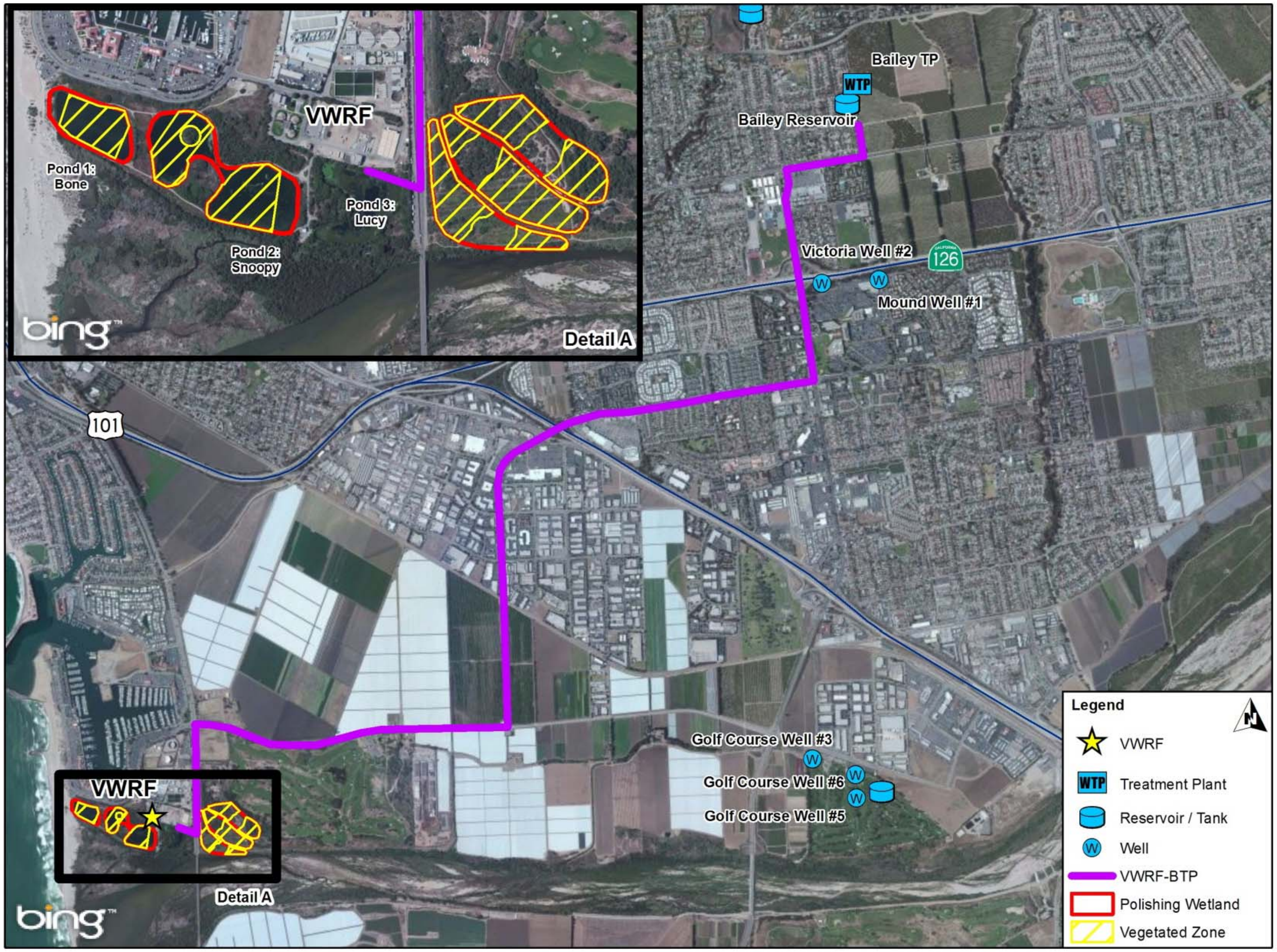

Figure 8.5
DPR ALTERNATIVE COMPONENTS
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

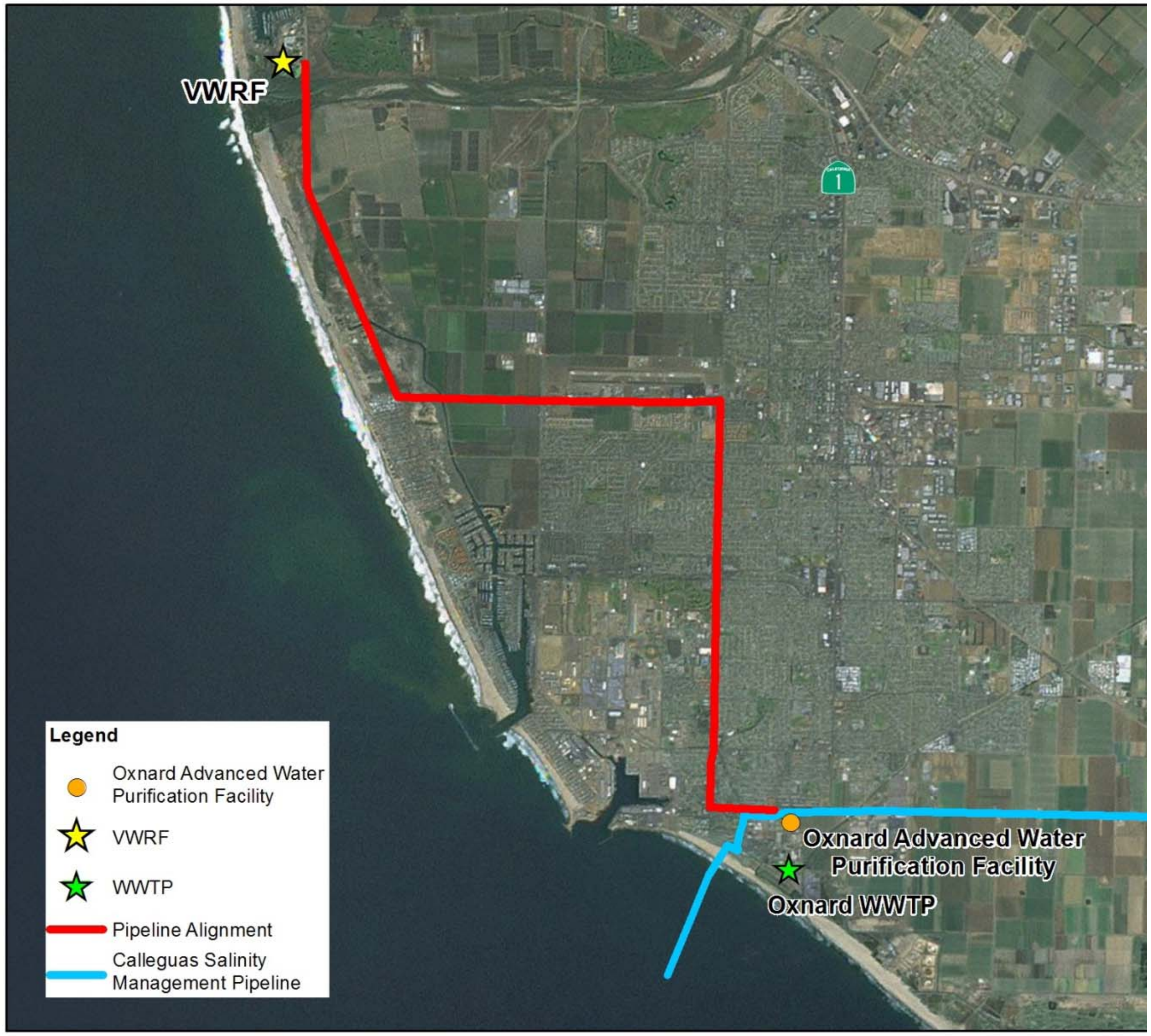

Figure 8.6
BRINE PIPELINE ALIGNMENT
PHASE 2 RECYCLED WATER STUDY
CITY OF VENTURA

Table 8.6 Recommended Project Cost
Phase 2 Recycled Water Study
City of Ventura

Alternative	Project Cost Components ($ millions)	O&M Costs ($M/year)	Annualized Project Cost ($M/year)(2)	Total Life Cycle Cost ($M/year)	Effluent Diversion Basis		Water Supply Basis	
					Effluent Diversion Capacity (AFY)	Unit Life Cycle Cost ($/AF)	Water Supply Flow (AFY)	Unit Life Cycle Cost ($/AF)
Mound Basin IPR								
Advanced Treatment	32	1.9						
Brine Disposal	22	0.8						
Conveyance and Injection	30	0.3						
Wetlands - Pond Modification	1	0.03						
Wetlands - City-Owned	6	0.12						
CEQA and Permitting	2.5							
Total	94	3.2	4.8	8	5,040	1,590	4,030	1,980
DPR								
Advanced Treatment	32	1.9						
Brine Disposal	22	0.8						
Conveyance and Storage	16	0.2						
Wetlands - Pond Modification	1	0.03						
Wetlands - City-Owned	6	0.12						
CEQA and Permitting	3							
Total	80	3.0	4.1	7	5,040	1,410	4,030	1,760
No Project Alternative								
Mound Basin RO (1)	39	0.86	2.0	2.8	NA(3)	NA(3)	12,320	230

Notes:
(1) Project cost includes the cost of a pipeline to Oxnard for brine disposal.
(2) Assumes a interest rate of 3% and a finance period of 30 years.
(3) Not Applicable (NA) because the project does nor provide any capacity for diverting water from the effluent discharge to the SCRE.

8.5 INSTITUTIONAL REQUIREMENTS AND PERMITTING

There are some challenging aspects to the institutional and permitting requirements for the IPR/DPR alternative.

8.5.1 Legal Issues

As discussed, the MEPDV has not been determined and this is a critical decision related to the capacity of the IPR/DPR project capacity. It is also important for the implementation of a treatment wetlands. It is possible that the MEPDV could be 100 percent of the VWRF discharge, in which case, there would be no flow for the treatment wetlands. However, the findings of the Phase 1 Estuary Study and the findings in this report suggest that zero discharge of VWRF effluent to the SCRE would not maximize the beneficial uses of the SCRE. Early implementation of a treatment wetlands is predicated on the assumption that the MEPDV is less than 100 percent of the discharge, and therefore some VWRF effluent will be available as a source to the treatment wetlands. However, to move forward with the proposed treatment wetlands, the parties of the settlement agreement will need to come to agreement that early implementation of the treatment wetlands will not be a lost investment.

8.5.2 Water Rights and Interagency Agreements

The City has retained all rights to use recycled water produced from wastewater originating in its service area. Treated wastewater discharged to the SCRE is not subject to downstream water rights, as there are no users of the SCR located downstream of the VWRF discharge to the SCRE. For the IPR/DPR alternative, all the treated water would be used by the City as part of their potable water supply system. Interagency agreements would not be required.

8.5.3 Discharge Requirements

The point of compliance identified in the VWRF NPDEs permit is the effluent transfer station. The point of compliance is located prior to the inlet to the treatment wetlands. The VWRF NPDES permit also includes receiving water limitations. The City's NPDES permit would need to be modified to include effluent flowing through the treatment wetlands. However, the City would want to retain the existing point of compliance of the effluent transfer station as wildlife use of wetlands and natural processes, can add bacteria and turbidity (as will also happen in the receiving waters).

8.5.4 Permitting Procedures

The City will need to obtain a number of permits and approvals from local, state and federal agencies to implement a DPR or IPR recycled project. Required permits and approvals may include, but are not limited to:

- CDPH – Approval to implement an IPR or DPR project. Note that the groundwater recharge regulations are in draft form and that there are no existing DPR regulations.
- LARWQCB – Modification to the City's NPDES permit to include the treatment wetlands and required discharge flow to the SCRE.
- ACOE – 404 Permit potentially needed if any jurisdictional wetlands are impacted by the construction of new wetlands.
- LARWQCB – 401 Certification potentially related to water quality impact related to 404 permit or to removal of some of the water from the SCRE.
- US FWS – Section 7 Consultation on endangered species habitat impacts related to removal of some of the water from the SCRE.
- CA DFW – Review of 404 permit and/or Section 7 consultation on habitat impacts to state special status species.
- Construction related permits – General Construction Permit, Permit to Construct (Air Permit).
- Coastal Commission-Coastal Development Permit.

8.6 ENVIRONMENTAL CONSIDERATIONS

Appendix F provides a preliminary review and analysis of the major environmental issues that may be a factor, or a result of, the construction and/or operation of the proposed IPR/DPR recycled water alternative. The review is based on the requirements of funding agencies with the intent to include sufficient information for each alternative to assess the potential measureable effects and costs that may be necessary to comply with NEPA, and other applicable Federal Law. This analysis can also be used to summarize potentially significant environmental impacts and to identify design and planning opportunities to minimize those impacts to less than significant, to reduce the need for mitigation and to identify the nexus with public agencies and organizations so as to reduce potential conflict and uncertainty of costs and timeline as the project progresses.

8.6.1 Conclusions

Based on the preliminary review, it is expected that the project will have some mitigable impacts. No unmitigable impacts were identified.

Some issues or areas where more investigation will likely be necessary are:

- Additional study of the effects of injection on groundwater quality and drinking water quality.
- Additional study of the effects of DPR on drinking water quality.
- Review of archeological resources within the entire project area.

- Additional biological resource investigations including a query of special-status species' databases.
- Review of known hazardous materials sites including leaky underground storage tanks (LUSTs).
- Additional review of potential floodplain impacts.

Much of this analysis can be addressed during the development of a more detailed project description and/or at the time the permitting process is initiated.

If the City desires to receive federal or state grants, then they will have to work with the other potential lead agencies such as Reclamation and/or the State Board to prepare the equivalent NEPA and CEQA-Plus documents, either jointly or separately. As this was a preliminary evaluation, additional analysis and effort may be required to fully comply with CEQA, NEPA and/or CEQA-Plus procedural requirements.

8.6.2 Recommendations

We recommend that if the City decides to move forward with the IRP/DPR alternative, that it uses this information as a basis for conducting a more detailed environmental review and go through the CEQA public review and disclosure process and procedures. In addition, we recommend that the City initiate contact as soon as possible with any and all potential funding agencies such as Reclamation and/or the State Board to investigate their specific requirements and procedures that they need to follow to meet NEPA and/or CEQA-Plus requirements and support the City's funding requests. The preliminary review provides a good framework for future discussions and will help the City, Reclamation, and/or the State Board develop a plan for moving forward.

8.7 IMPLEMENTATION PLANS

The City will need to address the following project components in implementing the IPR/DPR recycled water alternative (listed in no specific order):

- Design and construct the recommended alternative.
- Obtain permits and clearances from applicable regulatory agencies (RWQCB, CDPH, State and Federal Agencies).
- Conduct environmental process (CEQA) and develop compliance documents.
- Potentially obtain grant funds for design and construction.
- Develop a funding plan for the capital investment.

As described, the phased approach includes implementation of the treatment wetlands, followed by implementation of the other components of the IPR/DPR alternative. Table 8.7 presents a preliminary implementation schedule for Phases A and B.

Table 8.7 Planned Implementation Schedule for the Treatment Wetlands Phase 2 Recycled Water Study City of Ventura		
Description	**Start Year**	**End Year**
Phase A – Additional Studies	**2014**	**2016**
Phase B – Treatment Wetlands	**2017**	**2020**
Technical Design	2017	2018
Construction	2018	2021
Environmental Compliance (CEQA)	2017	2019
Permitting	2017	2019
Financial	2017	2018
Phase C- Reclaimed Water Structure (Advanced Treatment, Brine Disposal)	**2018**	**2023**
Technical Design	2018	2020
Construction	2020	2023
Environmental Compliance (CEQA)	2017	2019
Permitting	2018	2019
Financial	2018	2019
Phase D – Diversion Pipeline	**2019**	**2024**
Technical Design	2019	2021
Construction	2021	2024
Environmental Compliance (CEQA)	2017	2019
Permitting	2019	2021
Financial	2019	2021

8.7.1 Recycled Water State Policy

The SWRCB recognizes that a burdensome and inconsistent permitting process can impede the implementation of recycled water projects. The SWRCB adopted a Recycled Water Policy (RW Policy) in 2009 to establish more uniform requirements for water recycling throughout the State and to streamline the permit application process in most instances.

The newly adopted RW Policy includes a mandate that the State increase the use of recycled water over 2002 levels by at least 200,000 AFY by 2020, and by at least 300,000 AFY by 2030. Also included are goals for stormwater reuse, conservation and potable water offsets by recycled water. The onus for achieving these mandates and goals is placed both on recycled water purveyors and potential users.

Absent unusual circumstances, the RW Policy puts forth that recycled water irrigation projects that meet CDPH requirements and other State or Local regulations, be adopted by Regional Boards within 120 days. These streamlined projects will not be required to include a monitoring component.

As of June 2013, the Salt and Nutrient Management Plan for the Lower Santa Clara River is just beginning. However, the participants anticipate being largely complete by the May 2014 deadline established in the RW Policy.

8.8 OPERATIONAL PLAN

There are a number of unresolved issues that need to be addressed prior to developing an operational plan. These issues include final selection of a DPR or IPR project, as the monitoring and operational requirements for IPR and DPR will be different. In addition, the IPR regulations have not been finalized and DPR regulations have not yet been developed. Once implemented, an operational plan will be developed to address the regulatory requirements. However, some preliminary operational information has been provided as part of this report. Relevant information on the DPR and IPR alternatives is included in the reports in Appendices B and C, respectively.

8.9 RESEARCH NEEDS

The Reclamation Manual of the USBR requests a statement on whether the proposed water reclamation and reuse project includes basic research needs, and the extent that the proposed Title XVI project will use proven technologies and conventional system components. The treatment wetlands will use proven approaches to further treat wastewater effluent to achieve additional nutrient removal. The IPR/DPR alternative will include proven advanced treatment technologies, including MF, RO, and AOP. The treatment efficacy of these processes is well known, however, there is ongoing research on the controls and redundancies that will be required to be protective of public health, particularly in a DPR alternative. This issue will be addressed in the process of developing DPR regulations for California.

PROJECT FINANCING AND REVENUE PROGRAM

9.1 POTENTIAL FUNDING SOURCES AND CONSIDERATIONS

The adequate funding of capital costs is a primary constraint in implementing any construction projects. However, recycled water projects generally have some State, Federal, and local funding sources available.

This chapter describes potential funding opportunities and financing mechanisms for capital and operations costs, including an outline of current applicable grants and loan opportunities. The term “funding” refers to the method of collecting funds; the term “financing” refers to methods of addressing cash flow needs.

The recommended project is attractive for funding agencies, because of the benefits provided by implementing recycled water for indirect potable reuse/direct potable reuse (IPR/DPR) and a treatment wetlands to provide additional nutrient removal and wetland habitat.

1. The project provides integrated benefits and meets various objectives:
   a. Further improves the VWRF effluent quality prior to discharge into the SCRE.
   b. Implementation of IPR or DPR will help meet State recycled water objectives.
   c. With implementation of an IPR/DPR project, the flow through the wetlands will be reduced, and therefore the discharge into the SCRE will be reduced. While the amount of discharge into the SCRE that is environmentally protective has yet to be determined, there is scientific evidence that some level of reduced discharge to the SCRE will improve SCRE habitat.
   d. With implementation of an IPR/DPR project, the City will improve/augment their potable water supplies. This could potentially delay or eliminate future need for exercising the City’s SWP rights or developing other water supplies.
2. The project provides benefits to numerous stakeholders:
   a. City of Ventura (Ventura Water).
   b. Citizens of Ventura through improved potable water quality and additional recreational opportunities at the wetlands.
   c. NGOs.

Grants and loan interest loans are highly competitive. Competitive funding programs require enhanced recycled water programs to meet as many of the following objectives as possible:

- Regional partnerships.
- Integrated project benefits.
- Water conservation.
- Renewable energy improvements.
- Economic stimulus:
  - Job creation.
  - Job preservation.

9.2 FUNDING SOURCE IDENTIFICATION

Costs associated with the recommended project, consist of two components:

- Capital cost for construction of the advanced treatment processes, wetlands, and associated distribution system infrastructure.
- Operation and maintenance (O&M) costs associated with the treatment processes, wetlands, and distribution of recycled water.

The funding sources available range from traditional funding options such as pay-as-you-go funding, bond funding, grants, and State assisted loans to non-traditional funding sources such as market based programs. The sections that follow outline the mechanisms available to recover both capital and O&M costs.

The main instruments available for funding the capital costs include:

- Pay-as-you-go financing or upfront collection of project costs from existing and new users for future capital improvement projects.
- Debt financing or the acquisition of funds through borrowing mechanisms.
- Grants and loans or alternate source of funds at no or minimal interest cost. Examples include federal, state, and local programs that provide funding at zero interest for projects that meet select criteria.
- Market based programs that refer to financing through funds obtained from tax credits, purchase agreements, voluntary programs, trading and offset programs, and public-private partnerships.

All of these funding sources are discussed in additional detail in the following sections.

9.2.1 Pay-As-You-Go Financing

Pay-as-you-go financing involves periodic collection of capital charges or assessments from customers within the utility's jurisdiction for funding future capital improvements. These revenues are accumulated in a capital reserve fund and are used for capital projects in future years. Pay-as-you-go financing can be used to finance 100 percent or only a portion of a given project.

One of the primary advantages of pay-as-you-go financing is that it avoids the transaction costs (e.g., legal fees, underwriters' discounts, etc.) associated with debt financing alternatives, such as revenue bonds. However, there are two common disadvantages associated with this method. First, dependent upon the size of the capital program, it might be difficult to raise the required capital within the allowable time. Second, absent a buy-in component to the agency's capacity charge, fully placing the burden of funding a capital program on existing ratepayers might result in inequities in that existing residents would be paying for facilities that would be utilized by, and benefit, future residents. Agencies may account for existing assets in their capacity charges in order to recover a proportionate share of existing system costs from new developments.

9.2.1.1 Utility Fees and Benefit Assessment Fees

Utility fees or benefit assessments can be used to fund recycled water system improvements. To date, the City has chosen to fund the capital program through revenues generated through monthly user rates. The City could also implement an assessment through a public voting process, which would recover costs through the annual property taxes. Benefit assessment fees are usually included as a separate line item on the annual property tax bill sent to each property owner.

Utility fees are billed on a monthly interval. A utility has the authority to collect a benefit assessment fee, but only after approval by a majority of the voters, affected property owners, or ratepayers.

9.2.1.2 Connection Fees

As authorized under Government Code §66000, the City may impose a capacity charge on new development in order to recover a proportionate share of providing regional conveyance and treatment facilities. A capacity charge is a one-time fee imposed on a new development or upsize in system requirements. For the City, the end use of the recycled water will augment the City's potable water supply system and will require construction of advanced treatment facilities to produce recycled water for the purposes of IPR or DPR.. The City may appropriately recover costs through a recycled water capacity charge. As the City can also demonstrate benefits to water, wastewater and/or recycled water users, the City may also recover a portion of the system costs through each of those respective funds.

Capacity charges are collected at the timing of permitting for many agencies. Consequently, annual revenues from capacity charges depend solely on the rate of growth of the recycled water system. Consequently, funds may not be available to construct new facilities at the time it is needed.

9.2.2 Water Resources In-Lieu Fee

The City has explored implementing a water resources in-lieu fee. The City must maintain adequate water supplies to meet its long-term water demands. In order to provide adequate water supplies to its customers and not adversely affect existing customers, the City is evaluating a policy, which would require new developments to dedicate sufficient water rights to the City necessary to serve that development. The City has proposed adopting an in-lieu fee, which would allow these developments to fund a portion of the proposed recycled water system rather than dedicating a water right.

9.2.3 Debt Financing

There are several different options for debt financing of recycled water projects, ranging from issuance of short- or long-term bonds.

9.2.3.1 Revenue Bonds

Revenue bonds are historically the principal method of incurring long-term debt. This method of debt obligation requires specific non-tax revenues such as user charges, facility income, and other funds, pledged to guarantee repayment. There is often no legal limitation on the amount of authorized revenue bonds that may be issued, but from a practical standpoint, the size of the issue must be limited to an amount where annual interest and principal payments are well within the revenues available for debt service on the bonds. Revenue bond covenants generally include coverage provisions, which require that revenue from fees minus operating expenses be greater than debt service costs.

In the case of this project, based on policy decisions made regarding cost of service, any revenue bonds obtained would require proof of financial capacity to repay, using the City revenue sources that do not inequitably burden customers.

9.2.3.2 Certificates of Participation

Certificates of participation provide long-term financing through a lease agreement that does not require voter approval. The legislative body of the issuing agency is required to approve the lease arrangement by a resolution. The lessee (City) is required to make payments typically from revenues derived from the operation of the facilities. The amount financed may include reserves and capitalized interest for the period that facilities will be under construction. Within the State of California, most municipal water utility bonds are issued in the form of certificates of participation rather than traditional revenue bonds.

9.2.4 Grants and Loans

Grant and loan programs can be utilized to finance the recommended recycled water project alternative. These grants and loans are further discussed as state and federal funding sources in the succeeding sections. Table 9.1 provides a summary of the available state and federal funding sources. The grant and loan options presented herein are accurate as of Fall 2013. Please refer to the contact or website for the most up to date information for each of these grants and loans.

There are numerous factors that should be considered in the pursuance of grant funding. Several factors that should be noted in pursuance of grant funding include:

- Grant applications require demonstration of the ability to construct, operate, and maintain the project without grant funding.
- Grant award or funding authorization is NOT a promise of grant reimbursement:
  - Most grants are reimbursements and not cash up front. This requires that a source of funding be available for the construction of the project.
  - Grant reimbursements are subject to annual budget and appropriations process and thus disbursement of grant funds on schedule is not guaranteed.
  - It may take several years after project completion to receive reimbursements, especially in difficult economic times.
  - Most grants require a minimum cost share by project sponsor.
  - Federal grants typically require investment of additional resources to obtain lobbying support.

Despite the competitive nature of alternate funding, available funding sources should be considered to minimize ratepayer impacts. The following sections summarize available state and federal funding options.

9.2.4.1 State Funding

Several state funding sources are applicable to the recycled water project alternatives. Due to the California state budget difficulties, some of these programs may be suspended or not have funding available when the City is ready to move to construction.

9.2.4.1.1 *Water Recycling Funding Program*

One option for financing the Recycled Water Project is the Water Recycling Funding Program administered by the State Water Resources Control Board. The program offers funding for research, feasibility studies, planning, and construction. The program is financed through Propositions 13, 50, and the State Revolving Fund (SRF).

- Recycling projects are categorized by their potential benefits to state and local communities, which in turn determine which funding sources are applicable.
- Category I projects will offset state water supplies and increase water to the Delta.
- Category II projects will offset state water use, but do not provide benefits to the Delta.
- Category III projects use recycled water to supplement local water supplies but have no impact on the state water supply or the Delta.

Table 9.1 Funding Summary
Recycled Water Feasibility Study
City of Ventura

Program	Agency	Type	Description
State			
Water Recycling Funding Program	State Water Resources and Control Board	Grant/Loan	Funding is available for projects in the following categories: 1. Category I projects will offset state water supplies and increase water to the Delta. 2. Category II projects will offset state water use, but do not provide benefits to the Delta. 3. Category III projects use recycled water to supplement local water supplies but have no impact on the state water supply or the Delta. 4. Category IV projects will treat and reuse groundwater contaminated by human activity. 5. Category V projects will treat and dispose wastewater to meet waste discharge regulations. 6. Category VI captures miscellaneous projects that do not fall into other categories and have no benefits to state or local water supplies. The maximum award for construction grants for Category I through IV projects is the lesser value of $5 million per project or 25 percent of construction costs. Category V and VI projects are only eligible for SRF loans. Loans are capped at $50 million per agency per year.
Integrated Regional Water Management Grants Program (Prop 84)	Department of Water Resources	Grants	Grants are available for projects that support IRWM Plans and are related to water supply reliability, groundwater recharge, water quality enhancement etc.
Federal			
Title XVI	U.S. Bureau of Reclamation	Grants	Eligible projects include recycled water feasibility, demonstration, and construction projects. The program provides as much as 25 percent of construction costs with a maximum of $20 million. To meet eligibility requirements a project must have a Bureau of Reclamation approved feasibility study, comply with environmental regulations, and demonstrate the ability to pay the remainder of the construction costs.

- Category IV projects will treat and reuse groundwater contaminated by human activity.
- Category V projects will treat and dispose wastewater to meet waste discharge regulations.

Category VI captures miscellaneous projects that do not fall into other categories and have no benefits to state or local water supplies.

The recycled water alternatives fall into Category I as it should offset state water supplies and increase water to the Delta.

The source of available funding varies with the category in which the project is classified. The maximum award for construction grants for Category I through IV projects is the lesser value of $5 million per project or 25 percent of construction costs.

Category V and VI projects are only eligible for SRF loans. Loans are capped at $50 million per agency per year. The SRF interest rate is set at one-half of the state general obligation bond rate and has historically averaged around 2.5 percent.

The SWRCB provides one application package for both construction grants and SRF recycled water loans. The application package consists of:

- Financial Assistance Application.
- Facilities Plan composed of:
  - Project report.
  - Environmental documents including CEQA documents.
  - Construction Financing Plan.
  - Recycled Water Market Assurances documenting user participation in the project.
  - Authorized Representative Resolution (Legal Authority).
- Water Conservation Plan demonstrating that the applicant has a water conservation program in effect or has signed onto the California Urban Water Conservation Council's Memorandum of Understanding.

The SWRCB will review the application package and assess eligibility. Once the SWRCB receives and reviews the final plans and specs, it will issue project performance standards. Once performance standards are agreed to and the applicant chooses a contractor, the parties sign a funding agreement. The applicant must also have an Urban Water Management Plan filed with the Department of Water Resources to receive funds.

9.2.4.1.2 *Integrated Regional Water Management Implementation Grant Program*

Grants are available for projects that support IRWM Plans and are related to water supply reliability, groundwater recharge, water quality enhancement etc.

In transitioning from Prop 50 funding to Prop 84 funding, the DWR altered several of the standards it uses to evaluate regions including governance requirements, acknowledgement of water conflicts, and potential climate change requirements. To facilitate this change, DWR has allowed regions with standing IRWM plans to also receive funds under Prop 84 to comply with the new standards and to develop new projects. Projects seeking funding through this grant process generally submit a project summary to the respective local IRWM management group to review and assess the merits of a project and its ability to fulfill the intent of the IRWM plan. Once approved through this process, a project may be included in the region's implementation grant application.

9.2.4.2 Federal Funding – Title XVI

The U.S. Bureau of Reclamation administers funds for recycled water feasibility, demonstration, and construction projects through the Water Reclamation and Reuse Program authorized by the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Title XVI) and its amendments. The program provides as much as 25 percent of construction costs with a maximum of $20 million. To meet eligibility requirements a project must have a feasibility study, comply with environmental regulations, and demonstrate the ability to pay the remainder of the construction costs. Projects are authorized by Congress and recommended in the President's annual budget request by the Bureau of Reclamation. Congress then appropriates funds and the Bureau ranks and prioritizes projects and disburses the money on a competitive grant basis each year. Prioritized projects are those that postpone the development of new water supplies, reduce diversions from natural watercourses, reduce demand on federal water supply facilities, or that have a regional or watershed perspective.

9.3 FUNDING SOURCE AND TIMING SUMMARY

The City's settlement agreement Heal the Bay and Ventura Coastkeeper requires that the MEPDV must be determined by August 2018, and a project(s) that has the capacity to reduce the VWRF discharge to the SCRE must be implemented by 2025. Assuming this schedule, the design and construction of the proposed project would not occur until after the MEPDV determination in 2018. However, the settlement agreement does not preclude earlier determination of the MEPDV or earlier implementation of a project. The City has begun the financial planning process for the proposed recycled water project and has already implemented a dedicated Estuary Protection Fund Charge dedicated to funding a water reuse project.

In general, the City proposes to utilize a combination of funding sources to construct the proposed recycled water project. The priority of the funding will be to secure grants where available and then obtain debt financing in the form of general obligation bonds or revenue bonds for the cost of the project not covered by grants. Because there is uncertainty in the ability to secure grant funding, the City is proceeding with financial analysis, assuming that grant funding is not obtained.

The City's Cost of Service and Rate Design Study (Raftelis Financial Consultants, 2012) recommended rate restructuring and increases that were implemented in July 2012 and July 2013. As a part of these rate changes, a separate Estuary Protection Fund Charge was implemented, at 2 percent of utility bill in 2012 and 4 percent of the utility bill in 2013. The Estuary Protection Fund Charge is anticipated to generate approximately $26 million by 2021. The revenues generated from this charge will be used to help fund the overall recycled water program.

The City is currently in the process of updating their CIP and conducting preliminary financial planning. The updated CIP is expected to include three projects that comprise the components of the proposed recycled water project, as summarized in Table 9.2. The CIP projects total $112 million. The total program costs are within this estimate and will be updated if/when additional studies are conducted to refine the cost estimates. For example, the preliminary estimates for indirect potable reuse and direct potable reuse are $94 million and $80 million, respectively. The City is currently in the process of reviewing and updating the 2012 Cost of Service and Rate Design Study and this update is expected to be completed in Spring 2014. The update will include a forecast of revenue requirements for a ten-year planning horizon. This will include forecasting annual O&M expenses, reserve contributions, review of the CIPs (water and wastewater) to identify capital outlays, pay as you go capital items, and annual debt service. As part of the evaluation of revenue requirements, specific attention will be given to the capital expenditures associated with the proposed recycled water alternative so that the rate impacts that result from these capital expenditures are well documented and understood. An annual cash flow analysis will be conducted, with recommended rates for the next four years. The rate study will also provide a roadmap for how the City will fund the projected capital needs for the recycled water program, including anticipated bond issuances.

9.4 RECYCLED WATER PRICING POLICY

The City's pricing policy for its existing recycled water system is based on distribution costs only, and treatment costs associated with Title 22 compliance are incorporated into the City's wastewater rates since Title 22 treatment is a requirement of the City's NPDES discharge permit.

Table 9.2 Projects Included in the Draft CIP Recycled Water Feasibility Study City of Ventura

CIP Project	Description	Amount	Timing
Wastewater Plant – Wetlands Improvements	Expansion of existing effluent pump station, modifications to existing ponds or new wetlands	$7 Million	2017-2018
Wastewater Plant – Reclaimed Water Structure	Advanced wastewater treatment processes, brine line, and internal VWRF supporting infrastructure	$55 Million	2018-2019
Recycled Waterline-Diversion Pipeline	Distribution system for IPR or DPR	$50 Million	2019-2020

The cost of expanding the City's recycled water system may be recovered through a combination of methods where costs are shared amongst recycled water customers, potable water customers, and wastewater customers. As estimated and planned herein, the City is fully aware of the potential costs for the expanding its recycled water system for the purpose of IPR/DPR- capital, O&M and replacement. A recommended approach to recovering system costs from system users will be developed as part of the cost of service study currently underway.

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REFERENCES

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APPENDIX A – LETTER OF INTEREST

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VENTURA WATER

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November 21, 2013

Subject: City of Ventura's Interest and Intention to Expand Recycled Water Delivery

Dear To Whom It May Concern,

The City of Ventura wishes to express its interest in expanding recycled water delivery within the Ventura Water service area for the purpose of augmenting the City's water supply. The expansion of the City's recycled water system will lessen the potable water demands on local water sources, increase water supply reliability, and reduce potential demand on the State Water Project.

Currently the City's Water Reclamation Facility (VWRF) discharges most of its tertiary treated effluent to the Santa Clara River Estuary (Estuary) with approximately 700 acre-feet per year diverted as recycled water for landscape irrigation by several users. However, during the 2008 discharge permit re-issuance process, controversy arose on whether or not the City should be permitted to continue its current volume of discharge into the Estuary. The subsequent discharge permit issued allowed the continuation of the discharge but required the City to perform extensive studies which included the March 2010, Phase1: Recycled Water Market Study and March 2013, Phase 2: Facilities Planning Study for Expanding Recycled Water Delivery.

Based on the findings of this Phase 1 and 2 studies there are several recycled water opportunities. The preferred alternatives include, Direct Potable Reuse (DPR) and Groundwater Recharge of the Mound Basin (Indirect Potable Reuse or IPR), and were selected based on City interests and the outcome of a stakeholder process. These alternatives have the greatest potential for providing the City with a more reliable and diverse water supply portfolio.

In the City's most recent water planning efforts (RBF, 2013), we have identified a vulnerability with our water supply in both quantity and quality, and recommended that there is continued integration of new water supplies into the water supply portfolio. Recycled water is one strategy identified in the water planning efforts to provide a supplemental supply. Therefore, the City of Ventura is pursuing expansion of our

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recycled water system for the purpose of IPR/DPR. The City would like to express our interest in both providing and using recycled water.

Sincerely,

Shana Epstein
General Manager Ventura Water

cc: Omar Castro, Water Utility Manager
Dan Pfeifer, Wastewater Utility Manager
Susan Rungren, Principal Engineer

APPENDIX B – CITY OF VENTURA DPR CASE STUDY

City of Ventura

WATEREUSE RESEARCH FOUNDATION
EVALUATION OF RISK REDUCTION PRINCIPLES FOR DIRECT POTABLE REUSE
WRRF-11-10

DIRECT POTABLE REUSE CASE STUDY

DRAFT
January 2013

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CITY OF VENTURA

WATEREUSE RESEARCH FOUNDATION
EVALUATION OF RISK REDUCTION PRINCIPLES FOR DIRECT POTABLE REUSE
WRRF-11-10

DIRECT POTABLE REUSE CASE STUDY

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DIRECT POTABLE REUSE CASE STUDY

1.0 INTRODUCTION

The WateReuse Research Foundation is conducting Project #WRRF-11-10: Evaluation of Risk Reduction Principles for Direct Potable Reuse. The primary goal of this project is to develop recommendations for best practices for direct potable reuse (DPR), considering cost and practicality issues without compromising public health protection. The City of Buenaventura (City or Ventura) contributed funds toward this project in an effort to develop a case study that would evaluate differing logistical and treatment challenges, providing a specific example of how different options might be implemented in different municipalities. This case study illustrates some of the inherent trade-offs in logistics, complexity, and cost associated with DPR and will provide an enhanced understanding of what engineering practices could be incorporated into the design and control of advanced treatment systems for DPR.

2.0 BACKGROUND

The City of San Buenaventura is located 62 miles north of Los Angeles and 30 miles south of Santa Barbara along the California coastline. The City is located within the County of Ventura, and bound by the City of Oxnard to the south, by unincorporated Ventura County to the east and north, and by the Pacific Ocean to the west. The northwest portion of the City is bound by the Ventura River, while the southern portion is bound by the Santa Clara River. The Ventura Freeway (101) bisects the City in the north-south direction, while the Santa Paula Freeway (126) runs east to west through the center of the City. The Ojai Freeway (33) runs along the northwestern edge of the City. The City currently occupies an estimated 21 square miles and has an estimated population of 109,000 persons.

The City's domestic water supply is derived from local groundwater basins, Lake Casitas, surface water from the Ventura River, and sub-surface water from the Ventura River. The City also has a 10,000 acre-foot per year allocation from the California State Water Project. To date the City has not received any of this water because there are no facilities to get the water to the City. There are presently five water sources that provide water to the City water system (below and Table 1):

- Casitas Municipal Water District (Casitas)
- Ventura River Foster Park Area (Foster Park)
- Mound Groundwater Basin (Mound)
- Oxnard Plain Groundwater Basin (Fox Canyon Aquifer)
- Santa Paula Groundwater Basin (Santa Paula Basin)

Table 1 Ventura Water Supply

Water Supply Source	Historical Supply Projection[1] (AFY)	Average Annual Supply (2000-2009) (AFY)	Future Water Supply[2] (AFY)
Casitas	4,960-8,000	6,200	5,000
Foster Park	4,200-6,700	4,200	6,700
Groundwater from City Wells	9,600-11,100	9,440	11,100
Mound	2,500-4,000	4,000	4,000
Fox Canyon Aquifer	4,100	4,100	4,100
Santa Paula Basin	3,000	1,340	3,000
Recycled Water		700	700
Total	**18,760 - 25,800**	**20,540**	**23,500**

Source: (1) City of Buenaventura Water Master Plan, March 2011; (2) LAFCo Municipal Service Review, 2012.

2.1 Challenges Affecting Current Water Supply

Historical use of the Mound basin has been documented to temporarily exceed the yield of the basin and result in water levels that have fallen below sea level and created a threat of seawater intrusion (Water Master Plan, 2011). Water quality in the Mound is highly mineralized with high levels of total dissolved solids (TDS) and hardness. The City manages the water quality issues by blending groundwater from the Mound basin with lower TDS groundwater from the Fox Canyon Aquifer (via the Golf Course Wells). This operational strategy is required to meet drinking water standards established by the California Department of Public Health (CDPH). Thus, minimizing the amount of groundwater pumped from the Mound basin could potentially alleviate the water quality issues mentioned above.

The Ventura River water source is dependent upon local hydrology. The City is currently working with experts to ascertain a pumping regime that will balance production demands with environmental concerns and is presently studying the relationship between groundwater production and surface flows in the Ventura River.

Implementation of potable reuse could result in reduced reliance on groundwater supplies and/or surface water supplies (Ventura River) thus mitigating water quality issues and potential environmental concerns.

Flows from the City's wastewater collection system are treated at the City's Ventura Water Reclamation Facility (VWRF). Current average annual flows to the VWRF total about 9.3 million gallons per day (mgd). The VWRF produces tertiary treated water suitable for unrestricted reuse. Recycled water from the VWRF is used to irrigate two golf courses, a park and several landscaping areas. The remaining effluent is discharged to the Santa Clara River Estuary. In the last several years there has been tremendous debate by regulators, resource agencies and environmental organizations on whether or not the discharge is a benefit to the estuary to support the endangered species that inhabit the estuary. The City recently settled a lawsuit and agreed to increase diversion of recycled water from the estuary. However, ongoing studies and regulatory discussions may require a portion of flow to remain in the estuary to provide flows and adequate habitat. While there clearly is a need to better understand the available amount of VWRF water for future use, it is assumed that approximately 8 mgd of tertiary treated water will be available for DPR as part of this analysis.

2.2 Existing UF System at Avenue Treatment Plant

The Avenue Water Treatment Plant (AWTP) is a filtration plant designed to treat groundwater under the influence of surface water from the Ventura River. In some potable reuse schemes, advanced treated water could be sent to the Ventura River upstream of the AWTP. Thus, an understanding of the AWTP facilities could be relevant.

The AWTP is sized for 10 mgd and can be expanded to 15 mgd. The AWTP implements an in-line ultra filtration (UF) membrane and chlorine disinfection processes. Current configuration consists of 4 membrane basins with additional basins for future expansion. Each basin is designed for a 2.5 mgd capacity with 6 cassettes per basin. The removal credits for the existing Zenon UF system are 4-log Giardia, 4-log Crypotsporidium, and 3.5-log Virus. An additional 2 log and 6 log removal credits for Giardia and Virus respectively are attained by chlorine residual in the water coming from the Power Reservoir. This is based on 0.5 mg/l chlorine residual, 15°C, ph 8 and 1.7 hours of contact time. The Power Reservoir is a concrete lined covered reservoir used to store approximately 15 mgd of potable water from the Ventura River and Lake Casitas before entering the distribution system.

3.0 IPR VERSUS DPR POTABLE REUSE BASIC COMPARISONS

For IPR projects in the State of California (CDPH 2011), a minimum of 12-log enteric virus reduction, 10-log Giardia cyst reduction, and 10-log Cryptosporidium oocyst reduction, are needed through advanced treatment prior to consumption. While potable reuse is not a California only issue, the CDPH standards are used here as a starting point for DPR. Per CDPH (2011), the treatment train shall consist of at least three separate treatment processes, and can include a mixture of primary, secondary, and tertiary treatment. For each pathogen (i.e., virus, Giardia cyst, and Cryptosporidium oocyst), a separate treatment process may be credited with no more than 6-log reduction and shall achieve at least 1-log reduction.

For this case study, two levels of treatment were developed for comparison. The first alternative (Figure 1) is the conventional IPR treatment scheme. The VWRF would treat secondary effluent with ultra-filtration (UF), reverse osmosis (RO), and UV/H2O2, which CDPH would call the FAT (fully advanced treatment) treatment train. Note that tertiary effluent (filtered and disinfected to California's Title 22 "tertiary recycled water" standard) is available. However, for simplicity, we are assuming secondary effluent to the FAT process. The purified water from the FAT process would be:

- Pumped either North to the Ventura River; or
- Pumped East to the Bailey Treatment Plant; or
- Pumped East and injected into the Mound Basin.

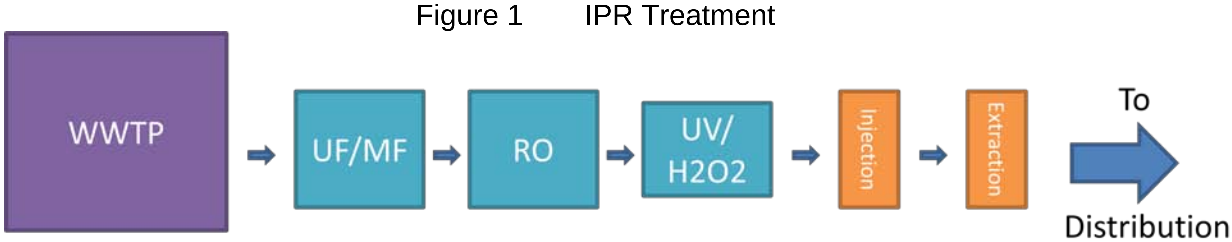
The first two options are more complex than the conventional IPR process. For this analysis, it is assumed that the third option (injection into the Mound) is selected. The associated log reductions for this IPR alternative are summarized in Table 2 below.

Table 2 IPR Log Reductions

	Cryptosporidium	Giardia	Virus
Secondary Treatment	0	2[a]	2[b]
UF	4.5[c]	4[d]	3[e]
RO	2[f]	2[g]	2[g]
UV/ H2O2	6[h,i]	6[i]	6[j]
Underground Travel Time	0[1]	6[k]	6[l]
Total	12	16	13

EPA, 1986 (see Table 2-1). (b) Francy et al, 2012 (see Table 2).(c) Reardon et al., 2005 and Lovins et al, 2002 . (d) Lovins et al., 2002 (The cited study shows 6-log removal is achievable, but project experience indicates that 6-log removal may not be achieved reliably; 4-log was chosen to remain conservative.) (e) Based on EPA (2008) and Reardon et al. (2005). Lovins et al, (2002) indicates 6-log may be achievable.(f) Schäfer et al., 2005; limited by online monitoring of conductivity (g) Reardon et al., 2005; limited by online monitoring of conductivity (h) Snyder et al., 2012 (i) Hijnen et al., 2006 (j) Rochelle et al., 2005 (k) EPA, 2008 (l) CDPH, 2011

Figure 1 IPR Treatment



The second alternative (Figure 2) is the DPR alternative in which additional treatment and monitoring is substituted for the environmental buffer. Similar to the IPR scheme, VWRF secondary effluent would be treated by UF and RO. At that point, the water would be stored for a set period of time, 12 hours is proposed here to allow for additional monitoring. The

[1] Literature suggests that at least a similar inactivation compared to virus can be assumed (Hogg et al., 2012). No credit is currently provided by CDPH.

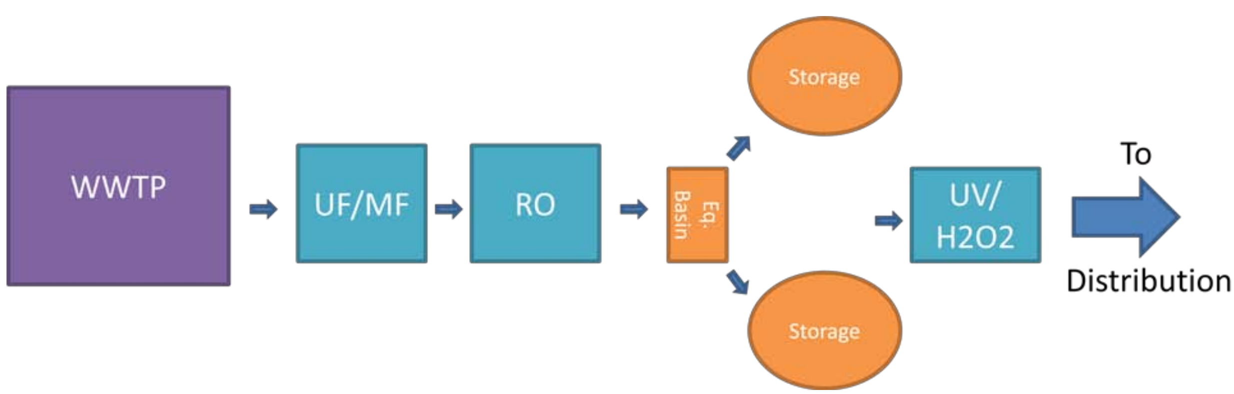
influent to the storage tank would be dosed with free chlorine to provide for an additional measure of disinfection and destruction of trace pollutants. Storage would be such that treated “potable” water would be diverted for 12 hours at a time to two tanks, “Tank 1” and “Tank 2.” After 12 hours of flow to Tank 1, the tank would be sealed and water would be diverted to start filling “Tank 2.” Water samples would be taken at constant intervals during the filling process and tested by one of the advanced monitoring methods described in Section 4.3 of this report. Upon successful completion of the advanced monitoring, water would be released from the full tank, undergo UV and advanced oxidation, and be delivered into the distribution system. The tank would subsequently be refilled while Tank 2 undergoes advanced monitoring. An equalization basin would be needed to regulate flow into the two tanks. As discussed in Section 4.3 of this report, additional innovative monitoring techniques are proposed for the RO process to further bolster process confidence. The associated log reductions of the DPR alternative are summarized in Table 3 below.

Table 3 DPR Log Reductions

	Cryptosporidium	Giardia	Virus
Secondary Treatment	0	2[a]	2[b]
UF	4.5[c]	4[d]	3[e]
RO	2[f]	2[g]	2[g]
Chlorine/Storage	3[h]	4[h]	4[h]
UV/ H_2O_2	6[i,j]	6[j]	6[k]
Total	15.5	18	17

EPA, 1986 (see Table 2-1). (b) Francy et al, 2012 (see Table 2).(c) Reardon et al., 2005 and Lovins et al, 2002 . (d) Lovins et al., 2002 (The cited study shows 6-log removal is achievable, but project experience indicates that 6-log removal may not be achieved reliably; 4-log was chosen to remain conservative.) (e) Based on EPA (2008) and Reardon et al. (2005). Lovins et al, (2002) indicates 6-log may be achievable.(f) Schäfer et al., 2005; limited by online monitoring of conductivity (g) Reardon et al., 2005; limited by online monitoring of conductivity (h) Bandy, 2009 (see Table 2.2), which is based on: Asano et al., 2007 and Meng, 1996 (i)Snyder et al., 2012 (j) Hijnen et al., 2006 (k) Rochelle et al., 2005

Figure 2 DPR Treatment Train



4.0 APPROACH AND LAYOUT

The distribution system and facility layouts required for each of the IPR and DPR alternatives are important in consideration of these options and thus, are presented in this section.

4.1 Conventional Indirect Potable Reuse

Under this alternative, 8 mgd of tertiary treated water would undergo FAT at the VWRF producing 5.8 mgd of finished water. The water would then be pumped approximately 8 miles near the vicinity of the Bailey Treatment Plant (BTP) where it would be injected into the Mound basin and then extracted by the existing wells Victoria No. 1 and Mound No. 2 after a travel time of 6-8 months. This option would provide an alternative supply, replacing the approximately 5 mgd currently pumped from the Mound basin and provide an additional 0.8 mgd, assuming 90% recovery following MF/UF and 80% recovery following RO, that could serve new users or potentially offset diverted/pumped water from one of the City's other water supplies. The additional 0.8 mgd could also potentially help supply the storage deficiency of 5.69 MG as described in the 2011 Water Master Plan (WMP). A summary of maximum extraction rates is provided in the table below:

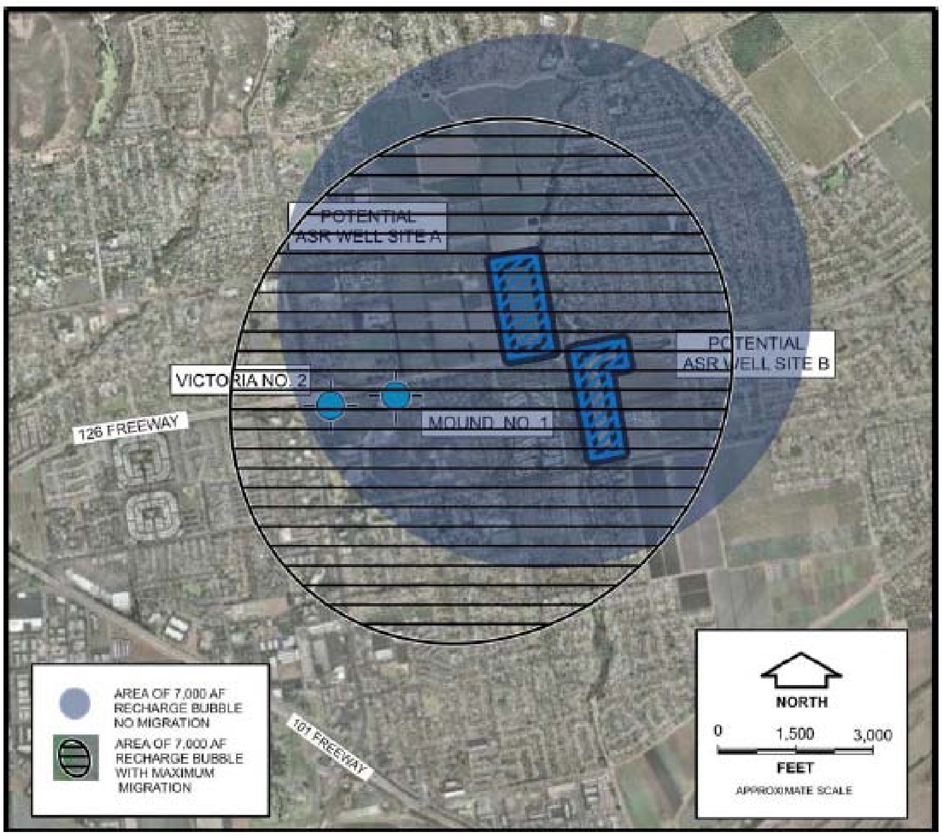
Mound Aquifer Extractions	Maximum Capacity (gpm)	Maximum Capacity (mgd)
Victoria 2	3,000	4.3
Mound 1	2,500	3.6
Total Supply	**5,500**	**7.9**
Total Current Use	3,455	5
Potential Supply from FAT	4,027	5.8

A pump station would need to be constructed in order to pump the water from the VWRF to the injection site. The following is a list of components that would be needed for a proposed IPR project injecting and extracting water from the Mound:

- FAT treatment train at VWRF including RO, UV and AOP
- 8 miles of 16" pipeline to injection well site
- Pump station sized at approximately 600 hp (4 pumps @ 1200 gpm including standby capacity)
- Monitoring Wells
- Injection Wells
- 1 additional extraction well

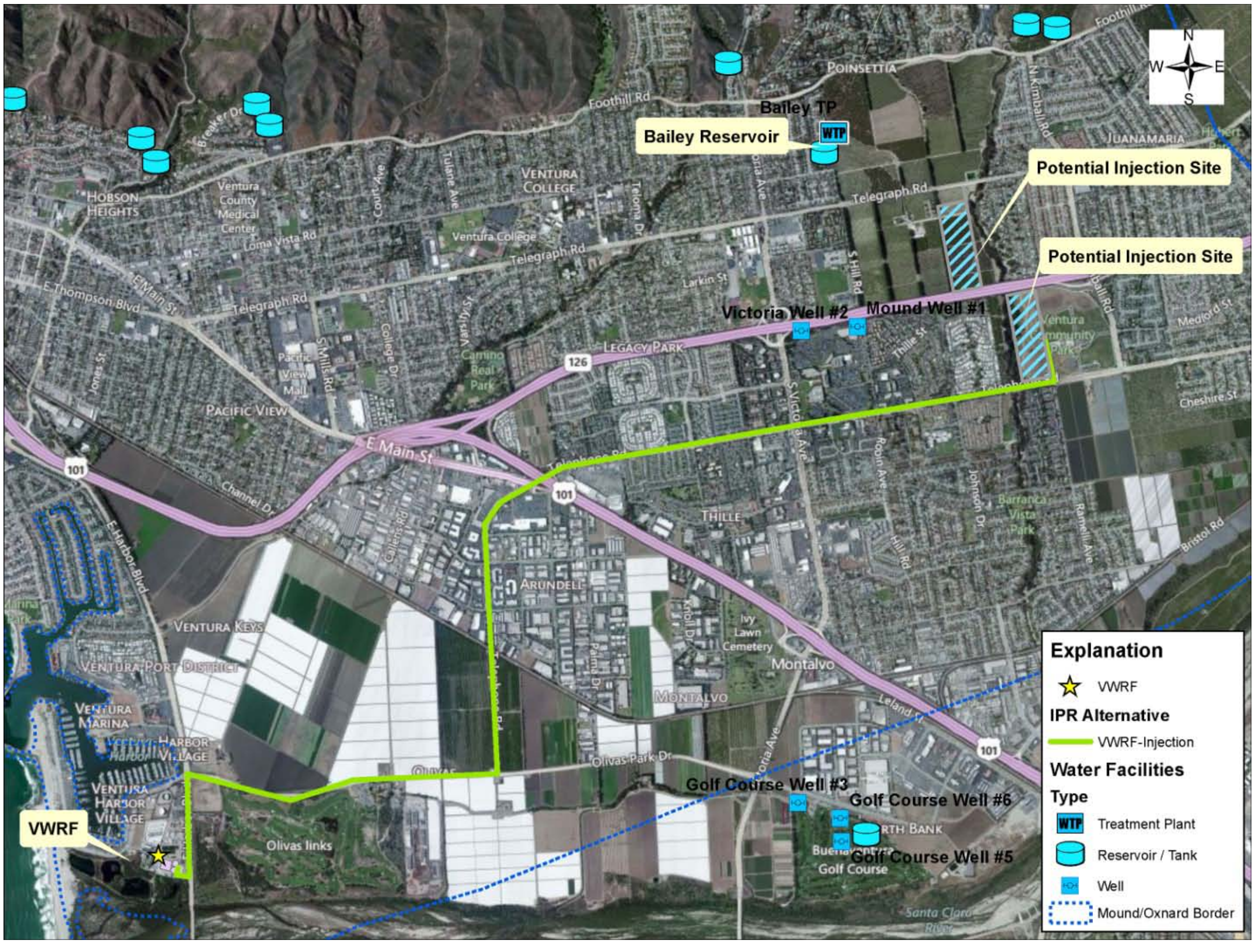
Indirect potable reuse is dependent upon the aquifer characteristics of the Mound basin. A preliminary hydrogeological study (Hopkins, 2013) of the Mound was conducted to assist the City of Buenaventura in evaluating the feasibility of IPR alternatives. It was estimated that approximately 7000 afy, or 6.25 mgd, could be injected into the Mound in the vicinity of the existing extraction wells (Victoria No.2 and Mound No. 1). This volume is based on the total water currently being extracted from the Mound by the City of Ventura as well as agricultural users. Assuming existing infrastructure limitations, the 5.8 mgd of high quality FAT treated water would provide a replacement supply to the poor quality water currently pumped from the Mound and supply both agricultural and potable use needs. Assuming that the entire volume of 7,000 afy is injected in a single well or closely spaced wells, the estimated travel time to reach Vitoria Well No. 2 is 6 to 8 months (Hopkins, 2013).

Figure 3   Area of Lower Aquifer Filled by IPR Water



(Hopkins, 2013)

Figure 4 IPR Alternatives in Vicinity of Bailey Treatment Plant



4.2 Direct Potable Reuse

Under this alternative 8 mgd of tertiary treated water would undergo treatment at the VWRF producing 5.8 mgd of finished water. The RO treated water would then be stored for a set period of time, with 12 hours proposed to allow for additional advanced monitoring. Upon successful completion of the advanced monitoring, water would undergo UV and advanced oxidation before being pumped to three possible locations for connection to the existing distribution system:

- Alternative 1: 5.3 miles to the North of the VWRF to Casitas Turnout #2
- Alternative 2: 8 miles to directly connect to the produced water side of the BTP (or to the 7.2 MG Bailey Reservoir)
- Alternative 3: 9.4 miles to the Power Reservoir or produced water side of the AWTP

Alternative 1

The Casitas Turnout #2 is one of the largest supply lines to the city. The 24" transmission main has a capacity for approximately 12 mgd with current use at approximately 6.6 mgd. The City currently purchases water from the Casitas Municipal Water District (CMWD). Storm water runoff from local watersheds is stored in Lake Casitas, located approximately 10 miles northwest of the City, then treated and delivered to customers by CMWD. The City's minimum annual purchase is 5.4 mgd (6000 AFY) which is subject to an allocation program put into effect during drought conditions. During extreme drought conditions, approximately 4.4 mgd would be available.

This alternative would enable the City to maintain its water purchase agreement with CMWD and provide a number of options to decrease water pumped from the Ventura River as well as reduce or eliminate the amount of water pumped from the Mound, in addition to providing supplemental supply during extreme drought. If the City were to maintain its minimum annual purchase agreement, approximately 11.2 mgd would run through the system, which is just under the stated capacity of the distribution infrastructure in place.

Casitas Turnout #2 is located in the 210-pressure zone, which is the lowest pressure zone in the distribution system. Water from the 210 zone is distributed throughout the system by a series of pump stations. The 330 and 430 pressure zones are currently supplied by water from the Victoria, Mound, and Golf Course wells. This alternative could potentially allow for discontinuation of Victoria Well No.2 and Mound Well No.1 by delivering water directly to the 330-pressure zone and 430 pressure zones by way of the 5 Points and 330 Pump Stations. The WMP recommended the construction of two wells, Mound Well No. 2 (CIP 97907) and Golf Course Well No. 7 (CIP 97908) in order to increase the capacity of the 330 Pressure zone by 5,000-6,000 gpm (7-8.5 mgd) eliminating a storage deficiency in the 330 pressure zone of 5.69 MG. This alternative would eliminate the need for these new wells. The existing wells could potentially remain operational to serve as additional storage capacity as well as an additional safety measure in the event of a malfunction in the FAT treatment train, or if a breach is detected by the advanced monitoring systems.

The following two figures, taken from the 2011 City of Buenaventura Water Master Plan, show a hydraulic schematic of the system depicting pressures zones, pump stations, storage reservoirs and the capacities of the separate components during typical operating conditions. Figure 5 provides a schematic of the distribution alternatives for finished water using the existing distribution infrastructure. Further hydraulic modeling would be needed to verify and optimize the new distribution of water depending on the City's desired adjustment of existing supply sources.

Figure 5 Existing System with Distribution Alternatives

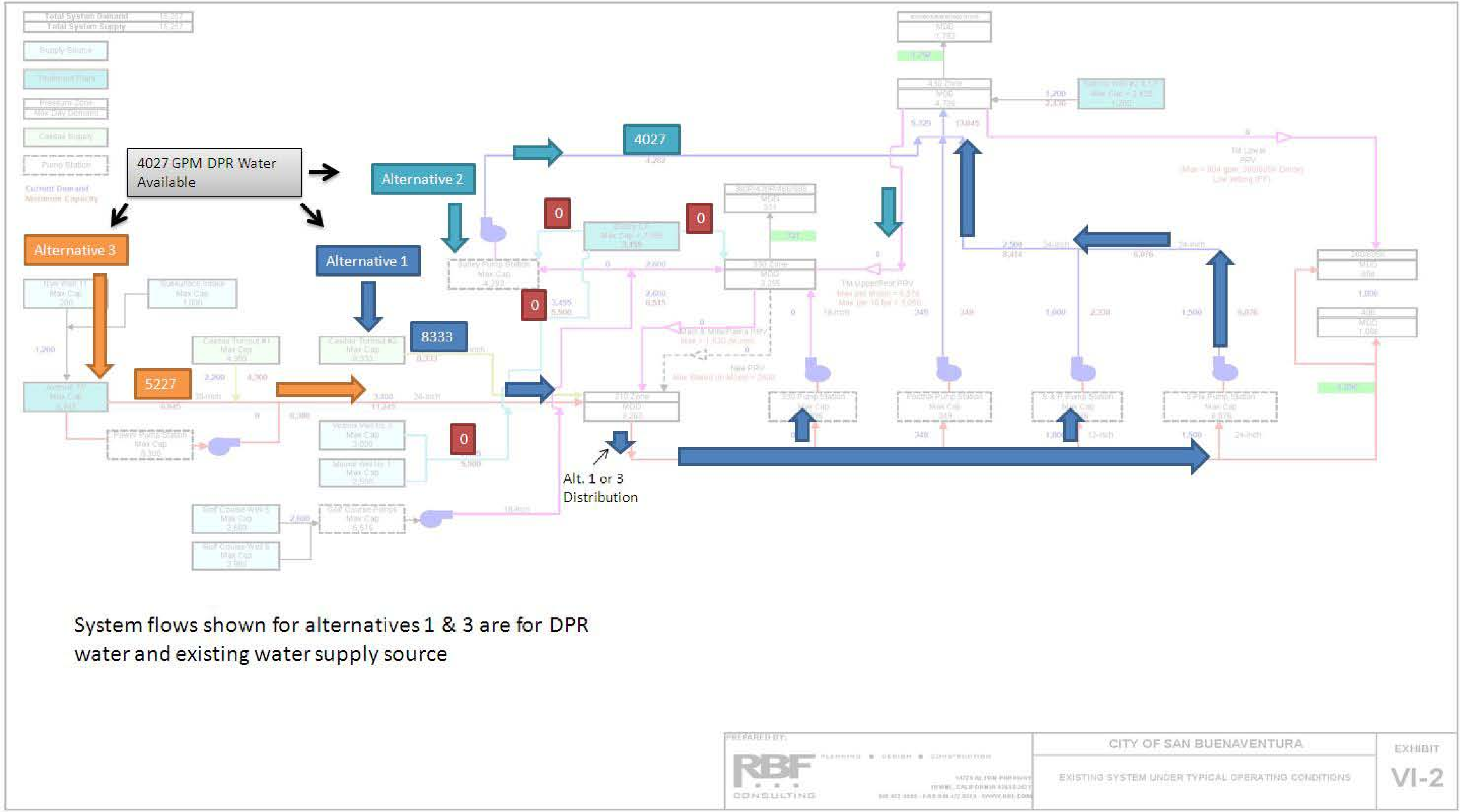
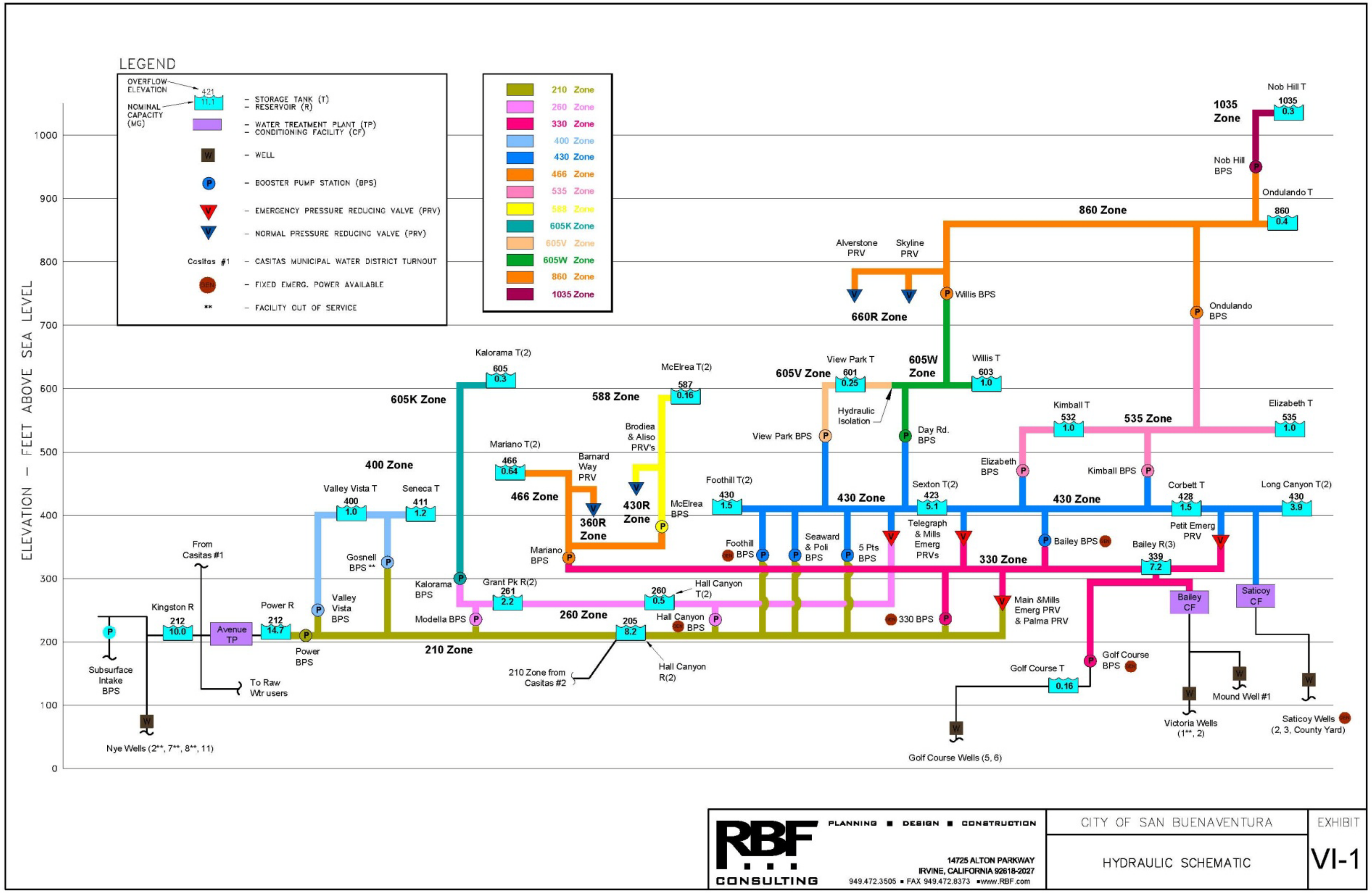


Figure 6 Hydraulic Schematic



The following infrastructure components would be included in this scenario:

- 8 mgd FAT treatment train at VWRF including RO, UV and AOP (5.8 mgd finished water)
- Pump station sized at approximately 600 hp (including standby capacity)
- Engineered storage for detention during advanced monitoring at VWRF
- 5.3 mile 16" pipeline to deliver 5.8 mgd high quality DPR water to the Casitas Turnout #2
- Discontinued operation of Victoria Well No. 2 and Mound Well No. 1.
- Could possibly keep one or both of the Mound wells operational to account for part or all of the storage supply shortage identified in the 2011 WMP (4.11 mgd) .
- Continued use of existing infrastructure.

Alternative 2

This alternative would deliver FAT treated water to either one of the following locations: the finished water side of the BTP, directly to the Bailey Pump Station, or to the Bailey Reservoir. The Bailey Reservoir is a 7.2 MG storage tank providing storage for the 330-pressure zone. This approach would replace the current low quality water pumped from the Mound (5 mgd) supplying the 330-pressure zone and enable a decreased amount of water to be pumped from the Oxnard Groundwater Basin via the Golf Course wells or decreased extractions from the Ventura River. The water would continue to be distributed in the 330-pressure zone and throughout the distribution system as it is currently, via the Bailey Pump Station and the pressure reducing valve (PRV) at TM Upper/Petit would be used to convey water to the 330-pressure zone. The PRV at Main and Mills would be utilized to convey water to the 210-pressure zone if desired. This alternative would also provide the ability to mix DPR water with water pumped from Golf Course Well No. 5 at the Bailey Reservoir, allowing for an alternative water supply for short-term treatment shutdowns. Assuming that all of the existing infrastructure remain in place and operational, groundwater from the Mound Basin could still be utilized in the event of an emergency.

Alternative 2 would include the following components:

- 8 mgd FAT treatment train at VWRF including RO, UV and AOP (5.8 mgd finished water)
- Pump station sized at approximately 600 hp (4 pumps @ 1200 gpm including standby capacity)
- Engineered storage for detention during advanced monitoring at VWRF

- 8 mile 16” pipeline to deliver 5.8 mgd high quality DPR water to the Bailey Reservoir.
- Discontinued operation of Victoria Well No. 2 and Mound Well No. 1.
- Continued use of existing distribution infrastructure.

Alternative 3

The third DPR alternative includes delivering finished water to the produced water side of the AWTP or into the Power Reservoir, which as mentioned, is a covered storage facility currently fed by Casitas Turnout #1 and finished water from the AWTP. This alternative is similar to Pumping DPR water to Casitas Turnout #2 with the key differences being:

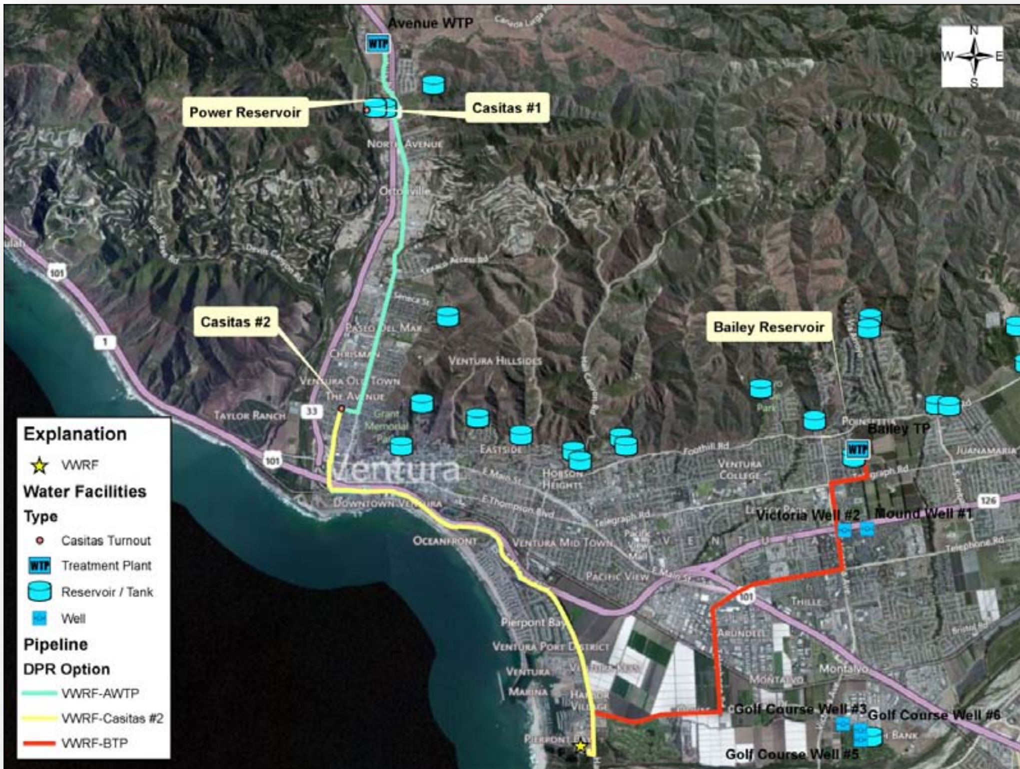
- The pipeline would be longer (9.4 miles)
- Water would have to be pumped to a higher elevation (Approx. 200 ft) than Casitas #2 (30 ft)
- Would enable supply to pressure zones supplied by the Valley Vista Booster Pump Station and Modella Booster Pump Station.
- Would provide additional flexibility for distribution of finished water

The main benefit of this option is that it would provide additional capability to distribute finished water. According to the hydraulic model developed as part of the WMP, Alternative 1 would be limited by the capacity of Casitas Turnout #2 (8,333 gpm) which currently uses 4,602 gpm of that capacity (see Figure 5 above). This alternative would allow the City to continue to purchase the same amount of water that it currently buys from Casitas at Turnout #2, while allowing the full 5.8 mgd of DPR water to enter the system at Casitas Turnout #1.

Similar to Alternative 1 the following infrastructure components would be included:

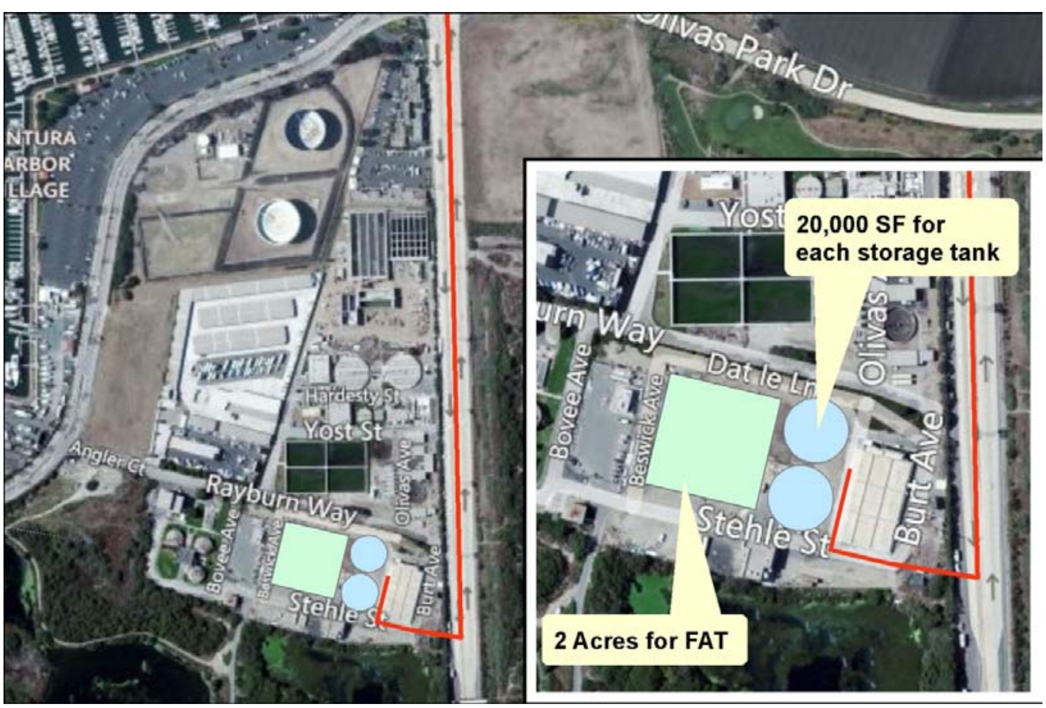
- 8 mgd FAT treatment train at VWRF including RO, UV and AOP
- Pump station sized at approximately 600 hp (including standby capacity)
- Engineered storage for detention during advanced monitoring at VWRF
- 9.4 mile 16” pipeline to deliver 5.8 mgd high quality DPR water to the AWTP or Power Reservoir
- Discontinued operation of Victoria Well No. 2 and Mound Well No. 1.
- Could possibly keep one or both of the Mound wells operational to account for part or all of the storage supply shortage identified in the 2011 WMP (4.11 mgd).
- Continued use of existing infrastructure.

Figure 6 DPR Alternatives



The following Figure 8 illustrates an approximate footprint for the 8 mgd DPR scenario:

Figure 7 DPR Footprint at VWRF



The FAT footprint includes 27,000 ft2 for the membrane facilities (UF/RO), 11,000 ft2, 50,000 ft2 for engineered storage and additional space required for equipment access points, additional roads, and a pump station for the finished water. The total space available at the southern end of the VWRF is approximately 185,000 ft2 (4.25 acres) which should be able to accommodate the required infrastructure. The Orange County Water District's advanced treatment facility, which is for 100 mgd of treatment, sits on 25 acres of land, and is well configured with wide roads and multiple equipment access points. A simple ratio for 8 mgd would consume about 2 acres of land.

4.3 Monitoring

Facilities that utilize advanced treatment for IPR have detailed water quality monitoring plans, including testing and analysis of the treatment process and of the water as it migrates from the point of application to the point of use. This discussion relates to the additional monitoring recommended for DPR projects. These proposed monitoring tools are intended to provide a higher degree of confidence in process performance.

4.3.1 Membrane Integrity

The membranes that are typically used in advanced treatment provide for a large amount of the total performance of the advanced treatment system. Accordingly, the ability to continuously and accurately track the membrane performance is desired.

In 2005, EPA published the Membrane Filtration Guidance Manual (MFGM) (EPA 2005) which put forth the following requirements to verify integrity for an RO and NF Membrane System (as per Section 1.3 of the MFGM):

- Removal efficiency must be established through product-specific challenge test and direct integrity testing.
- Continuous indirect integrity testing. The MFGM states that turbidity and particle counting are acceptable continuous integrity tests for MF/UF membranes (Sections 5.2 and 5.3) and conductivity is acceptable for RO/NF membranes (Section 5.4).
- Daily direct integrity testing using a method sensitive to the log removal rating that the system is credited for.

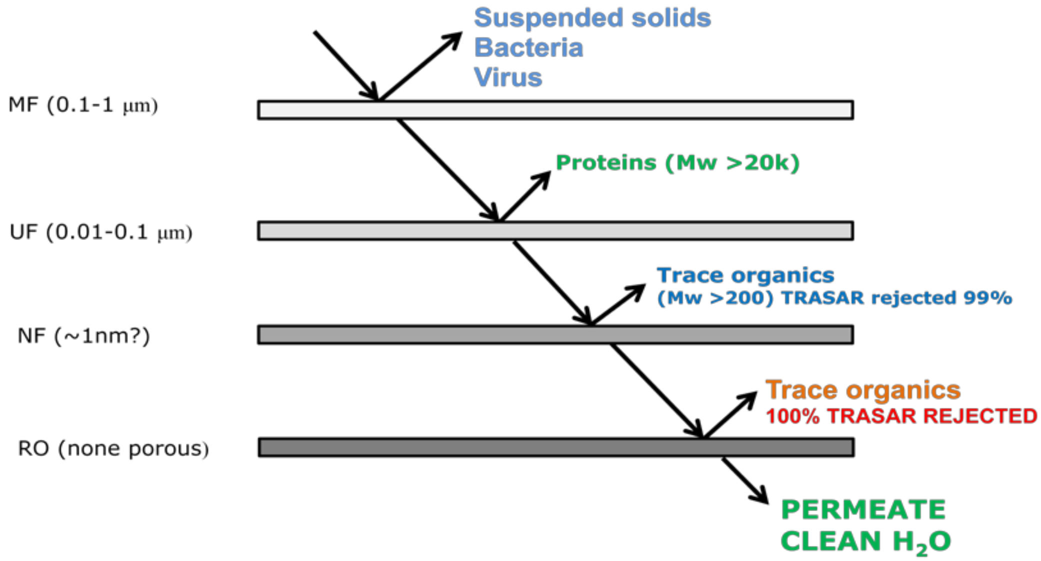
Regarding MF/UF, methods for direct integrity testing include, air pressure decay or hold tests, diffusive airflow monitoring, sonic testing, and bubble point tests. The most commonly applied direct integrity test method is the pressure decay test, which is a variation of the diffusion test, in which the leakage of air from a closed volume at known pressure through a wetted membrane is measured and converted to an equivalent water leakage rate. The air leaks only through pathways representing large pore sizes, since the smaller pores remain wetted due to capillary forces. By selecting the appropriate test pressure, typically between 10–20 psig, it is possible to measure the leak rate through only those pathways large enough to cause transmission of pathogenic protozoa.

One disadvantage of the direct integrity monitoring, is the need to perform the tests offline and the consequent interruption of normal operation. Another limitation of the pressure-driven integrity monitoring tests is the minimal detectable pore size that can be detected within the operating range of the membranes being tested. Typical pressure for conducting pressure decay or diffusive airflow tests is in the range of 10-20 psi, which would be able to detect defects on the order of 2-3 μm, approximately the size of protozoan cysts (Lozier et al., 2003). The required test pressure for a virus-sized resolution of 0.01 μm is over 4,000 psi, a value far in excess of what any current, commercially available water treatment membrane could withstand without rupturing (USEPA, 2005).

Regarding RO and NF, there is currently no recognized “direct integrity test” that can be conducted on a daily basis which can demonstrate more than 2-log removal (electrical conductivity (EC) can detect a 99% removal of pathogens). Improved monitoring techniques are needed and should be sensitive enough to pick up small but significant changes and trends in treatment performance that could have a significant impact on the safety of the finished water. An ideal monitoring system would be able to continuously detect up to 6-log reduction of a trace particle that is equal or smaller than the approximate virus size of 0.01 μm. This method could be used to test RO and NF as well as MF/UF systems.

There are a number of products on the market that could provide useful assurances for membrane integrity. Two possible examples of technologies that could provide membrane integrity verification would be the 3D Trasar® Technology by Nalco and Mem Shield by MINT. Trasar is an inert molecular tracer that can be detected down to concentrations of parts per trillion by fluorescence. It is currently used as part of a continuous online monitoring method for antiscalant used in RO facilities. The Trasar molecule is approximately 610 Da which is approximately 4 orders of magnitude smaller than the average virus. The Trasar molecule alone (or blended in with Antiscalants) has NSF Std 60 approval for use in potable water in front of an RO system. Trasar was tested in 2007 as part of the City of Sand Diego Advanced Water Treatment Research Studies (MWH, 2007), where results showed a log removal value of greater than 6 log. Further testing would be required in the future. The figure below illustrates the potential value of the Trasar or similar type of product.

MEM-SHIELD (http://www.mintmembranes.com/the-technology/) is an indirect integrity testing method for low-pressure membrane systems such as MF/UF, which can then be used to trigger a direct integrity test. The direct integrity test is based on correlation to the MFGM log removal values (LRV) calculations. Direct integrity testing based on correlation has not been accepted yet by regulators in the US. The principle of operation is based on measuring the differential pressure across a membrane that intercepts a portion of the permeate from the MF/UF modules relative to the differential pressure across a valve. The system is able to detect breaches of up to 0.001% broken fibers with a resolution of 3 μm. MEM-SHIELD claims to be able to reliably differentiate between 3 log removal and 4 log removal of protozoa sized pathogens (> 3 μm) with further work being done to differentiate between log 4 removal and log 5 removal. The product is currently being tested at the Bedok Newater Factory in Singapore. Existing monitoring methods such as the pressure decay test, microbial challenge test and high-sensitivity (0.5 µm or 0.05 µm) particle counters have been found capable of detecting as low as 1 cut fiber in a full-scale rack. A 2-µm particle counter has been shown able to detect between 1 to 0.001% cut fibers in a full-scale UF rack, depending on the feed water turbidity (Sethi et al, 2004).



4.3.2 Pathogen Monitoring

Continuous and accurate online monitoring of membrane performance should be complimented with rapid response water quality analysis. Ideally, an online monitor would be able to continuously monitor for bacteria, protozoa, and virus. There are a number of products currently on the market that can continuously monitor for bacteria sized pathogens: ZAPS http://www.zapstechnologies.com/ is an optical, online instrument for real time multi-parameter water quality monitoring which can detect E. coli among other water quality parameters. Biosentry http://www.jmar.com/wordpress/ uses optical spectroscopy to identify pathogens between 0.5 µm to 15 µm. Biosentry is based on light scatter from specific pathogens. RMS---W™ from Instant Bioscan http://www.ibioscan.com/ utilizes auto-fluorescence from certain metabolites and other proteins in the microbial cells and uses this fluorescence as biological marker for differentiating microbes from inert particles., but can only detect presence/absence of bacteria sized pathogens greater than 0.3 µm.

Current online detection methods are unable to detect virus-sized pathogens at levels of less than 1 CFU/1 ml without DNA enrichment or concentration, which takes time. Furthermore, none of the current online methods are able to detect virus size pathogens. Other Presence/Absence tests could provide a “red flag” however, results could be skewed due non-pathogenic microbial growth on membranes. The Zaps Technologies product

LiquID Station is currently being piloted in San Diego, CA and could possibly be sensitive enough to detect virus though this has not been demonstrated yet.

It is important to note that the time for testing and reporting of results is critical. Large engineered storage systems are costly and have a significant footprint. As methods are developed that can produce results in shorter amounts of time, costs will decrease accordingly. The currently proposed scheme is to utilize 12 hours of storage to allow for rapid response water quality monitoring. One method that could possibly achieve the sensitivities needed in under 12 hours is real time quantitative polymerase chain reaction (qPCR). This method has been widely used to detect viruses in environmental waters. A number of these uses are referenced in EPA Method 1615, 2010. This molecular procedure has the ability to obtain results in a very short time and is more rapid than cell culture but cannot distinguish between infectious and inactivated viruses. Research is ongoing on several promising approaches to detect infectious viruses (Reynolds, et al. 1996, Parshionikar, et al. 2010). However, qPCR is still a useful public health tool in spite of these problems. Because there is a strong relationship between indicator measurements by qPCR and health effects in recreational waters (Wade, et al. 2010), the EPA is considering using qPCR to set new criteria for monitoring recreational beaches (EPA Method 1615, 2010).

In theory, no virus would be able to penetrate the RO membrane. The advanced monitoring methods proposed above are proposed as an additional level of safety and would be employed before the UV and advanced oxidation process, which would provide an additional level of safety. As such, even in the event of a membrane malfunction anticipated virus concentrations would be extremely small on the order of 1 CFU/ 100 mL. Under these conditions, samples would have to be concentrated or enriched in order for there to be enough DNA to run a qPCR analysis. Concentration steps would possibly involve a bench scale RO system. Samples would be collected from the membranes at set time intervals and tested for virus and bacteria using qPCR. Additional research is needed to identify the current operational constraints of existing methods and to develop a protocol for a method using qPCR or other molecular techniques and perhaps combine these molecular techniques with one of the online monitoring techniques mentioned above.

With regard to trace organic contaminant monitoring, an accurate method has been developed for the trace analysis of 15 pharmaceuticals, four metabolites of pharmaceuticals, three potential endocrine disruptors, and one personal care product in various waters (Vanderford and Snyder, 2006). The method reporting limits for all compounds were between 0.25 and 1.0 ng/L, based on 500 mL of sample extracted and a final extract volume of 500 µL. The method is based on solidphase extraction (SPE) and liquid chromatography/tandem mass spectrometry (LC-MS/MS), using electrospray ionization (ESI) in both positive and negative modes. This method would be able to provide results in approximately 24 hours. Daily monitoring of trace pollutants (or surrogates) would provide further confidence in advanced treatment performance.

The following table (Table 4) summarizes a number of pathogen testing techniques currently available or under development:

4.4 Costs

A summary of preliminary costs estimated for the 4 supply alternatives presented above is presented in Table 5 below. Costs include infrastructure costs associated with each alternative (FAT, pipelines, pump stations, storage) as well as operation and maintenance (O&M) costs for each as well as annual costs associated with advanced monitoring. The total implementation cost includes all capital costs, engineering costs, construction contingencies, and contractor overhead and escalation. However, costs for administration, legal, CEQA and permitting were not included. In addition, costs for brine disposal were not included. The annual cost is determined by calculating the annual amortization of the capital cost for the treatment plant, calculated at 4 percent interest over 30 years and adding it to the annual O&M cost to determine the total annual cost. The total annual cost is then divided by the annual production in acre-feet (6500 AF) to determine a cost per acre-foot. Depending on the final distribution of water, the total finished water production could decrease and costs would have to be adjusted accordingly.

Costs provided in Table 5 are given in U.S. dollars as of December 2012. General assumptions utilized are provided below:

- FAT assumes 90% recovery from UF/MF and 80% recovery from RO
- 95% UVT is assumed for the UV/AOP process
- Feed flow is assumed to be 8 mgd
- Assumed rate of 4% over 30 year life span
- Distribution pipeline is estimated to be 16” DIP
- Permitting and outreach efforts associated with DPR have not been included
- Brine disposal costs have not been included

Table 4 Pathogen Monitoring Methods

Product	Company/Research	Description	Sensitivity	Pathogens Detected	Analysis Time	Cost	Ease of Use
MassCode PCR	Widely used in research	Endpoint amplification of a suite of indicators or pathogens. This method is good if for high throughput applications or for more than 10 types of pathogens and high level of sampling.	100-500 DNA copies (would require an enrichment step)	Can be used for Bacteria, Protozoa, and Virus. Specific probe for each different pathogen.	Could potentially have results in under 6 hours	NA	Manual, but could possibly automate
QPCR	Widely used in research	Amplified DNA is detected as the reaction progresses in real time. Cannot distinguish between infectious and inactivated viruses QPCR is much more sensitive than PCR, and more affordable.	Can detect down to 1 copy of DNA but would need a concentration or enrichment step.	Can be used for Bacteria, Protozoa, and Virus. Specific probe for each different pathogen.	Could potentially have results in under 6 hours	NA	Manual, but could possibly automate
Biosentry	Jmar	Microbial activity detection using light scatter. The concept is that specific pathogens (or microorganisms) scatter light in repeatable ways. Key here is that the organisms must be dispersed and wastewater particulates do not interfere. Should be acceptable for RO permeate. 3 channels of size and shape to determine biologicals plus unknown channel.	All Microorganisms and Particles are Detected from 0.5 microns to 15 microns in size. Previous calibration of the BioSentry showed a sensitivity of 1 CPM per 1.2 CFU per mL	Rod shaped bacteria (*E.coli*), endospores, protozoan cysts	Measurement each minute	NA	Continuous real time monitoring.
Endetect -TECTA- B16	Tecta Automated Rapid Microbial Detection Systems	Based on enzymatic reaction of *E.coli* growth in water. Technology assesses growth through continuous monitoring using an enzyme detection algorithm. This increases the sensitivity of the instrument and it is now quicker to detect low enzyme concentrations over the general background noise. This is particularly helpful when there are low levels of bacteria concentrations or where the bacteria are stressed and slow at producing the required detection enzymes. Similar to IDEXX.	Dynamic range of <1 to >10 CFU in 100 ml without requirement for sample dilution. Needs an additional step for enrichment, makes it 18 hrs.	E.Coli and Coliform	18 hrs	$20,000 + $525/box of 48 tests	Grab sample. Don't need lab
Anti-Body Based Bio Sensor	Dr. Alocilja, University of Michigan	Antibody based bio-sensor. Can change the antibody to any specific target	1 CFU /1 ML. Would need an additional enrichment step to get down to 1 CFU /100 ML	Specific antibody can be developed for target pathogen	18 hrs w/enrichment. 50 min for concentrations of 5-10CFU/1ML	NA	Manual. Could be automated
DNA Based Bio Sensor	Dr. Alocilja, University of Michigan	DNA based biosensor. Targets pathogen specific DNA target. Detection achieved electrochemically by measuring the Redox potential of attached electrically active magnetic nanoparticles	Has been able to detect redox signal of the nanoparticles as low as 0.01 ng/ul	In development. So far for *Bacillus anthracis* and *Salmonella enteritidis*	Under development	NA	Manual. Could be automated
RMS-W™	Instant BioScan	Continuous presence/non-presence monitoring. Monitors for certain particle sizes. Cannot speciate for different microbes. Works on a Mie Scatter for particle sizing using photodiode and fluorescence emission for bio detection using PMT. Flow rate of 100 mL/min.	Can detect down to 0.3um. Min resolution needed is 1 bio count	Not pathogen specific	Online/instant	$39,900 or Lease $2,500/month	Constant Online monitoring
LiquID Station (Multi-Frequency optical measurement)	Zaps Technologies	An optical, online instrument for real time multi-parameter water quality monitoring. Can detect multiple parameters using "hyperspectral" detection methodology. Also uses a hybrid spectrometer, which allows the system to monitor absorbance, fluorescence, and reflectance on the same optical platform.	BOD, cBOD, COD 1 to 10,000 mg/l, *Ecoli* ~1 CFU/100ml TOX 10mg/l NO3 0.05 – 500 mg-N/l	*E.coli*, BOD, cBOD, COD, NO3, TOC, TSS, TOX (disinfection byproducts)	Online/instant	$65,000 + minimal O&M	Constant Online monitoring
Bactiquant	Mycometer	BactiQuant®water is based on detection of a hydrolytic enzyme activity by use of fluorescence technology. Presence/Non presence only.	Sensitivity can be adjusted. Can detect down to 1 CFU/100ml but would need large sample volume (2 L).	Multiple Bacteria: E.Coli, Athrobacter, Bacillus cereus, Pseudomonas, Rhodobacter. Both gram positive and gram negative	2 hours	$7500 + $18 per test	Manual. Minimal human intervention needed

* NA – Not Available. Costs were either not available or more information is needed costs of developing technology.

All of the alternatives include a capital and O&M cost credit associated with the offset of future RO costs needed to treat water pumped from the Mound Basin as identified in a groundwater treatment study completed in March 2011 (AECOM, 2011). This credit assumes that water from the mound aquifer would no longer need to be used as a potable water supply and would thus not need to be treated. It also assumes that an equivalent amount of treatment will be needed in the future for VWRF effluent discharge reduction into the Santa Clara River Estuary. The DPR alternative would provide a solution to both issues of concern enabling a savings credit to be applied. An estimate of O&M costs that would be incurred by a future BTP RO system, approximately $860,000 annually, were deducted from the estimated O&M costs of each alternative presented above. An additional credit would be applied in the event that water was credited toward Ventura River extractions causing less water to be treated by the AWTP. In order to foster a conservative approach, this credit was not applied to this analysis. Additional cost savings for the DPR options will be achieved as advanced monitoring methods become more readily available and detection time decreases, thus reducing the large amount of storage currently needed and associated costs.

Table 5 Cost Summary

	Total Construction Cost	Annual O&M	Annual Cost ($/AFY)	Annual Cost ($/1000 gal)
Casitas #2 DPR	$51.6M	$2.6M	$860	$2.80
Bailey DPR	$52.4M	$2.6M	$860	$2.80
Avenue DPR	$57.8M	$2.7M	$920	$2.80
Bailey IPR	$70.0M	$2.9M	$1000	$3.10

The costs presented above are for the general information of the City, for comparison of alternatives. Detailed cost estimates for the above options are presented in the Appendix of this report. Before developing a final budget and financing for the preferred alternative, it is recommended that a preliminary engineering report be prepared, investigating in greater detail site-specific conditions that may affect costs.

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APPENDIX - DETAILED COST ESTIMATES

APPENDIX - DETAILED COST ESTIMATES

DPR Treatment Options
Alternative #1 Casitas Turnout #2
City of Buenaventura

Project Element		**Cost Estimate**
Pump Station		$870,000
Pipeline (Ventura to Casitas Turnout #2)		$4,222,500
FAT		$25,009,800
Storage (2 x 4 mgd) + Eq basin		$5,500,000
Bailey RO Credit		-$8,750,000
Total		**$26,860,000**
Construction Contingency	30.00%	$8,058,000
Subtotal		$34,918,000
General Contractor Overhead+Profit	10.00%	$3,491,800
Subtotal		$38,409,800
Sales Tax (7.25% of 50% of Total Cost)	7.25%	$1,265,778
Total Capital Cost + (30% Contingency)		**$39,680,000**
Engineering	30%	$11,904,000
Land Acquisition	0	$0
Total Estimated Project Implementation Cost		**$51,590,000**
Annualized Construction Cost		**$2,983,455**
O & M Pump Station + Pipeline	2.50%	$127,313
O & M Treatment (FAT)		$3,087,500
O&M Storage/Chlorination	2.00%	$110,000
Advanced Monitoring		$100,000
Bailey Treatment Credit		-$860,000
Total O&M		**$2,570,000**
Total Annualized Cost		**$5,560,000**
Annual Yield AF		**6500**
Unit Cost ($/1000gal)		**$2.60**
Unit Cost ($/AF)		**$860**

Notes:
FAT assumes 90% recovery from UF/MF 80% recovery from RO
95% UVT assumed for UV/AOP process
Feed flow assumed 8 mgd
Assuming 4 pumps (1 standby) pumping 1200 GPM 24/7
Rate of 4% assumed over 30 year life
Pumping costs from equalization basin and other costs are assumed to be taken into account by contingency.

DPR Treatment Options Alternative #2 DPR to BTP City of Buenaventura		
Project Element		**Cost Estimate**
Pump Station		$870,000
Pipeline (Ventura to Bailey)		$4,637,100
FAT (Total Implementation Cost)		$25,009,800
Storage (2 x 4 mgd) + EQ Basin		$5,500,000
Bailey RO Credit		-$8,750,000
Total		**$27,270,000**
Construction Contingency	30.00%	$8,181,000
Subtotal		$35,451,000
General Contractor Overhead+Profit	10.00%	$3,545,100
Subtotal		$38,996,100
Sales Tax (7.25% of 50% of Total Cost)	7.25%	$1,285,099
Total Capital Cost + (30% Contingency)		**$40,290,000**
Engineering	30%	$12,087,000
Land Acquisition	0	$0
Total Estimated Project Implementation Cost		**$52,380,000**
Annualized Construction Cost		**$3,029,141**
O & M Pump Station + Pipeline	2.50%	$137,678
O & M Treatment (FAT)		$3,087,500
O&M Storage + Chlorine	2.00%	$110,000
Advanced Monitoring		$100,000
Bailey Treatment Credit		-$860,000
Total O&M		**$2,580,000**
Total Annualized Cost		**$5,610,000**
Annual Yield AF		**6500**
Unit Cost ($/1000gal)		**$2.60**
Unit Cost ($/AF)		**$860**

Notes:
FAT assumes 90% recovery from UF/MF 80% recovery from RO
95% UVT assumed for UV/AOP process
Feed flow assumed 8 mgd
Assuming 4 pumps (1 standby) pumping 1200 GPM 24/7
Rate of 4% assumed over 30 year life
Pumping costs from equalization basin and other costs are assumed to be taken into account by contingency.

DPR Treatment Options
Alternative #3 VWRF to Avenue Treatment Plant
City of Buenaventura

Project Element		**Cost Estimate**
Pump Station		$870,000
Pipeline (Ventura to Avenue Treatment Plant)		$7,441,350
FAT		$25,009,800
Storage (2 x 4 mgd) + Eq basin		$5,500,000
Bailey RO Credit		-$8,750,000
Total		**$30,080,000**
Construction Contingency	30.00%	$9,024,000
Subtotal		$39,104,000
General Contractor Overhead+Profit	10.00%	$3,910,400
Subtotal		$43,014,400
Sales Tax (7.25% of 50% of Total Cost)	7.25%	$1,417,520
Total Capital Cost + (30% Contingency)		**$44,440,000**
Engineering	30%	$13,332,000
Land Acquisition	0	$0
Total Estimated Project Implementation Cost		**$57,780,000**
Annualized Construction Cost		**$3,341,423**
O & M Pump Station + Pipeline	2.50%	$207,784
O & M Treatment (FAT)		$3,087,500
O&M Storage/Chlorination	2.00%	$110,000
Advanced Monitoring		$100,000
Bailey Treatment Credit		-$860,000
Total O&M		**$2,650,000**
Total Annualized Cost		**$6,000,000**
Annual Yield AF		**6500**
Unit Cost ($/1000gal)		**$2.80**
Unit Cost ($/AF)		**$920**

Notes:
FAT assumes 90% recovery from UF/MF 80% recovery from RO
95% UVT assumed for UV/AOP process
Feed flow assumed 8 mgd
Assuming 4 pumps (1 standby) pumping 1200 GPM 24/7
Rate of 4% assumed over 30 year life
Pumping costs from equalization basin and other costs are assumed to be taken into account by contingency.

IPR Treatment Option

City of Ventura

Project Element		Cost Estimate
Pump Station		$870,000
Pipeline (Ventura to Bailey Treatment Plant)		$5,872,400
FAT (Total Implementation Cost)		$25,009,800
Injection Wells + Monitoring Wells		$10,000,000
Additional Extraction Well		$3,450,000
Bailey RO Credit		-$8,750,000
Total		**$36,460,000**
Construction Contingency	30.00%	$10,938,000
Subtotal		$47,398,000
General Contractor Overhead+Profit	10.00%	$4,739,800
Subtotal		$52,137,800
Sales Tax (7.25% of 50% of Total Cost)	7.25%	$1,718,178
Total Capital Cost + (30% Contingency)		**$53,860,000**
Engineering	30%	$16,158,000
Land Acquisition	0	$0
Total Estimated Project Capital Cost		**$70,020,000**
Annualized Capital Cost		**$4,049,264**
O & M Pump Station + Pipeline	2.00%	$134,848
O & M Wells	2.00%	$269,000
O & M Treatment (FAT)		$3,087,500
Bailey Treatment Credit		-$860,000
Total O&M		**$2,640,000**
Total Annualized Cost		**$6,690,000**
Annual Yield AF		**6500**
Unit Cost ($/1000gal)		**$3.10**
Unit Cost ($/AF)		**$1,000**

Notes:
FAT assumes 90% recovery from UF/MF 80% recovery from RO
95% UVT assumed for UV/AOP process
Feed flow assumed 8 mgd
Assuming 4 pumps (1 standby) pumping 1200 GPM 24/7
Rate of 4% assumed over 30 year life
Pumping costs from equalization basin and other costs are assumed to be taken into account by contingency.

APPENDIX C – HOPKINS PRELIMINARY HYDROGEOLOGICAL STUDY

HOPKINS GROUNDWATER CONSULTANTS, INC.

PRELIMINARY HYDROGEOLOGICAL STUDY

RECYCLED WATER MASTER PLAN GROUNDWATER REPLENISHMENT AND REUSE PROJECT VENTURA, CALIFORNIA

Prepared for:
City of San Buenaventura

January 2013

VENTURA
PUBLIC WORKS

VENTURA
WATER

HOPKINS GROUNDWATER CONSULTANTS, INC.
THE WATER RESOURCE SPECIALISTS

January 21, 2013
Project No. 01-009-07B

City of San Buenaventura
Ventura Water
Post Office Box 99
Ventura, California 93002-0099

Attention: Mr. Dan Pfeifer
Wastewater Utility Manager, Ventura Water

Subject: Preliminary Hydrogeological Study, Recycled Water Master Plan, Groundwater Replenishment and Reuse Project, Ventura, California, January 2013.

Dear Mr. Pfeifer:

Hopkins Groundwater Consultants, Inc. (Hopkins) is pleased to submit this final report summarizing the findings, conclusions, and recommendations developed from a preliminary study to assist the City of San Buenaventura (City) in understanding the potential feasibility for a Groundwater Replenishment and Reuse Project using highly treated recycled water. The study concludes that it is likely feasible to operate a 4,000 or 7,000 acre-feet per year recharge and recovery operation in the Mound Groundwater Basin. Groundwater replenishment can likely be accomplished at sites located upgradient of the existing City Mound Basin Wellfield and result in improving the native groundwater quality.

As always, Hopkins is pleased to be of service. If you have questions or need any additional information, please give us a call.

Sincerely,

HOPKINS GROUNDWATER CONSULTANTS, INC.

REGISTERED GEOLOGIST
CURTIS J. HOPKINS
EG NO. 1800
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Curtis J. Hopkins
Principal Hydrogeologist
Certified Hydrogeologist HG 114
Certified Engineering Geologist EG 1800

Report Copies Submitted: Three (3) Bound Copies, One (1) Electronic Copy

C: Ms. Susan Rungren, Principal Engineer, Ventura Water

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P.O. Box 3596, Ventura, California 93006 Phone: (805) 653-5306 e-mail: chop4@earthlink.net

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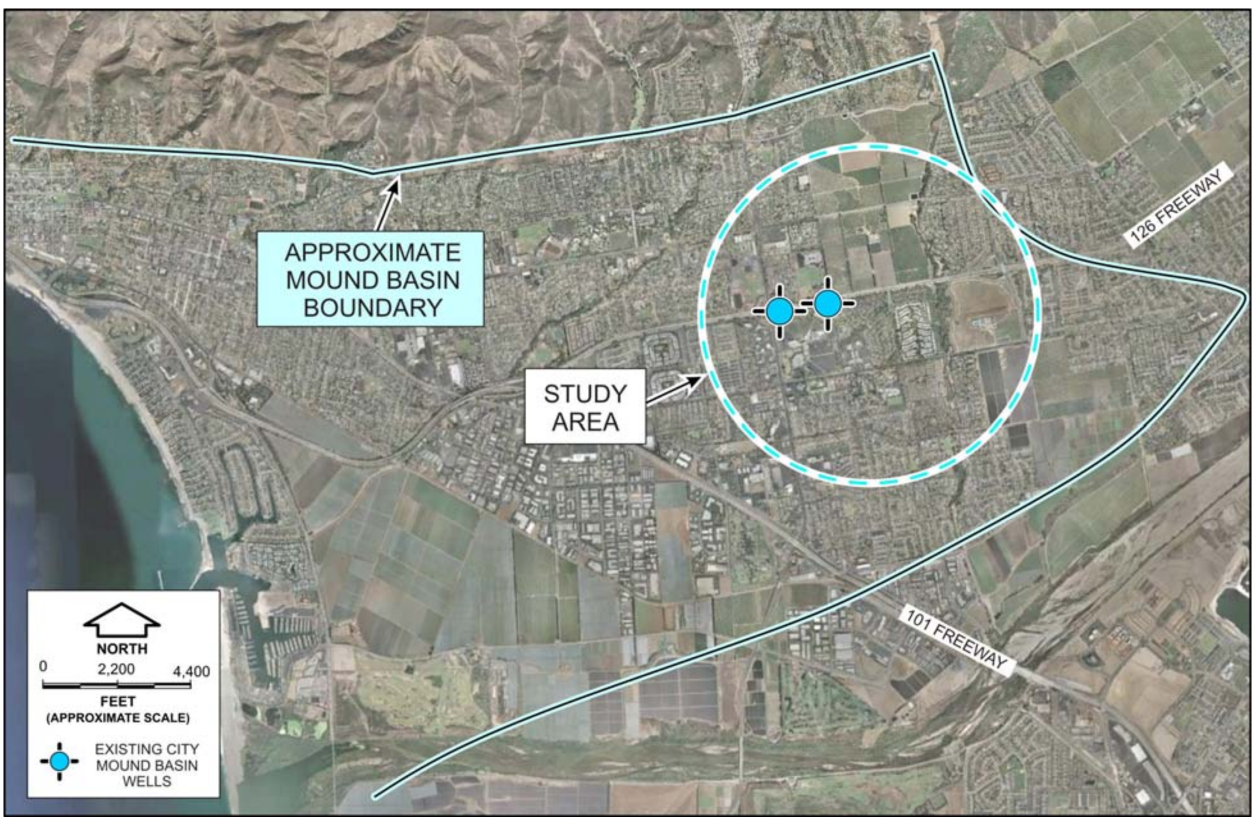
FIGURES

INTRODUCTION

GENERAL STATEMENT

Presented in this report are the findings, conclusions, and recommendations that were developed from a preliminary hydrogeological study conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) to assist the City of San Buenaventura (City) in evaluating the preliminary feasibility of a potential Groundwater Replenishment and Reuse Project (GRRP) using its recycled water. This supplemental study was conducted in support of the City's Recycled Water Master Plan (RWMP) that is presently in draft form. The City is interested in the potential of developing a sustainable program for replenishment and reuse of highly treated recycled water using aquifer units in the Mound Groundwater Basin (Mound Basin). The proposed GRRP could provide the ability for Indirect Potable Reuse (IPR) of this high quality supply that could augment the City's potable water system and improve the delivered water quality. The study area is shown on Figure 1 – Study Area Location Map.

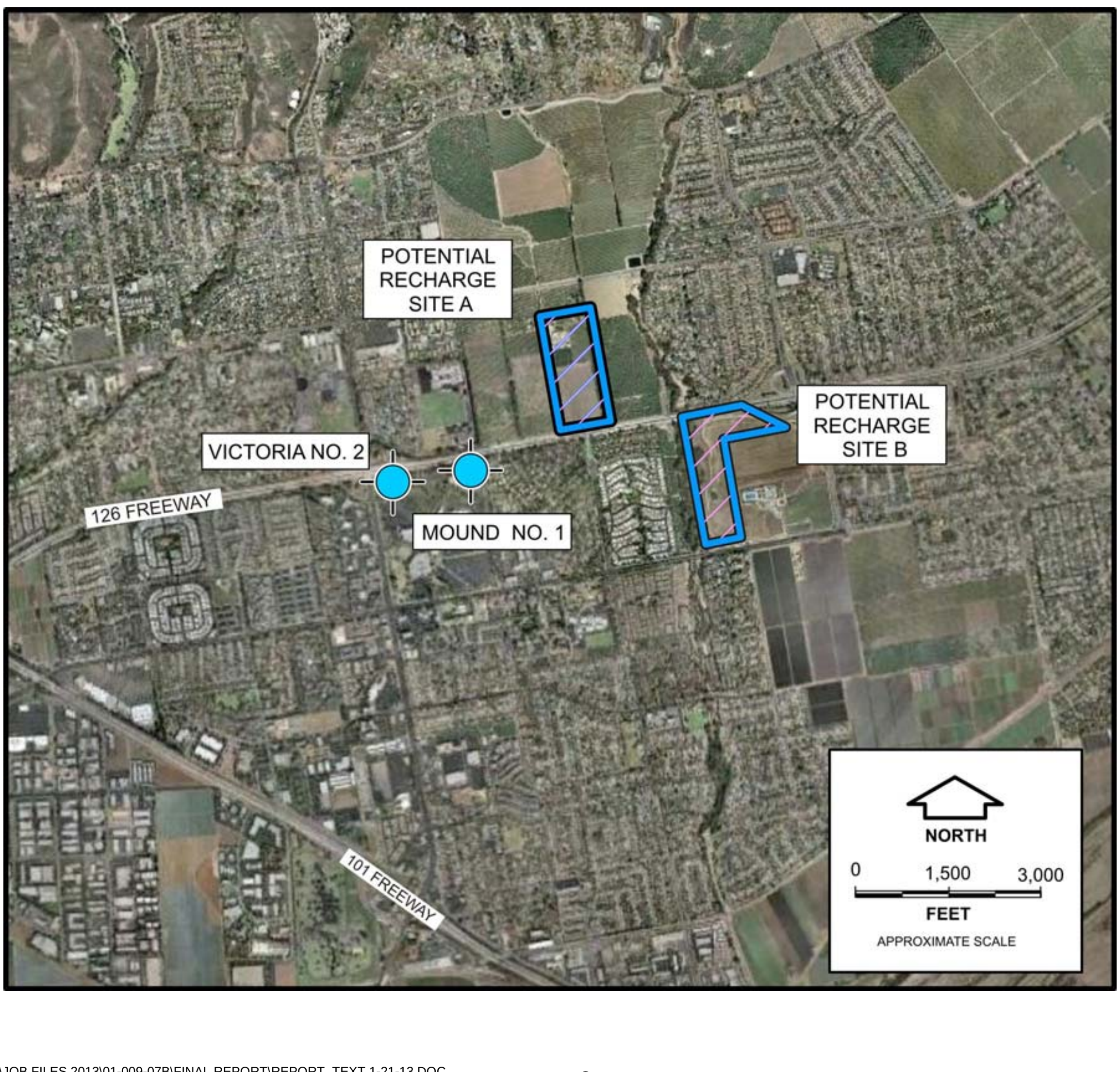
Figure 1 – Study Area Location Map



The two (2) proposed groundwater replenishment alternatives being considered by the City would provide the ability to store and reuse; 1) up to 4,000 acre-feet per year (AFY), or 2) up to 7,000 AFY of recycled water. The full advanced treatment water (FATW) proposed for use will be treated by desalination through a membrane process, advanced oxidation, and ultraviolet exposure. This study assumes that the FATW would be; a) produced at a constant rate on a daily basis, b) would be injected at a rate of 2,500 gallons per minute (gpm) (for the 4,000 AFY alternative), and c) injected at a rate of 4,340 gpm (for the 7,000 AFY alternative).

The supplemental planning study was requested to focus on the hydrogeology of the Mound Basin along the east side of the City where groundwater flows westward toward the City's existing Mound Wellfield. The preliminary locations identified for this study for groundwater recharge wells are designated as Recharge Sites A and B and are shown on Figure 2 – Potential Recycled Water Recharge Well Site Location Map.

Figure 2 – Potential Recycled Water Recharge Well Site Location Map



While the proposed use for the wells considered in this study is to strictly inject recycled water for the purpose of groundwater replenishment and downgradient withdrawal from the City's municipal supply wells, the wells will require routine recovery of groundwater by pumping in order to remove accumulated well plugging material and maintain a reasonable service-life. Future considerations for groundwater produced from the injection wells will need to include discharge to waste or onsite reuse alternatives.

PURPOSE AND SCOPE

The purpose of the study is to develop an understanding of the potential feasibility of the GRRP based on existing data and the present understanding of the Mound Basin. The study is also intended to preliminarily identify future facilities and studies that may be required to further assess project feasibility. The scope of work for the supplemental study was developed through discussions with Ms. Elisa Garvey and Ms. Lydia Holms, with Carollo Engineers, and Mr. Dan Pfeifer and Ms. Susan Rungren, with the City. As developed, the work scope included performance of the following tasks:

- Conduct a preliminary hydrogeological analysis based on the best available information to support the evaluation of the GRRP alternatives in the Mound Basin,
- Provide a rough estimate of travel time from possible injection locations east of the City Mound Wellfield,
- Provide a brief description of the method used to estimate travel time for the GRRP scenarios,
- Preliminarily identify potential investigations and studies that may be required to further assess project feasibility for IPR,
- Identify the potential injection and production capacities of aquifer zones that comprise the lower aquifer systems in the eastern portion of the Mound Basin,
- Prepare this supplemental report summarizing the findings, conclusions, and recommendations for use in the City's RWMP document.

Sources of available data and published information that were used for the study include; a) City data and reports, b) United Water Conservation District (UWCD) data and reports, and c) Ventura County Watershed Protection District databases.

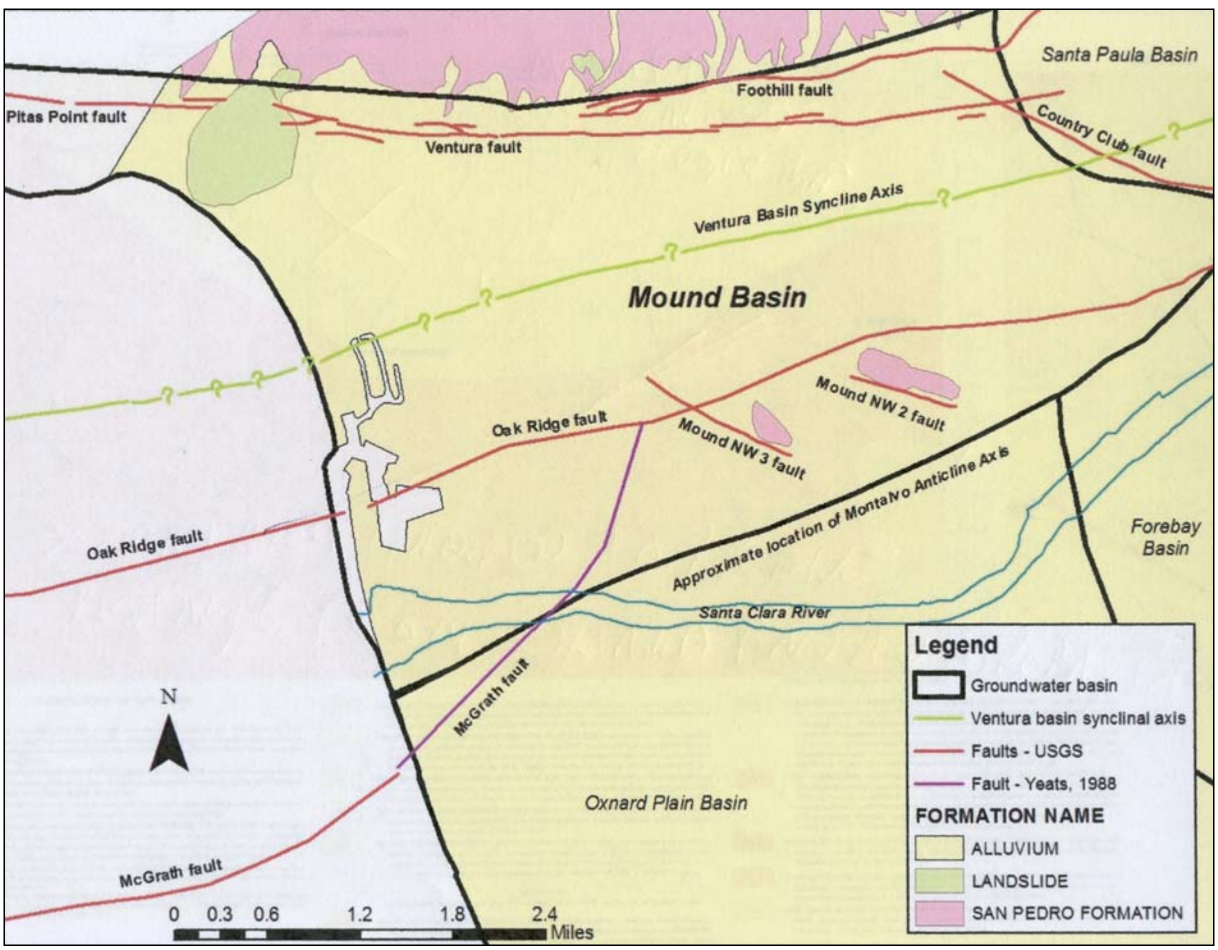
FINDINGS

HYDROGEOLOGY AND AQUIFER DELINEATION

Geology

The proposed City project is located in the Mound Basin which is part of the Transverse Ranges geologic/geomorphic province and is defined by a number of geologic structures and features that separate it from the adjacent groundwater basins. The geology of the Mound Basin has been described in detail by several authors including the California State Water Resources Control Board (SWRCB, 1953), Turner (1975), GTC (1982, draft), and UWCD (2012). Figure 3 – Generalized Geologic Map and Mound Basin Boundary shows the mapped boundaries of the Mound Basin along with the location of geological structures that influence groundwater flow within the basin and between adjacent basins.

Figure 3 – Generalized Geologic Map and Mound Basin Boundary



FROM UWCD, 2012b

The subsurface geology that controls groundwater flow in the study area has recently been differentiated into two geologic units (UWCD, OFR 2012-01). The units include; 1) the Holocene and late Pleistocene alluvium, and 2) the San Pedro Formation. The first unit is comprised of largely unconsolidated sedimentary deposits and includes all older and recent alluvium deposits. These shallower units are coarser grained in the vicinity of the Santa Clara River and form the Oxnard and Mugu Aquifers to the south in the Oxnard Plain Basin. The shallow alluvial deposits in the Mound Basin range in thickness and are dominated by fanglomerate deposits derived from the Ventura Foothills. These deposits lie unconformably on top of the San Pedro Formation. The San Pedro Formation is typically comprised of semiconsolidated Plio-Pleistocene sedimentary deposits and is up to 1,500 feet thick near the center of the Mound Basin along the axis of the Ventura Basin Syncline. The San Pedro Formation consists of consolidated marine and nonmarine clay, silt, sand, and gravel deposits that comprise the aquifer zones designated as the lower aquifer system. The low permeability materials underlying the San Pedro Formation are generally considered as non-water-bearing and effectively define the base of fresh water.

Groundwater Basin and Aquifer Zone Delineation

Within the Mound Basin, the aquifer system has recently been delineated (UWCD, OFR 2012-01) and divided into an upper aquifer system (UAS) and lower aquifer system (LAS) to facilitate understanding and management of the groundwater resources. These classifications define the UAS as the younger and older alluvium and the LAS as aquifers in the San Pedro Formation that are separated by an unconformable contact.

The Mound Basin groundwater is semi-protected from overlying land uses by the extensive silt and clay layers that are on the order of 200 to 500 feet thick. The Montalvo Anticline effectively defines the southern edge of the Mound Basin and separates it from the Oxnard Plain and Oxnard Forebay Basins (see Figure 3). The Country Club Fault zone defines the eastern edge of the basin and separates the Mound Basin from the Santa Paula Basin. The western boundary of the Mound Basin is defined by the offshore outcrop area of each separate aquifer zone which is largely undetermined. The RWMP recharge sites are located within the Mound Basin downgradient (west) of the Santa Paula Basin boundary.

The Mound Basin is further dissected by the Oak Ridge and McGrath Fault zones (see Figure 3). The effects of these structures on groundwater flow have not been evaluated through the use of field investigation methods. For the purpose of the study, we recognize that the Oak Ridge Fault likely creates an effective flow barrier to the south, and it is assumed that the City's Mound Wellfield will be in hydraulic communication with the proposed recharge sites because they are both located on the north side of this structure (see Figure 2).

Historically, many wells completed in the Mound Basin produced water from the shallower aquifers and have since been replaced by deeper wells in an attempt to produce better quality groundwater. The City wells produce from both the shallow (UAS) and deeper (LAS) aquifer zones and yield on the order of 2,500 gpm. The water quality is fair to poor, and generally of poorer quality in the UAS zones.

In the study area, the LAS is comprised of permeable strata contained in the San Pedro Formation and is a confined aquifer system. Although there are a number of coarse grained strata in the LAS, historical data indicate that there is an abundance of lower permeability materials that separate the aquifer zones and may create laterally discontinuous layers (lenticular layers) that may increase the difficulty of predicting cross-basin flow.

Historical groundwater production from the Mound Basin has annually been in the range of 3,000 to 10,000 AFY. Figure 4 – Mound Basin Annual Extractions shows the groundwater production historically reported to UWCD between 1980 and 2011.

Figure 4 – Mound Basin Annual Extractions

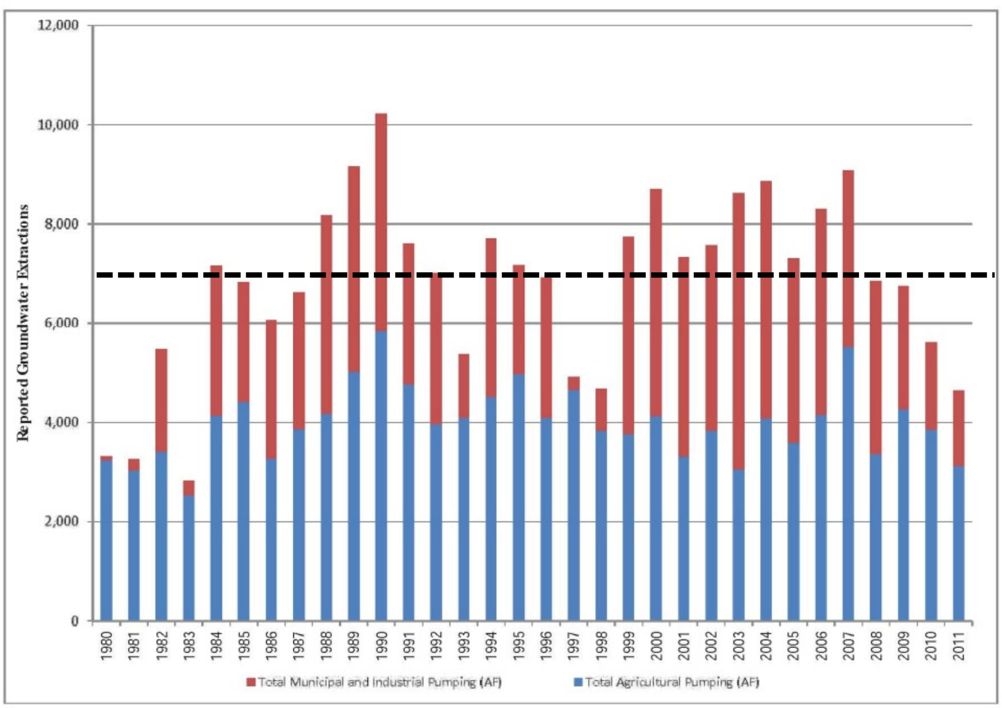


Figure 4.3-19. Historical reported groundwater extractions for the Mound Basin

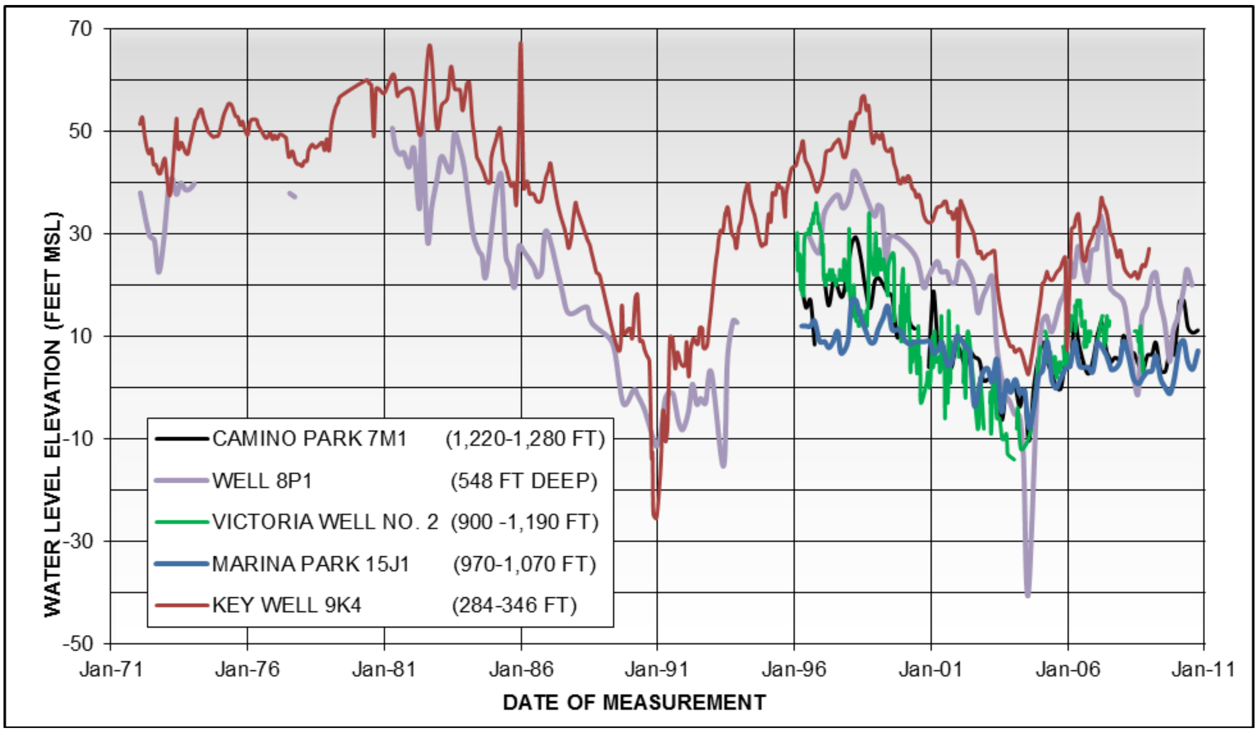
FROM UWCD, 2012a

As shown, the average annual production from the basin is on the order of 7,000 AFY. However, the safe yield, or sustainable perennial yield has not yet been determined.

Groundwater Levels

Groundwater elevations in the Mound Basin have varied significantly over time. Figure 5 – Groundwater Elevation Hydrograph shows the fluctuations in water levels in the basin that have occurred since 1972. The groundwater elevation within the Mound Basin in proximity to the study area dropped to approximately 20 feet below mean sea level (msl) during the 1986 to 1990 drought and has risen as high as 40 to 50 feet above msl in recent years. These available data indicate that seasonal fluctuations in the Mound Basin groundwater levels typically range between 10 and 15 feet. Dry climatic conditions result in consecutive annual declines in the regional water levels (see Figure 5).

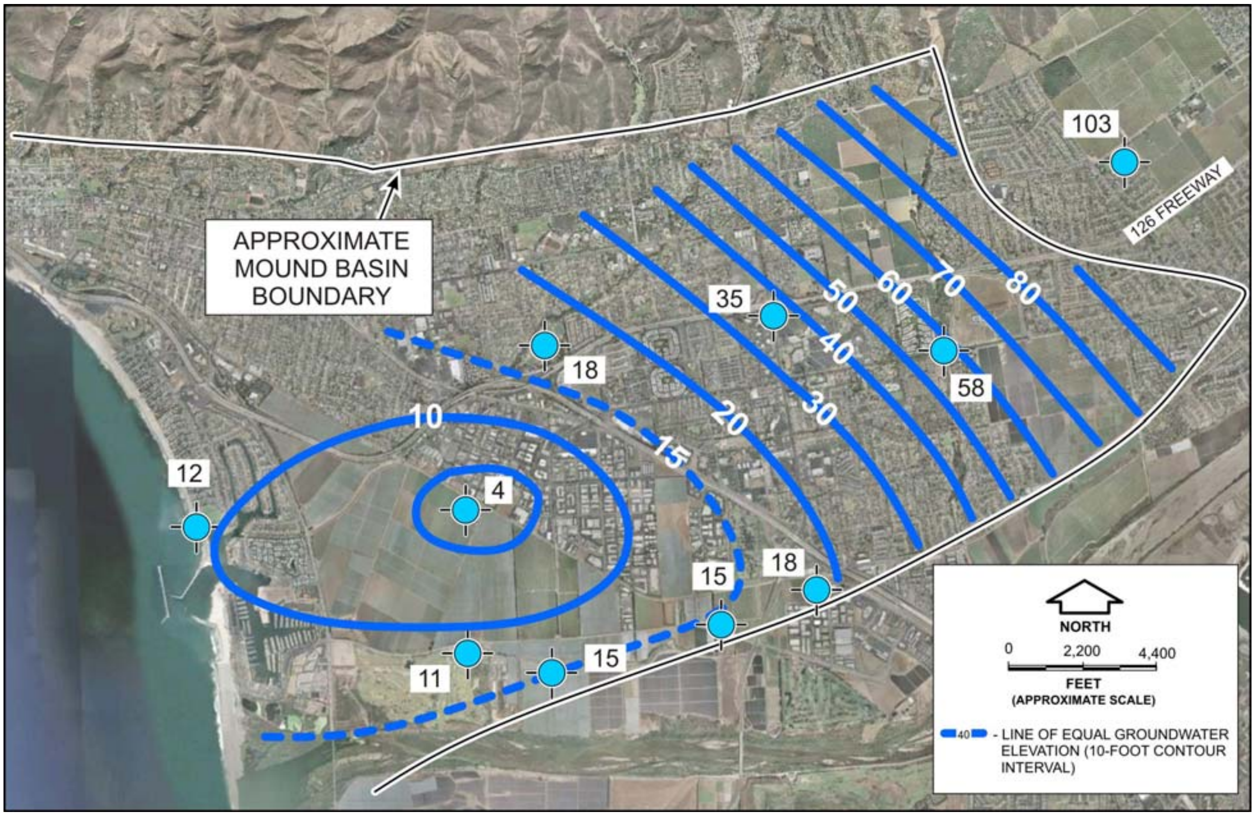
Figure 5 – Groundwater Elevation Hydrograph



Groundwater Gradient and Flow Velocity

Information available from the UWCD was used to construct the groundwater elevation contour maps for the Fall of 2011 (UWCD, 2012b). Figure 6 – Lower Aquifer System Groundwater Elevation Contour Map shows the groundwater elevations indicated by the available data and the approximate direction of flow in the LAS. The number of data points in the basin is very small and lends to the potential for error in trying to estimate the precise direction and gradient of groundwater flow. For the purpose of the preliminary study, the use of the groundwater gradient provided by these available data is believed sufficient for planning purposes to understand the approximate flow direction.

Figure 6 – Lower Aquifer System Groundwater Elevation Contour Map



Utilizing the water level contours from the 2011 data, the groundwater gradient was calculated at 0.0075 (dimensionless) in the southwesterly direction for the LAS which is believed to approximate typical eastern basin conditions in the vicinity of the recharge well sites and the City's Mound Basin Wellfield. To determine the area potentially influenced by recycled water recharge, the rate of flow away from the proposed recharge well sites was estimated using; a) a discrete cumulative aquifer thickness of 160 feet to estimate the hydraulic conductivity of the aquifer zones, b) the 2011 east basin gradient previously estimated, c) an average aquifer porosity of 15 percent, and d) the following equation:

$$V = K\, I/\eta$$

V	=	GROUNDWATER FLOW VELOCITY
K	=	AQUIFER HYDRAULIC CONDUCTIVITY
I	=	GROUNDWATER GRADIENT
η	=	AQUIFER POROSITY

The hydraulic conductivity of the cumulative aquifer zones was estimated from Victoria Well No. 2 production test data at approximately 100 feet per day (ft/d). The resulting groundwater flow velocities for the LAS in the eastern Mound Basin were estimated to be approximately 5 ft/d [1,840 feet per year (ft/yr)].

Using 15 percent as an aquifer porosity value and an cumulative aquifer thickness of 160 feet (combined thickness of the LAS zones produced by Victoria Well No. 2), the injected volume of FATW (4,000 AFY) would fill a storage area having a radius of over 3,900 feet. Figure 7 – Area of Lower Aquifer System Filled by Recycled Water shows the approximate areal extent of the displaced volume of native groundwater that is replenished by recycled water over a one-year-period. The estimated aquifer storage area shown in Figure 7 that is occupied by the recycled water (recharge bubble) is calculated assuming the entire volume of 4,000 AFY is injected in a single well or closely spaced wells solely completed in the LAS at any one of the recharge sites. Should the annual injection volume be distributed between sites or between aquifer systems, the displaced volume of native groundwater (areal extent) would be proportionally smaller. The use of a limited aquifer thickness (160 feet) and only 15 percent porosity is believed to be conservative and contribute to a larger affected area. If either of these parameters is increased (which is highly likely), the aquifer area required to contain the recharge bubble would be reduced.

As shown in Figure 7, the recycled water recharge bubble migrates in the downgradient direction at a rate of 5 ft/d. While the estimated area of recycled water influence does not account for advective or dispersive mixing, it is believed to provide a sufficient level of detail for the intended planning purposes. The result of this exercise indicates that water injected at potential Recharge Well Site A (at a steady rate of 2,500 gpm) would reach Victoria Well No. 2 within an 8 to 9-month period of time. Because of the above stated assumptions, this estimate is believed to be conservative and the travel time between the point of replenishment and the point of reuse is likely longer.

Figure 7 – Area of Lower Aquifer System Filled By Recycled Water

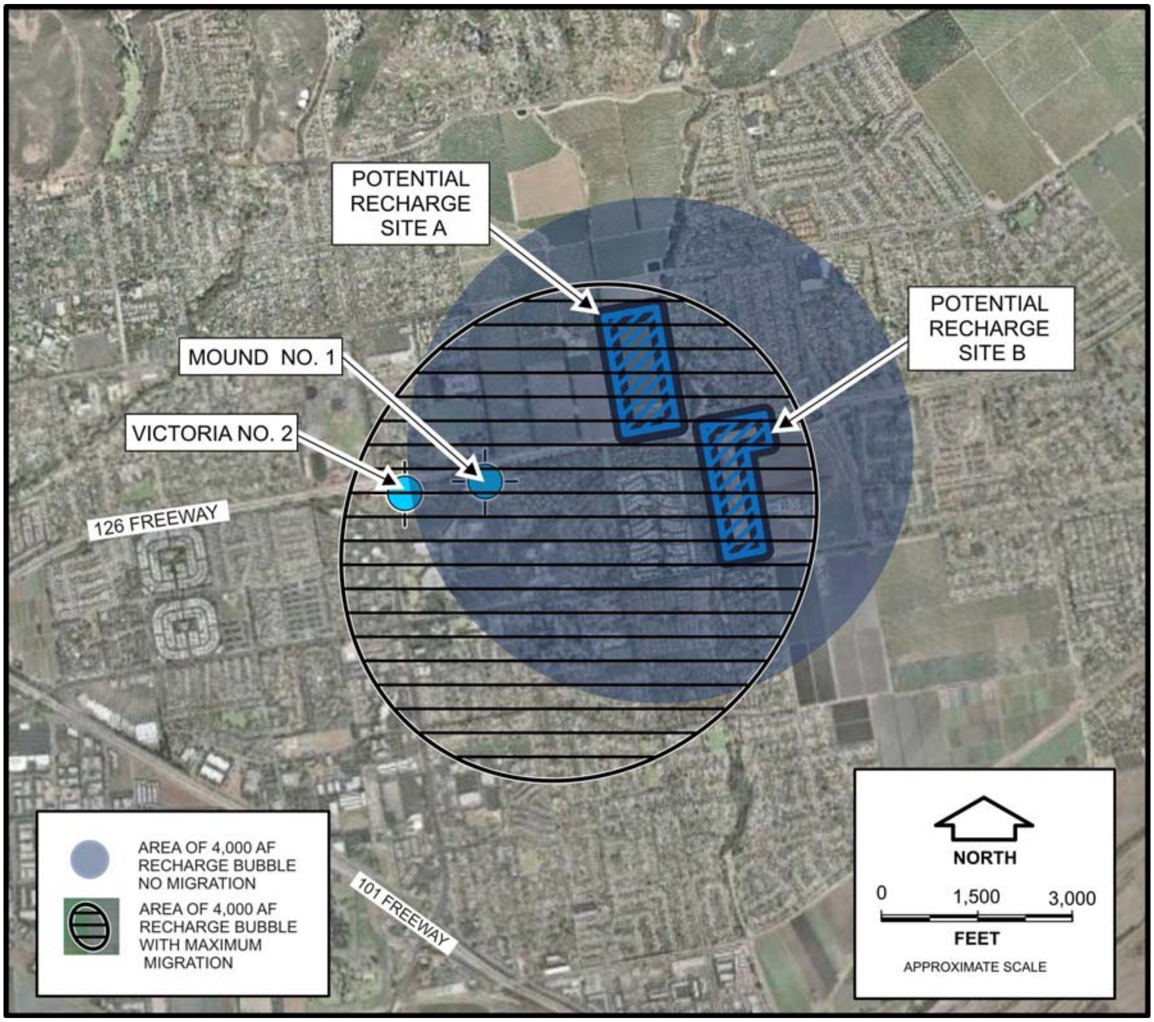
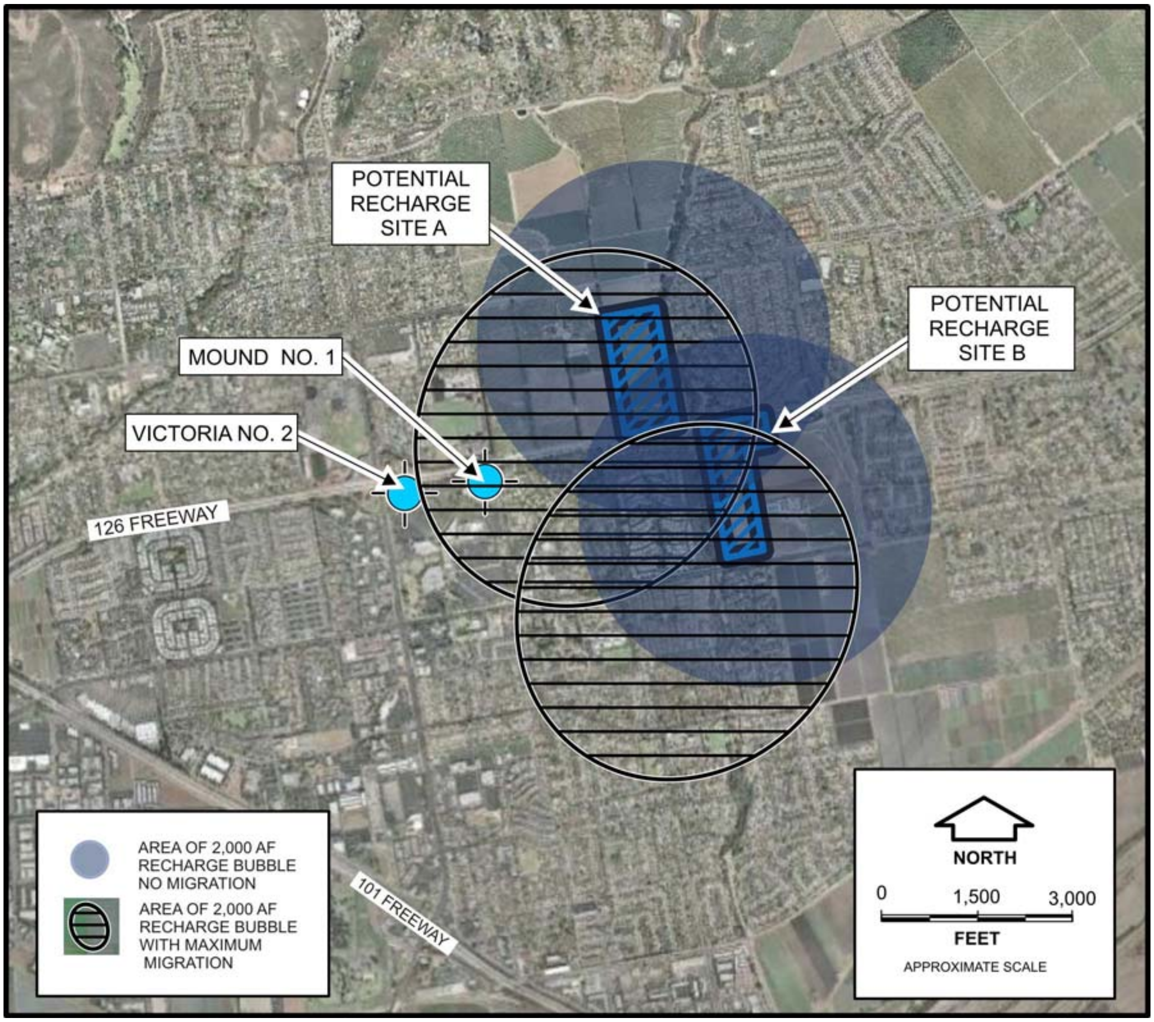


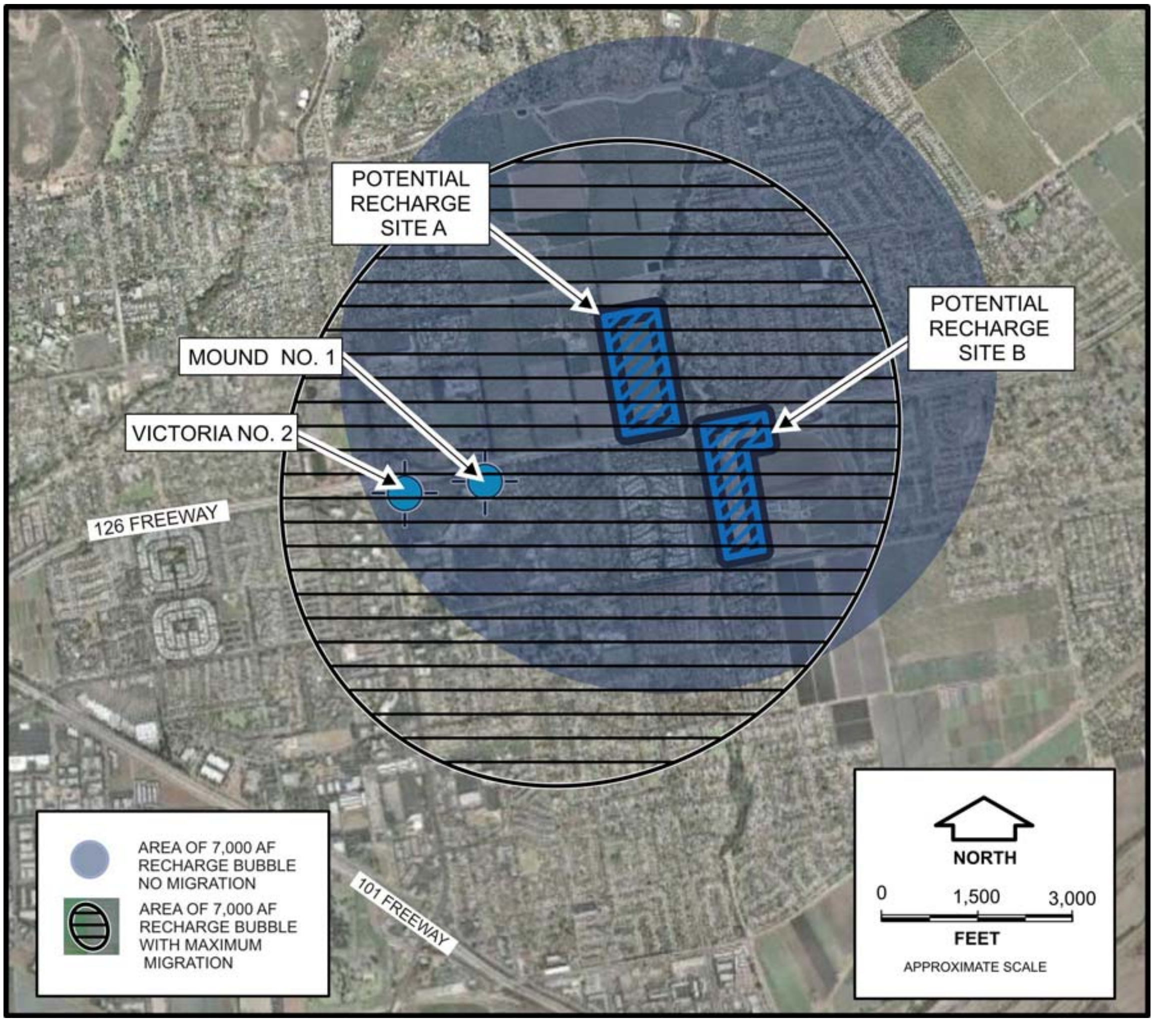
Figure 8 – Annual Recharge of 4,000 Acre-Feet Per Year Using Separate Well Sites shows the approximate corresponding areal extent of the aquifer that would be filled if the 4,000 AFY is injected using 2 separate well sites at a constant rate of 1,250 gpm. The results indicate that the injected recycled water would take approximately 1 year to travel to the site of Victoria Well No. 2.

Figure 8 – Annual Recharge of 4,000 Acre-Feet Per Year
Using Separate Well Sites



The injected volume of 7,000 AFY of recycled water would fill a storage area within the aquifer zones having a radius of approximately 5,200 feet. Figure 9 – Area of Lower Aquifer System Filled by 7,000 Acre-Feet of Recycled Water shows the approximate areal extent of the displaced volume of native groundwater that would be filled by recycled water over a one-year-period. The estimated aquifer storage area (recharge bubble) occupied by recycled water is calculated assuming the entire volume of 7,000 AFY is injected in at a single well site in closely spaced wells solely completed in the LAS at either of the recharge sites. The travel time for injected water on the east side of Potential Recharge Well Site A to reach Victoria Well No. 2 is 6 to 7 months. Should the annual injection volume be distributed between sites or if the effective aquifer thickness is greater, the displaced volume (areal extent) of native groundwater would be proportionally smaller and the travel time to the downgradient wellfield would increase.

Figure 9 – Area of Lower Aquifer System Filled By 7,000 Acre-Feet of Recycled Water



Water Quality

Review of historical water quality data indicate that groundwater in the LAS is generally of fair to poor quality with total dissolved solids (TDS) concentrations in the range of 900 to 1,500 milligrams per liter (mg/l) and sulfate concentrations that range from 400 to 650 mg/l. The LAS groundwater is generally a calcium sulfate chemical character. Historical data indicate that the storage of the proposed recycled water will improve the quality of groundwater in LAS and that injection water chemistry can likely be controlled (buffered) to be compatible with native groundwater.

Future Site Specific Investigations

Should the City decide to pursue the groundwater replenishment project at either of the proposed sites, it will need to develop a comprehensive plan for investigation that will determine site specific subsurface conditions and develop facilities that can be used to conduct demonstration testing that is required for application of the permits required for the GRRP. Site specific groundwater studies will be required to further define the aquifer replenishment potential at either recharge site. Field investigation will include exploratory drilling and construction of pilot test wells and monitoring wells to test the aquifer properties and confirm groundwater travel time estimates at each site. Ultimately, groundwater tracer testing using an intrinsic tracer will be required to satisfy California Department of Public Health (CDPH) and obtain a permit for the GRRP. Additional analyses to be conducted during the site investigation will include evaluating the geochemical compatibility of the FATW with the native groundwater and the lithology of aquifer materials through the use of sample analysis, bench tests, and geochemical modeling.

It is anticipated that the relative cost of exploration will reflect the difficulty and expense of drilling and constructing facilities to the depths on the order of 1,500 bgs. Based on our recent experience with these types of well construction projects we estimate that a nested monitoring well with 2 casing and screen assemblies installed to 1,500 and 1,000 feet will cost approximately $250,000. We estimate that an aquifer test well constructed to 1,500 feet bgs will cost approximately $600,000 and that the facilities design, construction management, subsequent demonstration testing and reporting may cost approximately $500,000. The total anticipated cost for each site to explore, test, and prepare the reporting necessary to determine site suitability and generate information for project permitting will likely range up to $2,000,000 and require an approximate 2- to 3-year-study period.

CONCLUSIONS AND RECOMMENDATIONS

In November 2011, the CDPH Drinking Water Program released a draft regulation that reflects its current thinking on the regulation for replenishing groundwater with recycled municipal wastewater. Based on the findings of this study, we conclude that available data indicate the proposed GRRP is feasible and that replenishment and recovery of groundwater with an improved quality could be effectuated in this portion of the Mound Basin that is consistent with the current draft regulation. It is anticipated that properly designed and constructed recharge wells located at or in the vicinity of the proposed recharge well sites will provide operational well capacities beneficial for the proposed recycled water replenishment program. Injection into the LAS in the Mound Basin will require multiple wells that will likely be capable of sustained injection rates of between 1,000 to 1,500 gpm.

We conclude that aquifer replenishment at Potential Recharge Well Site A or at the northern end of Potential Recharge Well Site B has a higher likelihood of being recaptured at the location of the existing City wells. The CDPH draft regulations require that the retention time of the FATW in the aquifer be no less than 2 months prior to reuse. We conclude that it is feasible for both the 4,000 and 7,000 AFY GRRP alternatives being considered to be designed at the two replenishment sites to meet the minimum aquifer retention time prior to being produced at the existing City Mound Wellfield.

We conclude that the sparse water level data available in the Mound Basin preclude the ability to confidently determine of the direction and rate of groundwater flow and that the effectiveness of capture and reuse of higher quality recharge water from the existing Mound Wellfield cannot be assessed with any accuracy from the available data. We conclude that the GRRP will require the construction of additional downgradient production wells and that new well site locations may need to be considered to maximize the capture of a greater percentage of the higher quality FATW.

For planning purposes we recommend the City use; a) a total of 3 wells for the 4,000 AFY alternative, b) a total of 5 wells for the 7,000 AFY alternative, and c) a cost of approximately $2,000,000 per well to construct the recharge well facilities and equip with pump and motor assemblies, and wellhead piping for injection operations. This cost does not include electrical power or automated controls, conveyance piping, site security, well housing, or purge water discharge disposal considerations. The well construction cost estimate does not include land acquisition or project environmental documentation.

We recommend that upon completion of field investigations that the City evaluate well location alternatives for both future recharge wells and downgradient production wells using groundwater modeling software. Groundwater modeling should include particle tracking to simulate well capture zones and optimize the placement of new well facilities.

CLOSURE

This report has been prepared for the exclusive use of the City of San Buenaventura and its agents for specific application to the City of Ventura Recycled Water Master Plan. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeological planning and engineering practices. No other warranty, express or implied is made.

□

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APPENDIX D – CITY OF VENTURA SPECIAL STUDIES PHASE 2 – VWRF DISCHARGE ALTERNATIVES ASSESSMENT

Stillwater Sciences

2855 Telegraph Ave, Suite 400, Berkeley, CA 94705
phone 510.848.8098 fax 510.848.8398

TECHNICAL MEMORANDUM

DATE: March 4, 2013

TO: Lydia Holmes, Carollo Engineers

FROM: Scott Dusterhoff and Noah Hume

SUBJECT: City of Ventura Special Studies Phase 2 – VWRF Discharge Alternatives Assessment

1 PURPOSE

The purpose of this memorandum is to provide the results for the assessment of Ventura Water Reclamation Facility (VWRF) discharge alternatives' impacts on Santa Clara Estuary (SCRE) habitat conditions and ecosystem functions. The findings presented herein provide an update to assessments developed in the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011) and are intended to be used in combination with the Phase 2 Recycled Water Market Study (Carollo Engineers 2013) and subsequent Phase 3 cost/benefit and permitting assessments to support selection of a preferred VWRF discharge alternative for review by the Los Angeles Regional Water Quality Control Board (RWQCB) and other Stakeholders that is sustainable, cost-effective, and further optimizes beneficial uses of the SCRE.

2 BACKGROUND

In 2008, the City of San Buenaventura (City) was required by the RWQCB to conduct interrelated "Special Studies for the Santa Clara River Estuary" as a condition of the City's NPDES discharge permit (CA0053651) for the VWRF. The special studies that were required by the RWQCB include an Estuary Subwatershed Study, a Treatment Wetlands Feasibility Study, and a Recycled Water Market Study. Collectively, these studies are intended to provide information necessary to determine: (1) whether the VWRF tertiary treated flow discharged in the existing condition to the Wildlife/Polishing Ponds and then to the SCRE creates fuller realization of beneficial uses as necessary to confirm "enhancement" under the California Enclosed Bays and Estuaries Policy; and (2) if alternative VWRF discharge scenarios might improve water quality and habitat conditions supporting existing beneficial uses in the SCRE and its watershed.

Phase 1 of the special studies began in the summer of 2009 and was completed in the fall of 2011. The work conducted for the three studies included the following:

- **Estuary Subwatershed Study** – A synthesis of information regarding the SCRE ecosystem functioning under existing conditions (characterized by tertiary treated VWRF flows discharged to the Wildlife/Polishing Ponds and then to the SCRE) to determine if the current discharge results in fuller realization of beneficial uses within the SCRE. In addition, this study included an assessment of a range of representative potential future

VWRF effluent discharge alternatives (including zero VWRF discharge) and other management measures that could be implemented to achieve further improvement in water quality and/or beneficial uses using water balance and water quality predictive tools developed with existing and newly-collected data.

- **Treatment Wetlands Feasibility Study** – Evaluation at a planning concept level the feasibility of implementing a constructed treatment wetland to achieve additional reductions in nutrients, copper and other metals in the VWRF tertiary treated discharge to further promote improvements in receiving water for beneficial uses. Depending upon flow volume requirements of one or more of the VWRF discharge alternatives developed under the Phase 1 Estuary Subwatershed Study, additional nutrient reductions were identified through a combination of process upgrades at the VWRF plant and a wetland design accommodating a hydraulic residence time of 4–12 days, or some combination of upgrades and multi-day residence time within treatment wetlands.
- **Recycled Water Market Study** – Evaluation and quantification at a conceptual planning level the feasibility of expanding the City's existing reclaimed water system through evaluation of potential users within a five-mile radius of the VWRF for purposes of providing an alternative to discharging VWRF effluent flow to the SCRE. Depending on the flow diversion requirements, this study determined that recycled water projects could be implemented for the purpose of diverting the VWRF discharge on a seasonal basis, provided that diversion requirements take into account technical constraints on diversion, such as public health and safety, design and capacity, and/or operational constraints that may make diversions at certain times infeasible or inappropriate to implement.

The results from the discharge alternative assessment conducted in the Phase 1 Estuary Subwatershed Study concluded that fuller realization of receiving water beneficial uses occurs under current levels of VWRF discharge as compared to the complete absence of discharge due to increased habitat area for listed species (RARE) including tidewater goby (*Eucyclogobius newberryi*), steelhead (*Oncorhynchus mykiss*), Western snowy plover (*Charadrius nivosus nivosus*), and California least tern (*Sterna antillarum browni*). In addition, the VWRF Wildlife/ Polishing Ponds provide habitat for bird and wildlife beneficial uses (RARE, WET, WILD) as well as recreational opportunities (REC-2). The results also suggested that a modification to VWRF effluent flow to reduce nutrient input to the SCRE during dry season, closed-mouth conditions (Alternative 5 in the Phase 1 study) would improve water quality by reducing periods of low DO in localized areas of the SCRE, as well as the frequency and duration of algal blooms, which together may benefit resident fish and bird species and thereby improve fish and wildlife-related beneficial uses. In addition, modeled reductions in discharge volumes during dry season, closed-mouth conditions were found to result in decreasing flooding potential within the McGrath State Beach campground (REC-2) and to benefit tidewater goby and steelhead habitat conditions by reducing the potential for unseasonal breaching. Consequently, the Phase 1 Estuary Subwatershed Study concluded that, on balance, discharge alternatives that reduce discharge volumes and nutrient levels would likely improve habitat conditions and further improve fish and wildlife-related beneficial uses in the SCRE (see Stillwater Sciences 2011 for more detail).

In 2012, Phase 2 of the special studies was initiated to develop additional information for improving the understanding of SCRE ecosystem functioning, and to integrate the conclusions of all three of the Phase 1 Studies into a process for selection, environmental review, and design of a preferred VWRF discharge/diversion alternative that creates a discharge regime that further improves beneficial uses of the SCRE. Per the recommendations provided to the City and RWQCB at the end of Phase 1 in a Recommendations Memorandum (Carollo Engineers and Stillwater Sciences 2011), the Phase 2 studies included: (1) additional data collection at existing and new locations within and adjacent to the SCRE based on RWQCB and project Stakeholder input; (2) development of feasible VWRF effluent discharge reduction and/or improvement alternatives that utilize treatment wetland and recycled water approaches (i.e., variations of the Phase 1 Alternative 5); and (3) a refined assessment of the impact of potential discharge alternatives on SCRE habitat conditions using developed predictive tools to increase confidence that adoption of any new VWRF discharge and/or diversion regime further improves beneficial uses. Phase 2 data collection occurred from mid-September 2010 to early December 2012 following the methodology laid out in a detailed Monitoring Plan (Stillwater Sciences 2012, which can be found along with the Phase 2 monitoring data at http://www.cityofventura.net/rivers). Through collaboration with the City, project Stakeholders, and other local entities, Carollo Engineers developed a set of viable VWRF discharge alternatives that include additional treatment to meet reuse requirements, decreased effluent outflow to the SCRE through diversion to agricultural water and groundwater recharge facilities, and increased reuse activities and improved water quality treatment for the effluent discharged to the SCRE (see Table 1-1). The alternatives developed include consideration of the existing dry season effluent flow volume to the VWRF Wildlife/Polishing Ponds (7.3 millions of gallons per day [MGD] on average) and the corresponding projected future effluent flow volumes (11.2 MGD on average).

Table 2-1. Estimated average dry season (June through September) flows and VWRF effluent outflow nitrate concentration by VWRF discharge alternative.

VWRF discharge alternative		Alternative description	VWRF Effluent treatment approach	Flow rate (MGD)				Outflow nitrate concentration (mg-N/L)
				Dry Season VWRF effluent flow[1]	Diverted effluent flow	Influent to treatment wetland	Outflow to the SCRE	
Current conditions	No Action	Current effluent treatment	Onsite wetland	7.3	1.0	0	6.3	8.0
Current conditions	Alternative 5.1	North decentralized plant[2]	Onsite + additional wetland[5]	7.3	2.0	5.3	4.0	4.0
Current conditions	Alternative 5.2	Recharge supply to Oxnard or UWCD[3]	Onsite wetland	7.3	7.3	0	0	0
Current conditions	Alternative 5.3	Agricultural water supply to UWCD	Onsite wetland	7.3	7.3	0	0	0
Current conditions	Alternative 5.4	IPR & DPR (4,000 AFY)[4]	Onsite wetland	7.3	4.5	2.8	2.0	4.0
Current conditions	Alternative 5.5	IPR (7,000 AFY)	Onsite wetland	7.3	7.3	0	0	0
Future conditions	Alternative 5.6	North decentralized plant	Onsite + additional wetland	11.2	2.0	9.2	8.0	5.0
Future conditions	Alternative 5.7	Recharge supply to Oxnard or UWCD	Onsite wetland	11.2	11.2	0	0	0
Future conditions	Alternative 5.8	Agricultural water supply to UWCD	Onsite + additional wetland	11.2	8.0	3.2	2.0	4.0
Future conditions	Alternative 5.9	IPR & DPR (4,000 AFY)	Onsite + additional wetland	11.2	4.5	6.7	5.0	4.0
Future conditions	Alternative 5.10	IPR (7,000 AFY)	Onsite + additional wetland	11.2	7.9	3.3	2.0	4.0

[1] Refers to the volume of flow into the VWRF Wildlife/Polishing Ponds from the Effluent Transfer Station (ETS).
[2] North decentralized plant refers to construction of an additional treatment plant for reuse in the northern sector of the VWRF service area.
[3] Oxnard refers to the City of Oxnard Groundwater Recovery Enhancement and Treatment (GREAT) program; UWCD refers to the spreading ponds operated by United Water Conservation District (UWCD) northeast of the SCRE.
[4] IPR is indirect potable reuse; DPR is direct potable reuse, AFY is acre-feet per year.
[5] Onsite refers to treatment using Wildlife/Polishing Ponds modified for improved treatment; additional wetland refers to treatment at a new off-site treatment wetland adjacent to the VWRF.

3 APPROACH

The approach used for assessing ecosystem functions affected by each VWRF discharge alternative during the dry season (June through September) included using the SCRE water balance and nutrient balance modeling tools developed during Phase 1 to predict effects of discharge alternatives on SCRE water quality conditions, particularly with respect to nutrients and focal species habitat conditions, while accounting for climate change and the modifications to VWRF effluent discharge (as summarized in Table 1-1). Within the Phase 1 VWRF discharge alternatives analysis, the flooding potential within the SCRE southern floodplain and subsequent impacts to McGrath State Beach recreational camping opportunities (REC-2) were considered in the evaluation of each alternative. Due to recent Stakeholder input suggesting that there is the potential for the campground to be moved out the floodplain in the near future, flooding impacts are not explicitly accounted for in the Phase 2 VWRF discharge alternatives assessment presented herein. However the flooding stage of the campground is noted at 9.5 ft NAVD88, as described in the Phase 1 reports.

Based on Stakeholder feedback received following the Phase 1 alternatives assessment, the Phase 2 alternatives assessment included developing SCRE stage/depth estimates for both dry and wet water year types as a means of elucidating the anticipated minimum and maximum values associated with each alternative. The impact of climate change within this analysis was reflected in values of future sea level elevation (approximate 1.3 ft increase in MSL) and air temperatures (approximately 2°C [3.6°F]) increase in average temperatures) projected to 2050. The data presented in the Phase 1 Climate Change Assessment (Carollo Engineers 2011) indicate that the projected increase in average annual precipitation is minimal, which suggests that the average annual groundwater elevation adjacent to the SCRE and the average annual river flow into the SCRE will likely be similar to current conditions. Although increased evaporation of the SCRE has been included in this assessment, increased air temperatures could also result in increased evapotranspiration and a decrease in local groundwater elevation and thus base flows to the river and SCRE during the drier months. We have not attempted to model these impacts and have also not included temperature related effects upon bacterial and algal respiration in the water column.

3.1 Water balance modeling

The SCRE water balance modeling tool developed in Phase 1 was updated with additional data and used to provide a hypothesized time series of SCRE stage for each alternative as a function of inflows and outflows for representative dry and wet water year conditions. The modeling assessment assumed a 2009/2010 lagoon morphology and a mouth berm that had just closed at the beginning of each model simulation (June 1). The SCRE stage data collected during spring/summer 2012 show that the mouth currently remaines closed for a stage up to 12.5 ft NAVD88. Based on the newly-collected data, the SCRE mouth was presumed to breach when the stage reached 12.5 ft NAVD88, which is approximately 2 ft higher than equilibrium SCRE stage previously observed during dry season, low-flow conditions and approximately 1.5 ft higher than estimated for the Phase 1 alternatives assessment. Although the cause for the higher breaching elevation is not fully understood, it is known that that the SCRE was mechanically breached in the past when the stage was 10–11 ft NAVD88 where no mechanical breaching occurred at this stage range from fall 2011 to summer 2012 (possibly due to increased patrols by California State Park employees). Therefore, 12.5 ft NAVD88 appears to be an appropriate current dry season, low-flow breaching stage.

Assumptions used to develop the flow rates and the average flow rate for each inflow and outflow component used in the alternatives assessment are given below.

VWRF effluent flow
The VWRF effluent outflow rates to the SCRE ranged from 0 to 8 MGD and were derived from the VWRF discharge alternative estimated average effluent outflow rates to the SCRE from June through September (see Table 1-1). As the average daily VWRF effluent discharge rate is fairly constant during the summer months for all years, we assumed that the VWRF effluent flow rates did not vary as a function of water year type.

Santa Clara River flow
The rate of Santa Clara River flow into the SCRE was derived from the monthly mean flow rates at two gages just upstream of the SCRE (USGS gage 11114000 and VCWPD Station 723) for a representative dry water year (water year [WY] 1957, no river discharge from June through September) and a representative wet water year (WY 1973, monthly mean river flow <1 cubic feet per second [cfs] in June and no river discharge from July through September). These flows were presumed to be representative of future conditions primarily due to an anticipated minimal increase in future mean annual precipitation over the next several decades.

Evaporation
Evaporation used in the modeling analysis was determined from combining present-day evaporation estimate with a multiplier to account for climate change. Present-day values were determined by first using evaporation data from El Rio to calculate median monthly SCRE evaporation rates for June through September (per the methodology used to determine SCRE evaporation in Phase 1) and then reducing that evaporation rate by 50% (the ratio of measured SCRE evaporation and calculated SCRE evaporation using El Rio data during summer 2012). Similar to the Phase 1 alternatives assessment, the present-day median monthly evaporation estimates were then increased by 4% to account for the anticipated increase in future dry season air temperatures (see Stillwater Sciences 2011 for the detailed methodology). Because summertime conditions are fairly similar for all years, evaporation estimates did not vary as a function of water year type.

Subsurface flow through the mouth berm
Similar to the Phase 1 alternatives assessment, the flow through the closed-mouth berm during the model simulation period was derived from the hydraulic variables determined as part of the water balance analysis and the gradient between the SCRE stage and the adjacent tidal elevation. A future tidal elevation time series was compiled using current normal tidal elevations combined with the anticipated increase in mean sea level. The current normal tidal elevations for each month were determined using the tidal time series for June through September 2010 and adjusting the elevations according to how much the mean monthly elevation differed from the long-term value. The current normal tidal elevations were then increased by 1.35 ft, or the average of the range of values for anticipated sea level rise (see Stillwater Sciences 2011).

Groundwater flows
Similar to the subsurface flow through the mouth berm, the groundwater inflows and outflows were derived from calculated hydraulic variables combined with local hydraulic gradients. For groundwater flow across the south bank at McGrath State Beach, the hydraulic gradient was derived from the modeled SCRE stage and an assumption that the water table elevation remained fixed at an elevation of 6.5 ft NAVD88 and that flow would be directed out of the SCRE when the SCRE stage was above this elevation. This assumption regarding the change in gradient direction was based on the data collected during both 2009–2010 (Phase 1) and 2010–2012 (Phase 2) monitoring periods. For the groundwater flow from the VWRF Wildlife/Polishing Ponds, the hydraulic gradient was derived from the modeled SCRE stage and an assumed constant VWRF Wildlife/Polishing Pond surface elevation that is the same as current conditions

(19 ft NAVD88). The variables and relationships used to determine the groundwater flow across the south bank and from the VWRF Wildlife/Polishing Ponds did not vary as a function of water year type.

For the unmeasured groundwater flow component, groundwater inflow rate varied between water year types based on the results from WY 2011 and WY 2012 SCRE water balance development. Between June and September, the unmeasured groundwater discharge to the SCRE in WY 2011 (a relatively wet water year) was calculated using the following relationship:

Unmeasured groundwater discharge = -9,500(SCRE stage) + 80,500 (1)

During that same period in WY 2012 (a relatively dry water year), the unmeasured discharge to the SCRE was calculated using the following relationship:

Unmeasured groundwater discharge = -8,000(SCRE stage) + 76,000 (2)

For the purposes of this analysis, these two relationships were considered to be representative of long-term dry and wet water year conditions and were used in the determination of dry and wet water year groundwater contributions for each discharge alternative.

3.2 Nutrient balance modeling

As a means of understanding the relative contributions of nutrients from the local watershed (VWRF and upstream sources) under alternative VWRF effluent discharge scenarios, a simplified nutrient balance for the SCRE was developed as part of the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011). This nutrient balance model was updated and used to assess nutrient concentrations in the SCRE associated with the Phase 2 alternatives. Using updated flow estimates (Section 2.1), primary flows from the water balance (e.g., Santa Clara River, VWRF, groundwater sources/sinks, ocean outflow) were assigned nutrient concentrations as total inorganic nitrogen (TIN = $NH_4 + NO_3 + NO_2$), of which nitrate-nitrogen (NO_3-N) is the dominant component. Similar to the approach from Phase 1, this mass balance was modeled assuming a balance of material inflows and outflows over the course of a day (i.e., mass in equals mass out), and the modeling further assumed that the lagoon is well mixed due to the shallow SCRE lagoon depth and consistent onshore winds. Although the mixing model assumptions were not met during periods with ocean exchanges, the approach was useful in assessing the relative magnitude of nutrient loadings to the SCRE from contributing sources with an equilibrium (steady-state) concentration in the water column. Representative flows by source were paired with up-to-date estimates of nitrate based upon both historical (2001–2010) as well as more recent estimates from data collected during 2012.

The TIN concentrations associated with each SCRE inflow component used in the modeling were updated to take into account Phase 2 monitoring data and are described below.

Santa Clara River Inflows
TIN levels arriving to the SCRE from the Santa Clara River were primarily comprised of NO_3 and have historically ranged from 5.5–6.4 mg-N/L (Stillwater Sciences 2011). More recent data collected in 2012 upstream of the SCRE have averaged 5 mg/L and we have assumed that TIN arriving from riverine sources will average 5 mg-N/L during the spring/summer months for all alternatives. However, because the Santa Clara River flow is frequently zero during summer months, contributions to the SCRE nutrient levels are expected to be minor.

VWRF Inflows
Recent upgrades to the VWRF denitrification processes have reduced NO_3 and TIN levels in the VWRF Effluent Transfer Station (ETS) discharge below the 10 mg-N/L water quality objective established under the Basin Plan. Recent data collected in 2012 has consistently shown 8 mg/L at the ETS. Therefore, we have assumed that TIN arriving to the SCRE from the VWRF will average 8 mg-N/L at most for the No Action alternative (i.e., 2012 nutrient conditions) (Table 1-1). Based upon updated sizing calculations from Carollo Engineers (2010), TIN levels following additional treatment at onsite and offsite wetlands will likely average 4 mg-N/L (Table 1-1) depending on estimated flows discussed in the Phase 2 Recycled Water Market Study (See Carollo Engineers 2013 for additional details).

Groundwater sources
TIN levels in groundwater were found to be low in the SCRE floodplain adjacent to McGrath State Beach based on monitoring well sampling conducted in 2009–2010 (Stillwater Sciences 2011). However, based upon groundwater sampling conducted in 2012 along the north side of the SCRE, TIN levels may be as high as 15 mg-N/L (See Section 4.2 for additional discussion). Because water balance modeling indicates significant groundwater inflows from the north bank from where these samples were collected, 15 mg-N/L is used as the estimate of groundwater TIN arriving in the SCRE year-round for all alternatives,

TIN uptake and removal within the SCRE Inflows
Based upon summertime observations of lower NO_3 and TIN concentrations under closed-mouth conditions at levels below the major sources to the SCRE (e.g., VWRF and Santa Clara River inflows), it is apparent that some combination of algal uptake and denitrification effectively reduces TIN levels in the SCRE during summer months. Based upon higher removal estimates of 79–359 mg-N/m^2-d due to denitrification in deeper estuaries with the reducing conditions (i.e., low oxygen) at the sediment-water interface (Seitzinger 1988, Horne 1995), we assumed conservatively low rates of TIN removal rates of 50–100 mg-N/m^2-d on an aerial basis by biological uptake and denitrification processes within the SCRE.

3.3 Estuary Habitat Conditions

Available habitat was assessed as a function of modeled SCRE stage and associated mouth breaching timing, modeled average nitrogen levels, and focal species habitat area (as a function of SCRE stage) associated with each VWRF discharge alternative. Development of the focal species habitat area vs. SCRE stage relationships can be found in Stillwater Sciences (2011). Because spatial variations in substrate, water temperature, salinity, and dissolved oxygen were considered to be relatively minor, focal fish species habitat use was related only to variations in depth and vegetative cover. For Central Coast steelhead, area vs. stage curves were limited to shallow water areas (0.15–1 m [0.5–3.0 ft]) adjacent and within flooded vegetation for juvenile rearing, and considered all open water habitats deeper than 1 m (> 3.3 ft) suitable for adult upmigrants. For tidewater goby, understanding that most seining efforts were concentrated along the SCRE margin, potential habitat was mapped within a depth range of 0.3–1.5 m (1.0–4.9 ft) (Stillwater Sciences 2011). For focal bird species, habitat area curves were related to unvegetated areas potentially used for nesting (western snowy plover and California least tern), as well as foraging (western snowy plover). For western snowy plover, the amount of open water areas potentially available for foraging was also included in the habitat area vs. stage relationships (Stillwater Sciences 2011).

4 RESULTS & DISCUSSION

4.1 Assessment of Impacts to Estuary Hydrology & Stage

Table 4-1 summarizes the calculated average dry and wet year flow rates used to assess each alternative, with SCRE stage and average depth during a hypothetical 4-month filling period beginning June 1 shown in Figures 4-1 to 4-6. Overall, these modeling results clearly illustrate the impact that varying VWRF effluent outflow rate has on SCRE stage and groundwater inflow rate. For zero effluent discharge alternatives (i.e., those alternatives with zero VWRF discharge into the SCRE), the maximum modeled equilibrium stage range for dry and wet water year conditions was the lowest of all the alternatives considered (~2.5–3 ft lower than the No Action alternative) and the average unmeasured groundwater inflow range (which is driven by SCRE stage) was the highest (~1.9–2.6 MGD lower than the No Action alternative). Increasing the effluent discharge rate within the modeling analysis resulted in a progressive increase in SCRE equilibrium stage and associated decrease in unmeasured groundwater flow rate. In addition, increasing the effluent discharge resulted in a decreasing difference in dry and wet water year stage and unmeasured groundwater inflow for individual discharge alternatives, suggesting that SCRE stage/depth and subsequent habitat area is more sensitive to water year type at lower VWRF discharge rates than higher rates. The maximum equilibrium stage for the 8 MGD discharge alternative was 11.5 ft NAVD88 (~0.5 ft higher than the No Action alternative), which, as previously mentioned, is considered to be below the current breaching threshold indicated by summer/fall 2012 SCRE stage data but is above the breaching threshold during the Phase 1 alternatives assessment. Although the SCRE mouth berm can currently remain closed at a stage up to approximately 12.5 ft NAVD88 during dry season, low-flow conditions, it should be noted that there is the possibility that this is a temporary condition and the breaching stage may be lower in the near future.

Stillwater Sciences
2855 Telegraph Ave, Suite 400, Berkeley, CA 94705
phone 510.848.8098 fax 510.848.8398

Table 4-1. Estimated average dry season SCRE inflows and outflows by VWRF effluent discharge alternative and water year type.

VWRF discharge alternative	Surface water inflow/outflow (MGD)				Subsurface water inflow/outflow (MGD)			
	VWRF to SCRE	Santa Clara River	Precipitation	Evaporation	Closed Mouth Berm	South Bank	VWRF Ponds	North Bank and other sources
No Action (DRY)	6.3	0	0	-0.4	-5.0	-0.2	0.9	0.7
No Action (WET)	6.3	0.01	0	-0.4	-4.8	-0.2	0.9	0.4
Alternatives 5.2, 5.3, 5.5, and 5.7 (DRY)	0	0	0	-0.3	-2.6	-0.3	1.0	3.3
Alternatives 5.2, 5.3, 5.5, and 5.7 (WET)	0	0.01	0	-0.3	-2.1	-0.2	1.1	2.3
Alternatives 5.4, 5.8, and 5.10 (DRY)	2.0	0	0	-0.3	-3.1	-0.2	1.0	1.9
Alternatives 5.4, 5.8, and 5.10 (WET)	2.0	0.01	0	-0.3	-2.5	-0.3	1.0	1.0
Alternative 5.1 (DRY)	4.0	0	0	-0.3	-3.7	-0.2	0.9	0.9
Alternative 5.1 (WET)	4.0	0.01	0	-0.3	-3.4	-0.2	1.0	0.5
Alternative 5.9 (DRY)	5.0	0	0	-0.4	-4.3	-0.2	0.9	0.8
Alternative 5.9 (WET)	5.0	0.01	0	-0.4	-4.0	-0.2	0.9	0.5
Alternative 5.6 (DRY)	8.0	0	0	-0.4	-6.1	-0.2	0.8	0.6
Alternative 5.6 (WET)	8.0	0.01	0	-0.4	-6.0	-0.2	0.8	0.3

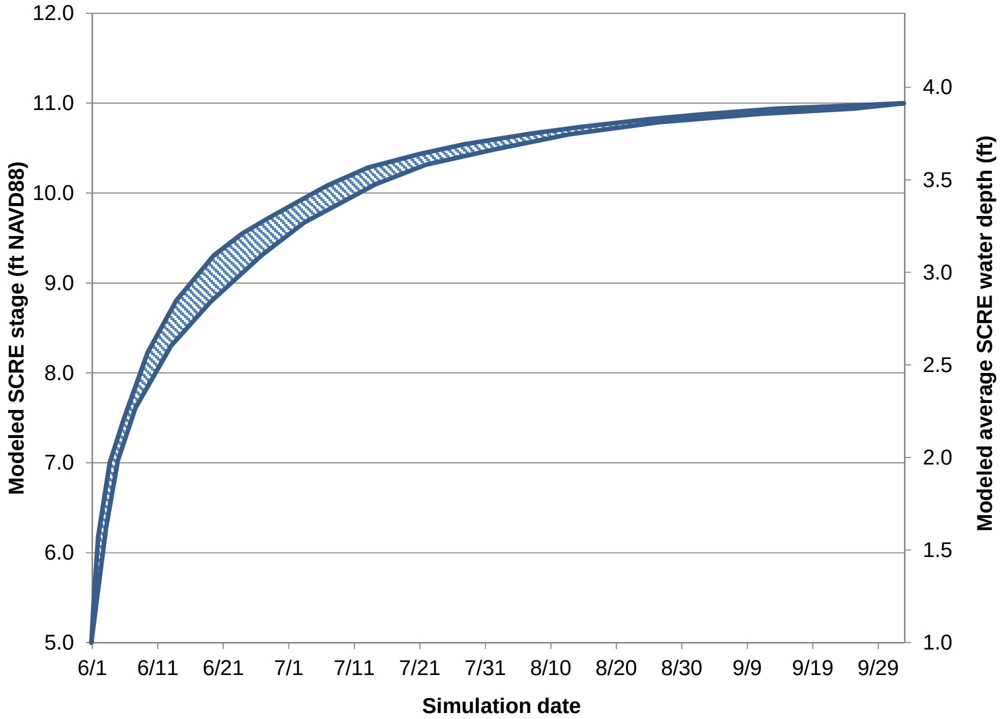

Figure 4-1. Modeled SCRE stage and average depth range for the No Action effluent discharge alternative (6.3 MGD average dry season discharge).

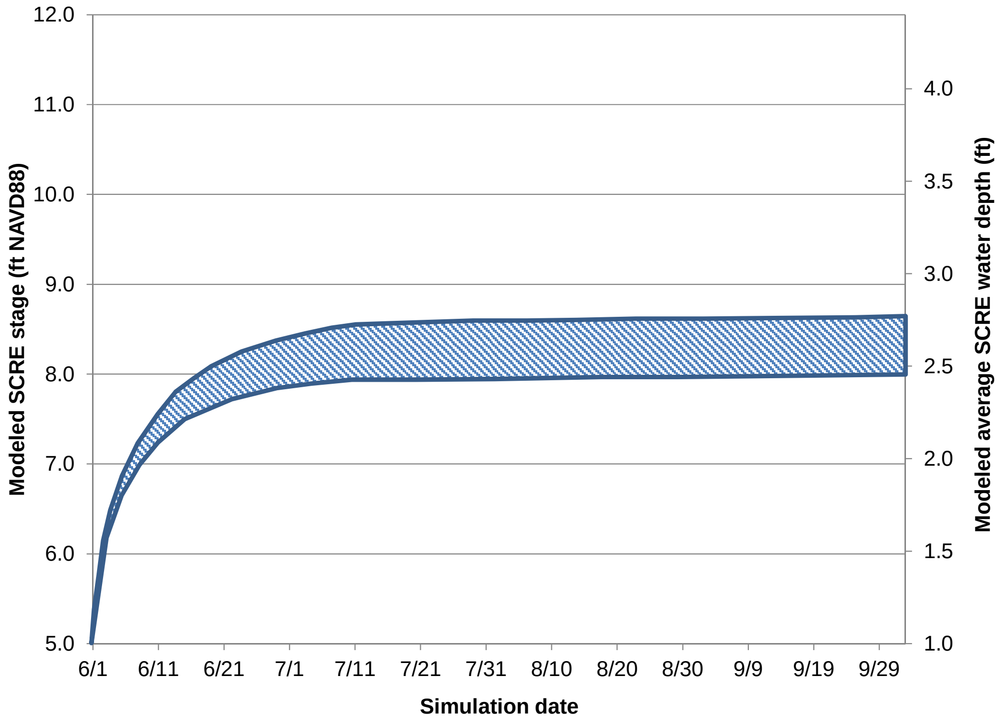

Figure 4-2. Modeled SCRE stage and average depth range for the 0 MGD dry season effluent discharge alternatives.

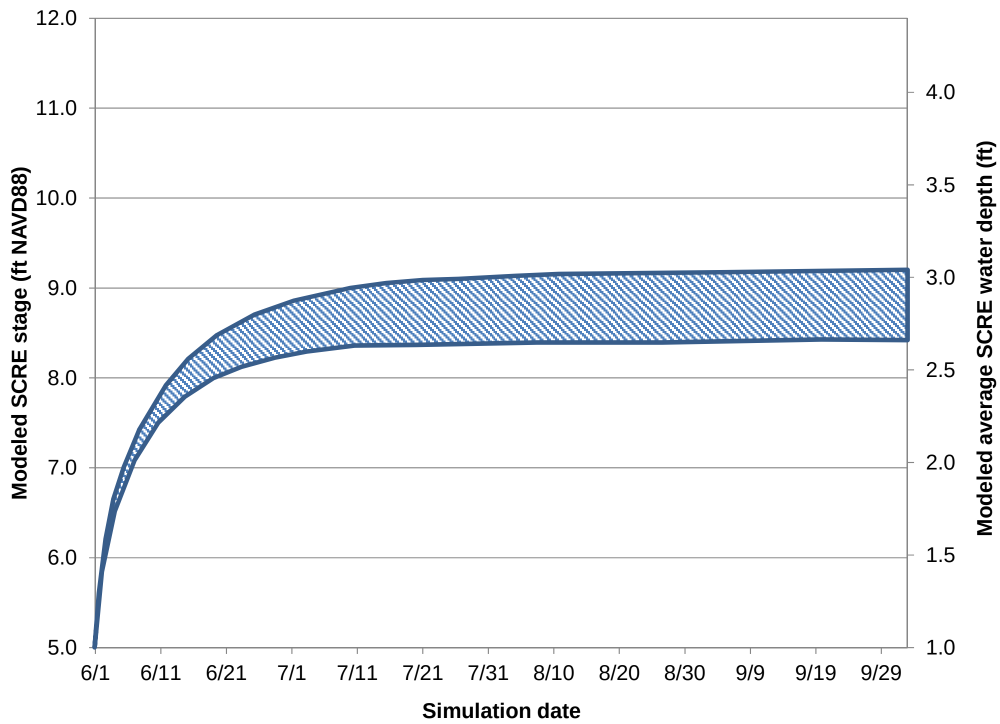

Figure 4-3. Modeled SCRE stage and average depth range for the 2 MGD dry season effluent discharge alternatives.

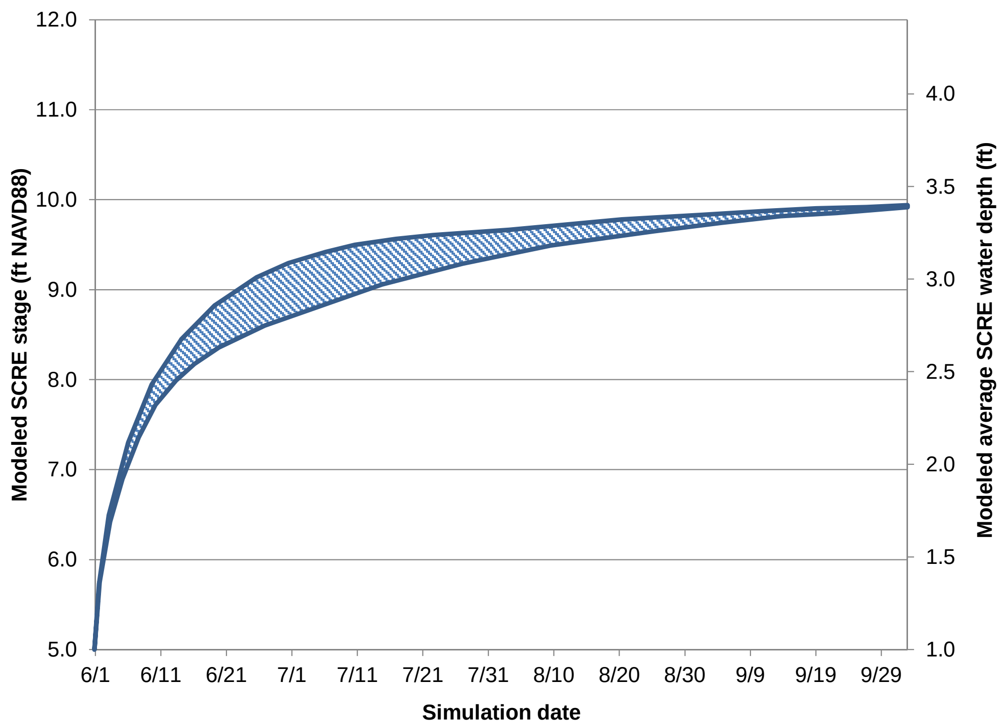

Figure 4-4. Modeled SCRE stage and average depth range for the 4 MGD dry season effluent discharge alternative.

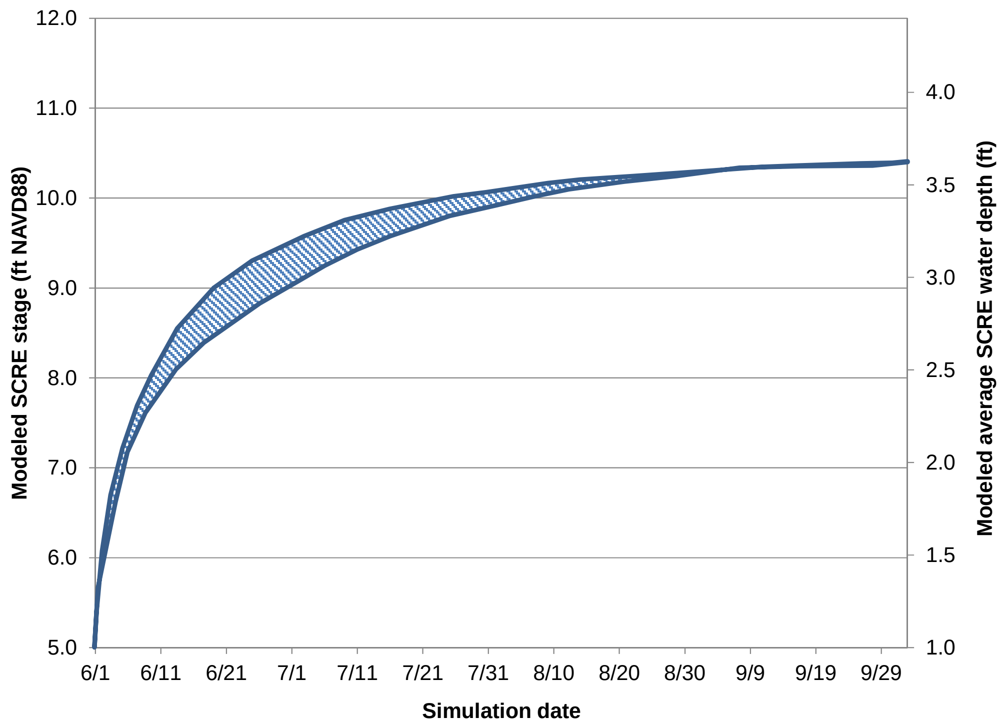

Figure 4-5. Modeled SCRE stage and average depth range for the 5 MGD dry season effluent discharge alternative.

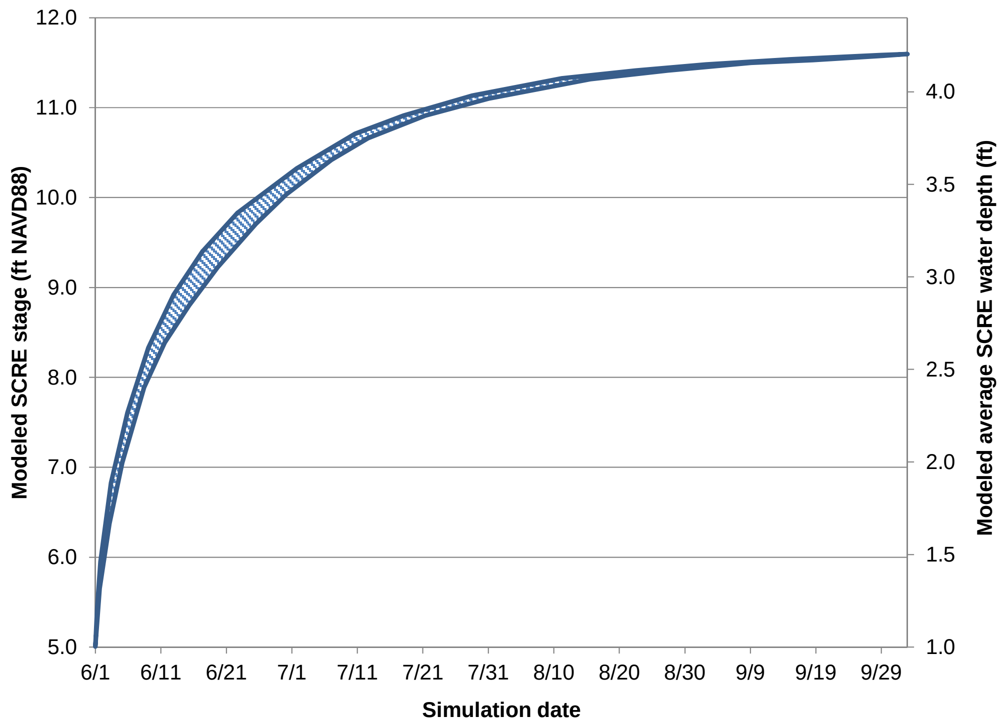

Figure 4-6. Modeled SCRE stage and average depth for the 8 MGD dry season effluent discharge alternative.

4.2 Assessment of Impacts to Estuary Water Quality

Using the nutrient balance developed in the Phase 1 study (Stillwater Sciences 2011), updated nutrient estimates from 2012, and average flows from the updated water balance modeling (Table 3-1), future nutrient loads to the SCRE were estimated for each of the Phase 2 VWRF discharge alternatives (Table 4-2). VWRF discharge nitrate concentrations used in the analysis represent current denitrification practices for the No Action alternative and additional denitrification occurring in on-site treatment wetlands for all other alternatives (see Table 1-1). The analysis below centers upon variations in the amount of NH_4 and NO_3 (i.e., TIN) arriving to the SCRE driven by flow reductions and various onsite and offsite treatment alternatives such as wetlands denitrification (Carollo Engineers 2013). Within the SCRE, TIN removal mechanisms included advective transport (i.e., lagoon berm and south bank of SCRE) as well as algal uptake and denitrification. Table 4-2 shows estimates of future TIN levels in the SCRE using the assumptions above along with future flow estimates (Section 2.1) and the nutrient balance approach discussed in Section 2.2.

For each alternative evaluated, future TIN levels were estimated by summation of the total of all loads arriving from each source and removed by algal uptake and denitrification (Table 4-2). The total SCRE TIN loading was then divided by the total water volume represented by the sum of SCRE outflows and storage terms from the water balance to arrive at an estimate of average TIN levels expected under the alternative.

As discussed for the development of the nutrient balance (Stillwater Sciences 2011), future TIN levels will rapidly approach the largest flow and thus load contribution to the SCRE under the future discharge conditions. Because recent water quality monitoring results show relatively high TIN levels in shallow groundwater along the north side of the SCRE that were previously un-identified and also show low TIN levels in the VWRF discharge due to the future improvement in water quality (shown as wetlands in all alternatives), the current modeling results suggest the projected lower TIN levels in VWRF discharges as compared to groundwater inflows may improve conditions in the SCRE affected by excess nutrients such as biostimulation of nuisance algae as well as any interrelationship with adverse dissolved oxygen conditions. For alternatives including complete VWRF discharge removal from the SCRE (Alternatives 5.2, 5.3, 5.5, and 5.7), modeled TIN levels in the SCRE approached levels found during the 2012 groundwater monitoring (Table 4-2). In the absence of habitat area considerations, the lowest TIN levels were achieved under the highest SCRE discharge alternatives corresponding to the North Decentralized Plant alternative (Alternatives 5.1 and 5.6), followed by indirect or direct potable reuse in the Mound Basin at 4,000 acre-feet per year (AFY) (Alternatives 5.4 and 5.9), indirect potable reuse in the Mound Basin at 7,000 AFY (Alternative 5.5 and 5.10), agricultural water supply to United Water Conservation District (UWCD) (Alternative 5.3 and 5.8), and groundwater recharge supply to the City of Oxnard or UWCD (Alternative 5.2 and 5.7).

As stated in the Phase 1, because significant levels of TIN are present in local groundwater and the Santa Clara River, it should be noted that reductions in nitrate levels under one or more alternatives may not result in substantially reduced algal levels and continued algal bloom episodes are likely to occur under all alternatives. Historically measured dissolved oxygen levels in some locations within the SCRE were periodically found below Basin Plan objectives (Stillwater Sciences 2011). It is expected that the frequency and duration of algal blooms and any related dissolved oxygen impacts should decrease with reduced TIN levels. As discussed in Stillwater Sciences (2011), however, measurable reductions of algal biomass in the SCRE may not occur until the TIN:PO_4 ratio approaches 4.5:1 by mass, with TIN approximately below 1.5–4.5 mg-N/L under current conditions.

Table 4-2. Estimated average future TIN loading and SCRE concentration by VWRF discharge alternative and water year type.

VWRF discharge alternative	Alternative description	Water year type	Santa Clara River (lb-N/day)	VWRF pond ground-water (lb-N/day)	Onsite/ Offsite wetland (lb-N/day)	Area (ac)	Denitrification/algal uptake (lb-N/day)		Equilibrium TIN (mg-N/L)	
							Low	High	Low	High
No Action	Current effluent treatment	Wet	0.0	58	420	183	-82	-163	6.4	7.7
		Dry	0.5	59	420	179	-80	-159	6.2	7.5
Alternative 5.1	North decentralized plant	Wet	0.0	62	133	156	-69	-139	3.7	5.2
		Dry	0.4	64	133	150	-67	-133	3.0	4.6
Alternative 5.2	Recharge supply to Oxnard or UWCD	Wet	0.0	68	0	136	-61	-122	10.7	12.5
		Dry	0.5	71	0	127	-57	-113	9.6	11.8
Alternative 5.3	Agricultural water supply to UWCD	Wet	0.0	68	0	136	-61	-122	10.7	12.5
		Dry	0.5	71	0	127	-57	-113	9.6	11.8
Alternative 5.4	IPR & DPR (4,000 AFY)	Wet	0.0	65	67	144	-64	-128	6.3	8.0
		Dry	0.5	69	67	134	-60	-120	4.5	6.4
Alternative 5.5	IPR (7,000 AFY)	Wet	0.0	68	0	136	-61	-122	10.7	12.5
		Dry	0.5	71	0	127	-57	-113	9.6	11.8
Alternative 5.6	North decentralized plant	Wet	0.0	55	334	201	-90	-180	3.7	4.9
		Dry	0.4	56	334	198	-88	-177	3.5	4.7
Alternative 5.7	Recharge supply to Oxnard or UWCD	Wet	0.0	68	0	136	-61	-122	10.7	12.5
		Dry	0.5	71	0	127	-57	-113	9.6	11.8
Alternative 5.8	Agricultural water supply to UWCD	Wet	0.0	65	67	144	-64	-128	6.3	8.0
		Dry	0.5	69	67	134	-60	-120	4.5	6.4
Alternative 5.9	IPR & DPR (4,000 AFY)	Wet	0.0	60	167	168	-75	-150	3.3	4.7
		Dry	0.4	62	167	162	-72	-145	2.8	4.2
Alternative 5.10	IPR (7,000 AFY)	Wet	0.0	65	67	144	-64	-128	6.3	8.0
		Dry	0.5	69	67	134	-60	-120	4.5	6.4

4.3 Assessment of Estuary Habitat Conditions

Table 4-3 shows average SCRE habitat parameters for the VWRF discharge alternatives developed directly from the water balance modeling results (average depth and wetted area) and by combining the modeled SCRE stage with stage-habitat area relationships for the four focal species pursuant to the methodology developed in the Phase 1 Estuary Subwatershed Study (Stillwater Sciences 2011). To provide a clear picture of anticipated average habitat conditions associated with each alternative, the dry year and wet year model results were combined. The data presented in Table 4-3 show that modifying the VWRF effluent during closed-mouth, dry season conditions has varying impacts on SCRE habitat conditions. As expected, the highest VWRF discharge into the SCRE (8 MGD) resulted in the highest average depth and wetted area (with values being ~10% higher than for the No Action alternative discharge average dry season flow of 6.3 MGD). Similarly, steelhead habitat area increased with increasing VWRF discharge, reaching the maximum value for all alternatives under the 8 MGD discharge scenario (which was ~6% higher than the No Action alternative stage). Because of the relatively high stage and inundated area of the SCRE, California least tern foraging habitat area remained fairly static for all alternatives, varying very little between 125 and 129 acres. Conversely, tidewater goby and California least tern/Western snowy plover nesting habitat was essentially static for the zero through 5 MGD VWRF discharge alternatives then dropped considerably as stage increased going from a discharge of 5 to 8 MGD. The relatively high equilibrium SCRE stage and wetted area associated with the 8 MGD alternative is thought to result in unsuitable depths for tidewater goby spawning and rearing habitat as well as inundation of California least tern and western snowy plover nesting and open mudflat habitat along the south bank of the SCRE main lagoon (see Stillwater Sciences 2011 for more detail).

The assessment of the impacts of VWRF discharge volume on habitat area provided similar results to our Phase 1 VWRF discharge alternatives assessment. However, the results from the 2012 groundwater monitoring and the nutrient balance modeling suggest that in the absence of VWRF discharge, high groundwater nutrient concentrations may cause poor SCRE water quality. The implemented effluent treatment process improvements at the VWRF combined with the potential to gain further TIN reductions with wetland treatment would likely result in lower TIN levels from the VWRF discharge than groundwater from the northern floodplain. Therefore, under dry season, closed-mouth conditions when the VWRF discharge is the dominant inflow to the SCRE, the VWRF discharge may improve water quality conditions with respect to nutrient levels and may represent an improvement relative to an alternative with zero VWRF discharge to the SCRE

Combining the habitat parameter results in Table 4-3 with the nutrient balance modeling results in Table 4-2 suggests there is no one VWRF effluent recharge/reuse approach currently being considered that would maximize habitat conditions for both existing and future flows. Under existing VWRF effluent flow conditions (7.3 MGD from June through September), Alternative 5.1 (North decentralized plant) appears to provide the most SCRE habitat benefit of all the alternatives due to the relatively large habitat area for all focal species and the relatively low range of TIN concentrations. However, under future effluent flow conditions (11.2 MGD, Alternative 5.6), the VWRF discharge to the SCRE during the dry season is anticipated to increase from 4 to 8 MGD, which would result in less tidewater goby and bird nesting habitat as well as an increased potential for unseasonal breaching (which could negatively impact both tidewater goby and steelhead habitat). Therefore, based solely on SCRE habitat impacts considerations and our understanding of likely future water quality conditions within the SCRE, an effluent recharge/reuse alternative that results in a VWRF discharge to the SCRE of 4 to 5

MGD for both existing and future conditions appears to maximize habitat conditions from both a habitat area and water quality perspective. This VWRF discharge volume range would, however, cause the SCRE stage to rise above 9.5 ft NAVD88 during extended dry season, closed-mouth periods, thereby causing flooding at the McGrath State Beach campground (see Stillwater Sciences 2011 for more detail). However, based on stakeholder input, the City plans on conducting further groundwater studies and other data collection to confirm the Phase 2 data and water quality analysis.

Table 4-3. Average habitat parameter values for each VWRF effluent discharge alternative for the June through September model simulation period.

VWRF discharge alternative	VWRF Discharge to SCRE (MGD)	Avg. Water Depth (ft)	Wetted Area (acres)	Habitat Area (acres)			
				Steelhead	Tidewater Goby	CLT & WSP nesting[1]	CLT foraging
No Action	6.3	3.4	181	148	101	167	129
Alternatives 5.2, 5.3, 5.5, and 5.7	0	2.5	132	58	107	183	125
Alternatives 5.4, 5.8, and 5.10	2.0	2.7	139	78	110	183	127
Alternative 5.1	4.0	3.1	153	115	111	182	125
Alternative 5.9	5.0	3.3	166	132	110	177	128
Alternative 5.6	8.0	3.7	200	157	85	160	129

[1] CLT = California least tern; WSP = Western snowy plover

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APPENDIX E – MEETING MINUTES FROM FEBRUARY 21, 2013 STAKEHOLDER WORKSHOP

February 21, 2013 Santa Clara River Estuary Stakeholder Workshop

Location: City of Ventura
501 Poli Street
Ventura, CA 93001

PLEASE WRITE LEGIBLY

	NAME	AGENCY/COMPANY RESIDENT	MAILING/E-MAIL ADDRESS	TELEPHONE NUMBER
1.	DOUG MCPHERSON	USBR	dmcpherson@usbr.gov	951-695-5310
2.	NOAH HUME	Stillwater Sciences	noah@stillwatersci.com	510.848.8098
3.	Karin Patrick	Aquatic Bioassay	karin@aquabio.org	805-643-5621 x17
4.	Mary Vorissis	CH2M Hill	mary.Vorissis@ch2m.com	(805) 217 8494
5.	Terry Foreman	CH2M HILL	Terry.Foreman@CH2M.com	(805) 371-7822
6.	Jeff Savard	Kennedy/Jenks	jeffsavard@kennedyjenks.com	(805) 973-5700
7.	KEITH BAUERLE	CITY	kbauerle@cityofventura.net	
8.	Ellen James	CA Parks + Rec	ellen.james@parks.ca.gov	805-585-1853
9.	Alexis Frangis	CA State Parks	alexis.frangis@parks.ca.gov	(805) 585-1852
10.	Brian Smith	Ventura	smyt46@gmail.com	661.302.0592

February 21, 2013 Santa Clara River Estuary Stakeholder Workshop

Location: City of Ventura
501 Poli Street
Ventura, CA 93001

PLEASE WRITE LEGIBLY

	NAME	AGENCY/COMPANY RESIDENT	MAILING/E-MAIL ADDRESS	TELEPHONE NUMBER
1.	Florence Jay	Ventura Water	City of Ventura P.O. Box 99 Ventura CA 93001	805-677-4134
2.	DANIEL CORMODE	EVCC	186 GORRION AVE VENTURA, CA 93004	805-647-4063
3.	Dan Detmer	United WCD	dand@unitedwater.org	805-525-4431
4.	TIM FARRELL	CITIZEN	SWEEPTF@GMAIL.COM	
5.	Rick Conrad	SamLogic	rick@samlogic.us	609-7700
6.	Marylynn Coffee	Nossaman	mlcoffee@nossaman.com	949-922-8960
7.	Karen Waln	City	kwaln@ci.ventura.ca.us	677-4128
8.	Brooke Sheridan	State Parks	Brooke.Sheridan@parks.ca.gov	585-1858
9.	Nat Cox	State Parks	ncox@parks.ca.gov	
10.	Brittany Struck	NOAA Fisheries	brittany.struck@noaa.gov	562-432-3905

February 21, 2013 Santa Clara River Estuary Stakeholder Workshop

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PLEASE WRITE LEGIBLY

	NAME	AGENCY/COMPANY RESIDENT	MAILING/E-MAIL ADDRESS	TELEPHONE NUMBER
1.	Paul Jenkin	Surfrider	pjenkin@surfrider.org	805-205-4953
2.	Elizabeth Ericksen	RWQCB	eericksen@waterboards.ca.gov	213 576 6605
3.	M. Hasan	HASAN CONSULTANTS VTA	hasaneng@dslextreme.com	218-5574
4.	Ron Bottorff	FSCR	bottorffm@verizon.net	
5.	Brandi Outwin-Beals	RWQCB	boutwin@waterboards.ca.gov	213-576-6664.
6.	Antal Szijj	USACE	antal.j.szijj@usace.army.mil	805 585-2147
7.	Michael Lyons	LARWQCB	mlyons@waterboards.ca.gov	213-576-6718
8.	Kirsten James	Heal the Bay	kjames@healthebay.gov	
9.	Lily Verdone	TNC	lverdone@tnc.org	805-258-7202
10.	Mariel Attento	Carollo Eng.	mattento@carollo.com	805-630-8590

February 21, 2013 Santa Clara River Estuary Stakeholder Workshop

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501 Poli Street
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PLEASE WRITE LEGIBLY

	NAME	AGENCY/COMPANY RESIDENT	MAILING/E-MAIL ADDRESS	TELEPHONE NUMBER
1.	Catherine McCalvin	UWCD	cmccalvin@unitedwater.org	(805)317-8985
2.	Stephanie Snyder	Ventura County Star	stephanie.snyder@vcstar.com	805-437-0216
3.	Richard Sweet	myself	rsweet_46@hotmail.com	644-2802
4.	Susan Rungren	Ventura Water	srungren@ci.ventura.ca.us	652-4523
5.	Jenny Marek	USFWS	Jenny_Marek@fws.gov	644-1766 x.315
6.	Bob McCord	Resident	—	(805)653-6020
7.	Dale Zurawski	Farm Bureau VCAILG	Dale@FarmBureauVC.com	289-0155
8.				
9.				
10.				

APPENDIX F – PRELIMINARY ENVIRONMENTAL ANALYSIS

Stillwater Sciences
850 G Street, Suite K, Arcata, CA 95521
phone 707.822.9607 fax 707.822.9608

TECHNICAL MEMORANDUM

DATE: Tuesday, December 31, 2013

TO: Elisa Garvey and Lydia Holmes, Carollo Engineers

FROM: Mike Wilson and Noah Hume

SUBJECT: Preliminary Environmental Review for the Ventura Water Reuse Project

1 OVERVIEW

To supplement the *Estuary Special Studies Phase 2: Facilities Planning Study or Expanding Recycled Water Delivery* ("Facilities Planning Study"), this technical memorandum provides a preliminary environmental review of the potential environmental effects of the recommended project ("Project") includes effects of the indirect potable reuse (IPR) or direct potable reuse (DPR) alternatives. Both alternatives also include creation of constructed wetlands within City owned lands. This review is based on the requirements of Section 7(a)(i) through 7(a)(iv) and 7(a)(vii) of the Reclamation Manual WTR 11-01 (USBR 2007) with the intent to include sufficient information for each alternative to assess the potential measureable effects and costs that may be necessary to comply with NEPA, and other applicable Federal Law. This analysis can also be used to summarize potentially significant environmental impacts and to identify design and planning opportunities to minimize those impacts to less than significant, to reduce the need for mitigation and to identify the nexus with public agencies and organizations so as to reduce potential conflict and uncertainty of costs and timeline as the project progresses.

In order to maintain some consistency with known or anticipated permitting processes and to provide a broad environmental review, typical resources areas for a general "CEQA checklist" were used as the basis for analysis including the following sections:

- Aesthetics
- Agricultural Resources
- Air Quality
- Biological Resources
- Cultural Resources
- Geology and Soils
- Greenhouse Gases
- Hazards & Hazardous Materials
- Hydrology & Water Quality
- Land Use Planning
- Mineral Resources

- Noise
- Recreation &Public Services
- Transportation/Traffic
- Utilities/Service Systems
- Housing

In order to more efficiently present the information only those review elements determined to have direct relevance to the project are discussed in this document. Mineral Resources and Population/Housing elements were pre-screened from the analysis as having no direct nexus with the project alternatives.

1.1 Jurisdiction (CEQA Lead Agency)

This project is being led by the City of Ventura ("City" or "City of Ventura") and for the most part is within their city limits. In terms of CEQA this will identify them as the "lead agency". Although, this analysis mostly focuses on City of Ventura's plans and ordinances, portions of project facilities and actions (discussed below) occur within the County of Ventura and the City of Oxnard. This will make them "responsible agencies". As responsible agencies, this will allow their review comment to ensure it matches their local plans and ordinances. Additionally, any action that they need take regarding this project in their jurisdiction will also be covered by a single CEQA process and document.

1.2 Ventura County and the City of Oxnard

The only part of the project proposed in areas outside the City of Ventura is the brine conveyance pipeline to the Salinity Management Pipeline (SMP). The proposed brine line is within the jurisdiction of Ventura County and the City of Oxnard. It is assumed that the pipeline would follow existing road alignments adjacent and through mostly agricultural lands. A review of a similar project in Ventura County indicates that temporal impacts to agricultural resources and precautions to protect archeological resources are the primary concern for the pipeline infrastructure (e.g., VCWPD 2010).

1.3 Coastal Commission

Portions of the project including the existing "wildlife ponds", the City owned property and estuary located within the Coastal Zone boundary (California Coastal Commission Map. 1982). While the City of Ventura, City of Oxnard and the County of Ventura all have approved Local Coastal Plans allowing them to issue Costal Development Permits (CDP), some areas within the project boundary appeals of CDP to the Commission are allowed. And there is some area that will require a LCP directly from the Coastal Commission.

The City owned property (proposed treatment wetland area) is within the City of Ventura's Local Coastal Plan jurisdiction. However, the wildlife ponds, proposed discharge location and the SCRE are within the direct jurisdiction of the Commission. This requires the Commission and staff to review the project for consistency with the Coastal Act. The Commission will likely focus on polices regarding environmental and recreational (access) resources including potential impacts to environmentally sensitive habitat areas (ESHAs).

1.4 General Construction Activities

In order to streamline this preliminary review, general construction impacts such as air quality, Agricultural Resources, Noise, as well as disruption to Traffic, Public Services as well as Utilities are all considered temporal in nature and not in need of further analysis. These issues are most often addressed by implementing local standards, regulations, existing policies and procedures of the responsible Community Development and Public Works Departments. Potential impacts to Air Quality and Water Quality are similarly temporal in nature. However, they require additional coordination with regulatory resource agencies and so are discussed in more detail in Section 2.3 (Air Quality) and Section 2.8 (Hydrology/Water Quality) below. Lastly, the potential for impacts to Cultural Resources due to construction could be significant if not addressed properly and is also discussed further in Section 2.5 below.

Project alternatives assessed in the following sections include the No Project Alternative, the IPR and DPR alternatives.

1.5 Summary of Findings

In summary, in terms of NEPA and CEQA, it appears from this preliminary review that the project will have some mitigable impacts. No unmitigable impacts were identified.

Some issues or areas where more investigation will likely be necessary are:

- Additional study of the effects of injection on groundwater quality and drinking water quality.
- Additional study of the effects of DPR on drinking water quality.
- Review of archeological resources within the entire project area.
- Additional biological resource investigations including queries of special-status species' databases (e.g., CNDDB, CNPS, USFWS Species List generator).
- Review of known hazardous materials sites including leaky underground storage tanks (LUSTs).
- Additional review of potential floodplain impacts.

Much of this analysis can be addressed during the development of a more detailed project description and/or at the time the formal permitting process is initiated.

2 INDIRECT POTABLE REUSE ALTERNATIVE

The IPR Alternative is comprised of the following components. They are:

- Construction of 29 acres of new treatment wetlands on City-owned property.
- Modifications to the existing 14.5 acres of treatment/wildlife ponds to wetlands.
- Modifications to flow rate (6.3 to 4-5 MGD) and water quality of effluent to the estuary.
- Advanced treatment facilities (including microfiltration [MF], reverse osmosis [RO], an advanced oxidation process [AOP]) within an approximately 40,000 ft^2 footprint).
- Construction of approximately 5.6 miles of pipeline for treated water (from the Ventura Water Reclamation Facility [VWRF] to the injection site) and 10 miles of pipeline for taking brine from Ventura, through the county, to the SMP.

- Construction of three groundwater injection wells.

More detailed descriptions of the IPR alternative may be found elsewhere in Chapter 8 of the Facilities Planning Study.

2.1 Aesthetics

The Project components that could have measurable impacts to aesthetics resources are:

- Construction of new treatment wetlands on City owned property.
- Modifications to flow rate and water quality of effluent to the estuary.
- Advanced treatment facilities.
- Construction of groundwater injection wells.
- Installation of lighting associated with new infrastructure.

2.1.1 New Treatment Wetlands

The most significant change in aesthetics would be from the development of approximately 43 acres of treatment wetlands and associated infrastructure. Currently the area is mostly comprised of highly disturbed woodland coyote brush (Stillwater Sciences 2011) to be replaced by three treatment wetlands about nine acres each in size surrounded by managed landscaping. Treatment wetlands will be planted with emergent plant species and it is anticipated that berms will be designed using a mix of native tree and shrub species (Carollo Engineers 2010). Due to the highly disturbed nature of the site there are no known or anticipated significant structural or botanical (trees) features.

The area is well known for having a large transient population associated with large amounts of debris as well as vegetation and ground disturbance. It is believed that conversion of this area to the proposed wetland would be considered an aesthetic enhancement by much of the community. The new facility could be integrated into the existing City of Ventura Parks Master Plan with public access elements including trails, interpretation and wildlife viewing areas further enhancing the aesthetic qualities of the site.

2.1.2 Injection Wells

With a construction footprint as large as 2,500 ft^2, including associated parking and infrastructure, the installation of the proposed injection wells may have a visual impact on adjacent agricultural and/or recreational areas. Accounting for this in location, orientation and design of this infrastructure should help to lessen this potential impact.

2.1.3 Advanced Treatment Facilities

The building housing the advanced treatment processes would require approximately 40,000 ft^2 and would be located at least 200 feet from Harbor Boulevard within the VWRF property. Any development of the site would be required to conform to the Zoning Regulations and Conditions of Approval, which would include setbacks, lots coverage, and parking lot lighting standards to ensure that new structures would not impact adjacent uses. As such, the Project would unlikely cause visual impacts, unusual light generation as well as sunlight obstruction.

2.2 Agriculture Resources

The Project components could have measurable impacts to agricultural resources are:

- Construction of groundwater injection wells in agricultural areas.
- Construction of pipeline infrastructure adjacent to or within agricultural areas.

An array or series of injection wells are proposed to be installed. Depending on final design considerations, much of the proposed Project pipelines and injection wells would be built adjacent to and/or within agricultural lands. Due to the phased nature of this potential Project the location of injection wells are not accurately known. Most agricultural areas in the City of Ventura are protected by a Save Our Agricultural Resources (SOAR) initiative approved by the voters in 1995 (City of Buenaventura 2005a). The scale of this infrastructure and its operation will need to be designed so that potential impacts to agricultural uses are not significantly adverse. The installation of transmission pipelines will likely all be subsurface at standard depths and would not pose any long term impact to agricultural uses.

2.3 Air Quality

The Project site is located within the Ventura County Air Basin and is under the jurisdiction of two air quality management agencies. The California Air Resources Board (CARB) is responsible for the control of the Project site's mobile emission sources, and the Ventura County Air Pollution Control District (VCAPCD) has oversight on the regulation of stationary sources.

For purposes of identifying established air quality impact thresholds, the VCAPCD and the City consider operational air quality impacts to be significant if more than 25 pounds per day of Reactive Organic Compounds (ROC) or Nitrogen Oxides (NOx) would result from Project implementation.

There is no anticipated change in air quality or odors from the addition of the proposed treatment processes. Further, routine operations and maintenance activities are not expected to significantly increase traffic or emissions of air quality pollutants.

2.4 Biological Resources

The project components mostly likely to have measurable effects on biological resources are:

- Conversion of the existing wildlife ponds at the VWRF to treatment wetlands.
- Construction of new treatment wetlands on City-owned property.
- Modifications to flow rate and water quality of effluent to the Santa Clara River Estuary.

Detailed descriptions of existing biological conditions can be found in the City of Ventura Treatment Wetlands Feasibility Study (Carollo Engineers 2010) and the SCRE Subwatershed Study (Stillwater Sciences 2011).

2.4.1 Existing Wildlife Ponds

The project proposes to modify three existing open water wildlife ponds (approximately 17 acres) to treatment wetlands in order to improve their water quality treatment efficacy. The ponds will be converted from open water habitats to emergent marsh with some remaining open water areas at the inlets and outlets. This will result in the conversion of about 12.4 acres of open water pond to emergent wetland plant species, likely dominated by bulrush (*Schoenoplectus* spp.) and/or cattails (*Typha* spp.).

No focused special-status plant or animal surveys have been conducted for this Project in the wildlife pond area. Additional analyses, particularly on special-status plants and wildlife, will need to be completed as part of a comprehensive CEQA process.

2.4.1.1 Vegetation

Emergent freshwater marsh dominates the perimeter of the two wildlife ponds proposed for conversion to treatment ponds. This vegetation community is dominated by two vegetation types, stinging nettle (*Urtica dioica*) and western ragweed (*Ambrosia psilostachya*) (Carollo Engineers 2010). These vegetation communities could be enhanced to create more beneficial and diverse native habitat. Two important vegetation communities are the *Typha domingensis* (southern cattail) Alliance and the *Schoenoplectus californicus* (California bulrush) Alliance (Sawyer et al. 2009), both of which occur in large areas within the Santa Clara River Estuary.

Outside the emergent freshwater marsh fringe, the wildlife ponds are surrounded by dense riparian forest cover, dominated by willow (*Salix lasiolepis*). Myoporum (*Myoporum laetum*), a moderately invasive riparian species in southern coastal California, is commonly present in the shrub layer. Enhancing native vegetation and habitat in the area of the wetlands could be an important design element.

2.4.1.2 Birds

Increasing and enhancing the emergent vegetation may support a greater abundance and wider variety of birds as a result of increased nesting, roosting, foraging, and cover opportunities. Increased extent of the freshwater marsh would provide increased nesting opportunities for both species that may construct nests directly suspended in tules or cattails (e.g., marsh wren [*Cistothorus palustris*], red-winged blackbird [*Agelaius phoeniceus*], common yellowthroat [*Geothlypis trichas*]) as well as species that construct nests on matted vegetation or mud while concealed behind emergent vegetation (e.g., ducks, rails, or grebes). Foraging opportunities may be improved with a subsequent increase in prey species, and more emergent vegetation will provide new areas for cover and protection from predators. Conversely, a reduction in open water habitats may negatively affect common bird species (including dabbling ducks, diving ducks, gull, herons, and grebes) that rely on these habitats for foraging and loafing. Some species may move from the wildlife ponds to open waters of the estuary and/or open water areas within the newly created treatment wetlands, lessening these impacts.

Special-status bird species that have not been documented at VWRF but have the potential to occur within suitable habitats include southwestern willow flycatcher (*Empidonax traillii extimus*) and Least Bell's vireo (*Vireo bellii pusillus*) (both federally and state-endangered species), yellow warbler (*Dendroica petechia brewsteri*), yellow-breasted chat (*Icteria virens*), and tricolored blackbird (*Agelaius tricolor*) (all state species of special concern).

2.4.1.3 Other special-status wildlife

Special-status reptile species that may reside in the area of the wildlife ponds include western pond turtle (*Actinemys marmorata*), south coast garter snake (*Thamnophis sirtalis* ssp.) and two-striped garter snake (*Thamnophis hammondii*); all state species of special concern. Western pond turtles require open water habitat for basking, and a reduction in such areas may negatively affect this species. Western red bat (*Lasiurus blossevillii*), a state species of special concern, may roost in riparian habitats present around the Wildlife ponds.

2.4.2 Constructed Treatment Wetlands

The proposed Project would clear and regrade most of a 34-acre City-owned parcel to construct 29 acres of treatment wetlands and associated infrastructure. This area currently shows signs of being heavily graded in the past, and is significantly disturbed due to extensive unregulated and unmanaged public use, primarily related to numerous homeless encampments.

2.4.2.1 Vegetation

Currently the vegetation on the City-owned property proposed to be converted to treatment wetlands is highly disturbed upland coastal scrub (including coyote brush [*Baccharis pilularis*]) and ruderal herbaceous vegetation, with a large strip of mixed forest (including willow [*Salix* spp.], cottonwood [*Populus* spp.], and myoporum) and a riparian berm. The mixed forest is associated with a drainage area on the northeast side of the City-owned site, near the Olivas Links golf course. The southern boundary of the City-owned site includes the riparian berm along the Santa Clara River.

This entire 34-acre area will be replaced by 29 acres of emergent wetlands composed of mostly bulrush, cattail, and native pondweed (e.g., *Potamogeton* spp.), with some associated open water. Non-wetted areas will be landscaped with native species as required by the design process.

2.4.2.2 Birds

Creation of the proposed treatment wetlands would increase nesting, roosting, foraging, and cover opportunities for wetland bird species. Incorporating existing riparian areas into the design of the treatment wetlands will help provide a variety of habitats to encourage an increase in diversity and abundance of bird species.

2.4.2.3 Other special-status wildlife

Creation of the proposed treatment wetlands on this previously disturbed City-owned site may create aquatic habitat for special-status species such as western pond turtle, two-striped garter snake, and south coast garter snake; and may increase foraging opportunities for western red bat.

2.4.3 Santa Clara River Estuary

The proposed project will decrease the volume of treated VRWF effluent entering the SCRE from 6.3 to approximately 4–5 million gallons per day (MGD). It will also increase the water quality of the effluent, represented by a decrease in nitrate from 8 mg-N/L to 4 mg-N/L. Additional detail on the effect of a reduced discharge and reduced nitrate concentrations are included in Chapter 7 of the Facilities Planning Study.

Direct physical changes to the SCRE are estimated to include:

- A decrease in the elevation of the estuary from 8 to 10 ft NAVD88 in summertime during low flow.
- An 11% reduction in the area of the estuary during low flows.
- A reduction in nutrient loading of the estuary waters.

- An increase in salinity due to the reduction in freshwater flow from the VWRF.

Indirect physical changes to the SCRE are estimated to include:

- Reduction in the occurrence and duration of algal blooms due to a decrease in nutrients from the effluent and increase in salinity.
- Reduction in the occurrence of unseasonable anthropogenic breaches of the sand bar due to actions taken to increase coastal by members of the Public.
- Establishment of upland plants into formerly inundated estuarine areas.
- Changes in habitat conditions for special status fish (Tidewater goby and Southern California steelhead) and bird (western snowy plover and California least tern) species.

2.4.3.1 Vegetation

As open water recedes within the estuary due to reduced flow rates, new upland dune and marsh areas would be created. Native and nonnative plant species would soon colonize these areas. The dominance and distribution of native plant species could be enhanced with appropriate vegetation management.

2.4.3.2 Tidewater Goby and Steelhead

While over a dozen fish species are known or suspected to occur in the SCRE, special-status Tidewater goby (*Eucyclogobius newberryi*) and Southern California steelhead (*Oncorhynchus mykiss*) were selected to represent aquatic focal species during development of the Estuary Subwatershed Study (Stillwater Sciences 2011). Tidewater goby is the most common and wide-ranging fish in the estuary.

It is suspected that tidewater goby would be relatively insensitive to the reduction in size and depth of the SCRE as a result of the proposed project (Stillwater Sciences 2011). However, tidewater goby is very sensitive to more extreme water elevation changes that can occur due to unseasonable breaches, that can lead to dewatering of burrows and large areas where fish become stranded. Therefore, a reduction in the frequency of breaching events will benefit this species. It is also anticipated that the increase in salinity and reduced area for non-native predator species will benefit tidewater goby.

The reduction in size and depth of the SCRE may reduce the amount of steelhead rearing habitat, potentially impacting the species. Nevertheless, steelhead survival is predicted to improve due to the reduction in stranding events due to reduced unseasonal breaches and improved water quality.

While it is presumed that the proposed change in effluent volume and quality will have an overall benefit for fish species, additional analysis would be required to complete a comprehensive CEQA assessment.

2.4.3.3 Birds

The two avian focal species chosen for the Estuary Subwatershed Study (Stillwater Sciences 2011) were western snowy plover (*Charadrius alexandrinus nivosus*) and California least tern (*Sternula antillarum browni*). For nesting, both species require barren or sparsely-vegetated sand or gravel beaches above the high tide line. New upland dune areas created as open water recedes due to reduced flow rates may provide increased nesting opportunities for these two bird species.

Conversely, there may be a reduction in the amount of open water habitat for foraging for least tern as well as common bird species using the estuary, especially waterfowl and shorebirds.

2.5 Cultural Resources

The project components that will likely require review for archeological resources are areas where there will be sub-surface construction activities such as the:

- treatment wetlands and associated infrastructure on City-owned property.
- water and brine convenience pipelines.
- injection wells.

There are many known archeological and cultural resources in the region identified on City's General Plan data base (City of San Buenaventura 2010) that is adjacent to the current Project area(s). The only historic site adjacent to any of the proposed project elements is Olivas Adobe (www.cityofventura.net/olivasadobe).

All components of the Project would be required to be reviewed against available cultural resources map. Maps relating to Native American resources are considered confidential and coordination of review of these maps must be made through qualified City and County planning staff. If it is identified that there are Sensitive Native American Resources in the area then mitigation will be required such as:

- archeological review and monitoring using a qualified professional archeologist,
- work suspension in the event archaeological resources are discovered,
- and the establishment of human remains discovery procedures according to State Health and Safety Code 7050.5.

Project areas not identified by City or County staff as being on or adjacent to significant cultural resources impacts will likely be addressed through existing policies and procedures of the Community Development and Public Works (City of San Buenaventura 2010). Policies and procedures are summarized on the City's website (www.cityofventura.net/files/file/comm-develop/Historic%20Preservation/HRA%20Process.pdf).

Several City of Ventura projects were reviewed that involved foundations and subsurface utilities installation similar in scope to this project. For those projects, MND's were required solely for potential impacts to cultural (archeological) resources which were considered mitigable potentially significant impacts. Mitigation was achieved by using standard archeological methods described above.

2.6 Hazards and Hazardous Materials

The project components that will likely be the routine handling of small amounts of hazardous chemical agents associated with the maintenance of treatment processes and the potential to encounter contaminated soils during construction excavation activities. The proposed project would be required to comply with the City's Hazardous Material regulations regarding storing, using, and discarding chemical products typically used during the operation of the proposed wastewater treatment technologies. Each component of the project area will need to be reviewed to see if it is on a local list of hazardous materials sites including known contaminated or leaky underground storage tank (LUST) locations as part of a more rigorous environmental review process. Lastly, vector control associated with development of new constructed wetlands will also need to be addressed.

A review of proximity to community assets and concerns shows no public schools, hazardous materials site, airport, or wildlands. The proposed development will be required to be reviewed by emergency personnel to ensure it would not interfere with any emergency response plans.

2.6.1 Vector Control

Often projects that seek to modify or create open water features, mosquito control can be a concern. This can be addressed in the design and management of these systems. Some solutions include incorporation of open water areas within each wetland that should be designed and maintained to be large enough to support swooping insect eaters such as swallows and bats and, if not already stocked, these ponds should have populations of both of Mosquitofish (*Gambusia* spp.) species as well as Three-spined stickleback (*Gasterosteus aculeatus*) for vector control.

2.7 Geology/Soils

The project components could have measurable impacts due to geology and soils are:

- Advanced treatment facilities at the VWRF
- Construction of new treatment wetlands on City-owned property.

The 2005 General Plain FEIR (City of Buenaventura 2005b) shows that the VWRF and the adjacent City property are not situated within the Ventura-Foothill Alquist-Priolo Zone. The primary seismic features near the area are the Ventura-Foothill fault, the Oak Ridge fault, the McGrath fault, and the Country Club fault. The nearest known fault, the McGrath Ridge fault, is located approximately 0.3 miles south of the site. These local faults are classified as active or potentially active and impacts in these areas are considered potentially significant are within a Liquefaction Hazard Zone but not within an area of defined or questionable landslide morphology, such as slopes. The design of buildings and bermed pond/wetland areas often require special attention to potential seismic loading. Implementation of the General Plan (City of Buenaventura 2005a) policies of compliance with California Building Code requirements, as well as the Alquist-Priolo legislation would reduce the risk associated with groundshaking and surface rupture to less than significant.

The native topsoil and alluvial soils in the project area may be moderately susceptible to erosion. These materials will be particularly prone to erosion during construction or earth moving activities, especially during heavy rains. Fill soils generated during grading and any development may also be subjected to erosion. The proposed project is required to comply with the City's requirements to comply with the MS-4 Stormwater Permit to control the quantity and quality of runoff. Implementation of these erosion control measures in accordance with the California Building Code, City, and County requirements would reduce potential impacts to less than significant.

2.8 Hydrology/Water Quality

The project components could have measurable impacts to hydrology and/or water quality are:

- Modifications to flow rate (6.5 to approximately 4–5 MGD) and water quality of effluent to the estuary.

- Development of new treatment wetlands on City-owned property.
- Operation of groundwater injection wells.

2.8.1 Receiving Water Quality in the Santa Clara River Estuary

As discussed previously the project proposes additional wetland treatment and reduction of flows to from the VWRF to the SCRE. As issued by the Los Angeles Regional Water Quality Control Board, the City holds a National Pollutant Discharge Elimination System (NPDES) permit No. CA0053651 for the VWRF that includes receiving water limitations based on water quality objectives (WQOs) contained in the Basin Plan (LARWQCB 1995). Table 1 summarizes the anticipated qualitative effects of the treatment wetlands on receiving water quality in the SCRE. For many of these constituents, the addition of a treatment wetlands located between the Effluent Transfer Station and the discharge to the SCRE, are anticipated to improve the quality of the water that discharges to the SCRE. The Phase I Wetlands Treatment Feasibility Report (Carollo Engineers 2010) included a literature review of wetland performance. This literature review suggested that treatment wetlands have been shown to effectively reduce levels of a wide range pollutant including nutrients, TSS, metals, organics, and bacterial pathogens.

Table 1. Anticipated Water Quality Effects of Proposed Treatment Wetlands

Constituent	Water quality effect of treatment wetlands
Temperature	It is anticipated that while there will be a longer residence time for the flow through the treatment wetlands as compared to the existing wildlife ponds, the wetlands will be densely vegetated, and will provide shading. Significant increases in water temperature are not expected.
pH	Removal of nitrate and other nutrients may be expected to reduce the occurrence and duration of algal blooms in the SCRE, which will reduce the occurrence of pH exceedances associated with algal photosynthetic activity.
Dissolved Oxygen	The Phase 2 Estuary Studies suggested that the reduction in VWRF effluent nitrate (thought treatment wetlands) may improve water quality conditions in the SCRE with respect the frequency of algal blooms. The presence of algae in the SCRE contributes to the Chl-a concentrations and extreme DO conditions.
Bacteria	While wetlands can reduce bacterial concentrations, it is also possible that during periods of more intensive use by birds, fecal coliform concentrations may increase. This is a potential adverse impact on water quality.
Turbidity	Although the VWRF is not associated with the direct discharge of turbidity, removal of nitrate and other nutrients may be expected to reduce the occurrence and duration of algal blooms in the SCRE, which will reduce turbidity levels associated with algal blooms.
Toxicity (Acute and Chronic)	No anticipated change
Biological Oxygen Demand	No anticipated change
Biostimulatory Substances (Nitrate, Ammonia, Total Kjeldahl Nitrogen [TKN])	Removal of nitrate was identified as the being the greatest opportunity for water quality improvement. Preliminary sizing and future design of the treatment wetlands will target nitrate removal to 4 mg-N/L. The VWRF effluent is low in ammonia due to nitrification at the treatment plant. Significant changes in ammonia concentrations are not anticipated. TKN is the sum of organic nitrogen and ammonia. Organic nitrogen may be reduced in a wetland through the processes of ammonification followed by nitrification and denitrification.
Biostimulatory Substances	Particulate phosphorus concentrations may decrease through the process

(Phosphorus)	of sedimentation.
Vectors	No anticipated change due to water quality. However treatment wetland will have to be managed to reduce the potential for breeding of mosquitos and other insects.
Visual Aesthetics	Aesthetics are expected to be improved with increased bird use of the treatment wetlands. Removal of nitrate and other nutrients may be expected to reduce the occurrence and duration of algal blooms in the SCRE, which will improve aesthetic experiences.
Pesticides	No known occurrence or anticipated change

In most cases, water quality improvements or no change in constituent concentrations is anticipated. The exception is the potential for the treatment wetlands to lead to an increase in fecal and total coliform concentrations as a result of bird use of the treatment wetland habitats. Changes in coliform concentrations (reductions or increases) would need to be assessed based on site-specific monitoring data. If the treatment wetlands presented a risk to compliance with receiving water bacteriological limitations, then the City would need to investigate alternatives to mitigate the adverse effects on bacteriological water quality resulting from the treatment wetlands.

2.8.2 Mound Basin Water Quality

Reclaimed water from the VWRF would be used to recharge the Mound (groundwater) Basin for the purpose of augmenting the potable groundwater supply. IPR performance and technology requirements for treatment would be governed by the California Department of Public Health's (CDPH) Draft Groundwater Reuse Regulations. For subsurface injection, full advanced treatment (FAT) is required consisting of reverse osmosis (RO) and advanced oxidation process (AOP).

The IPR alternative will include proven advanced treatment technologies, including MF, RO, and AOP. The treatment efficacy of these processes is well known, however, there is ongoing work to finalize the CDPH Groundwater Reuse Regulations. Although the current NPDES permit does not contain specific groundwater limitations beyond existing WQOs, future groundwater protections may be applied[1]. Any changes in the LARWQCB and CDPH regulations prior to implementing the project or getting permits would need to be addressed in developing the project facilities. .

2.8.3 Flooding and Floodplain Areas

The City of Ventura's online "City Map" FEMA FIRM map layer delineates some of the City owned property where the proposed new constructed treatment wetlands could have some of its peripheral areas located are within the 100 (and 500) year floodplain of the Santa Clara River. This will be a design consideration both for the protection of the proposed infrastructure and/or its potential impacts to floodplain performance. All buildings and other structures located in the floodplain will need to be protected against potential flood elevations and the wetlands will need to be designed in a way as to not affect the floodway capacity by more than a one foot increase in the predicted 100 year flood stage elevation. A Floodplain Development Permit would be required from the City's Planning Department.

[1] LARWQCB Order No. R4-2013-0174 requires a study to characterize the hydrologic connection between the effluent, the Estuary and the groundwater and to identify any existing municipal beneficial uses of the perched and unconfined aquifers of the Oxnard Groundwater Basin in the vicinity of the Estuary. The information will be used by the LARWQCB to determine if additional groundwater protection is necessary.

Maps of potential Dam Inundation Areas in the General Plan (City of Buenaventura 2005a) show both new and existing pond areas are all or partially within the inundation areas due to potential failure of the Bouquet, Castaic, Pyramid and Matilija Dams in the upper Santa Clara River watershed.

2.9 Construction

Project construction and grading activities associated with future development would involve on-site operation of heavy equipment and excavation. The potential for soil erosion is considered to be low, but peak storm water runoff could result in short-term sheet erosion within areas of exposed or stockpiled soils. Furthermore, on-site compaction of soils by heavy equipment may reduce infiltration capacity of soils and increase runoff and erosion potential. If uncontrolled, these soil materials could result in engineering problems including the blockage of storm drains and downstream sediment. Generally speaking, construction-related impacts to pre and post-construction water quality impacts would be addressed through the project's required MS-4 stormwater general construction permit. The project would be consistent with the policies of the General Plan (City of Buenaventura 2005a) and would comply with the applicable regulations located within the Stormwater Quality Management section of the Municipal Code.

2.10 Land Use Planning

The project components may conflict with current land use designations and/or require some land use changes are:

- Construction of new treatment wetlands on City-owned property
- Construction of three groundwater injection wells.

2.10.1 Wildlife Ponds

The existing wildlife ponds are currently zoned Parks (P(SH)). SH is a special overlay “Sensitive Habitat” designation. Depending on design, recreational and educational opportunities could improve with conversion to treatment wetlands. It is not anticipated that this change will impact, or be in conflict with, the current land use designation of the wildlife ponds.

2.10.2 Treatment Wetlands

The area where the new treatment wetlands are proposed is currently zoned Parks (P). It does not appear that the development of treatment wetlands (if treatment is the designated use) is a principally permitted use for that area. Although the property zone designation is “Parks” the area is currently not managed as a part of the City’s park system nor is the current occupation by homeless encampments considered a conforming use. As discussed in the following “Recreation” section of this analysis a new treatment wetland can be designed to include strong recreational and educational elements creating a park like setting and use.

In addition, there is also a small strip of land along the levee adjacent to the SCRE that is identified as a “linear park” in the General Plan Parks map (City of Buenaventura 2005a). However, it is not named and there is no written plan for its incorporation into existing or future park planning. Lastly, it should be noted that some of the VWRF is currently zoned Parks and that there is no Public Facilities (or Municipal) zone designation on the City’s zoning map.

Determination as to the final design's conformity to current land use policy or the need to modify existing code must be made by City staff through the appropriate planning and political process.

2.10.3 Injection Wells

Currently proposed injection wells would be located either on Agricultural Exclusive (AE) or Parks (P) zoned parcels. Determination as to the land use consistency of the proposed injection wells will need to be made depending on location. Scale and design of the infrastructure will influence the determination of potential impact to the designated use of the specific parcel.

2.11 Noise

The primary vibration and noise source generally associated with the development of buildings results from the use of equipment utilized during construction of foundations, a short term noise impact. Once completed, the proposed project is not anticipated to generate excessive ground borne vibration or noise.

2.12 Recreation

The project components mostly likely to have measurable impacts to recreational resources are:

- Modifications to flow rate and water quality of effluent to the estuary.
- Construction of injection wells (if located at the Community Park).
- Modifications to the existing treatment/wildlife ponds
- Construction of new treatment wetlands on City-owned property

2.12.1 Within the Estuary

Reducing flows and increasing treatment of effluent flowing into the estuary is anticipated to enhance recreational values in two significant ways. First, reducing flows will lower the stage in the SCRE which should reduce or eliminate the open water area that often lies between the state park and the beach providing more reliable access. Also, the additional removal of nutrients in the VWRF effluent entering the estuary is expected to reduce the occurrence of algal blooms. This is anticipated to improve aesthetic experiences for recreational beneficial uses (REC-1 and REC-2) and to make the estuary more desirable for potential recreation users.

There appear to be a few locations within the SCRE and adjacent floodplain areas where the Project could have impacts on or a nexus with existing and/or planned recreational resources.

The Nature Conservancy (TNC) and Coastal Conservancy own a number of parcels just upstream of the site along the Santa Clara River and are planning on implementing environmental restoration and recreational enhancements on those properties as part of the Santa Clara River Parkway project (Stillwater Sciences 2007). The Parkway project was established to achieve three goals:

1. conserve and restore aquatic and riparian habitat for native species, and the hydrologic and geomorphic processes that create and maintain those habitats;
2. provide enhanced flood protection for adjacent private land and public facilities;
3. provide public access and environmental education, including the creation of a continuous public trail system along the length of the Parkway.

The levee structure associated with the City owned property along the Santa Clara River and could be used link the proposed Project to upstream TNC properties. This could help meet the contiguous public trail goal of the Parkway project as well as fit in with long term linear park facilities planning for the City.

The proposed groundwater injection infrastructure, if located in the Ventura Community Park, could have a potential impact on the associated trails and other facilities. Siting and design would likely reduce any impact to less than significant.

2.13 Public Services

The Construction of new treatment wetlands would convert a large portion of the City owned property from open scrub woodland to a managed wetland landscape. This should not create a need for additional public services for the property.

2.14 Transportation/Traffic

The only Project components that could have measurable long term impacts to traffic patterns is the development of new treatment wetlands on City-owned property. The proposed development of new treatment wetlands will need to ensure means of ingress and egress, adequate road and driveway widths that do not interfere with an emergency response access.

2.15 Utilities/Services Systems

The Project components mostly likely to have measurable impacts to utilities and services are:

- Construction of new treatment wetlands on City-owned property.
- Groundwater injection of additionally treated water in to the Mound Aquifer.
- Delivery of brine effluent from the VWRF to the City of Oxnard for ocean disposal.

The development of the new treatment wetlands will likely generate a significant amount of fill material, vegetative material and other debris. In 1991, in order to help address capacity issues in regional landfills and under the mandate of the California Integrated Waste Management Act, the City of Ventura adopted a Source Reduction & Recycling Element (SRRE). New development projects in the City are required to implement site specific source reduction, recycling, and re-use programs to comply with AB 939. This includes construction waste.

The Project proposes to add approximately 3.6 MGD of highly treated water into the Mound Aquifer with the intention that it will be reused down-gradient of the injection site. As discussed previously, the benefits of IPR include augmenting the amount of recharge to the Mound Basin and potentially improving the water quality, resulting in additional capacity for the City of Ventura's water supply.

As described previously in this document the brine from the RO process is proposed to be conveyed to the SMP. As discussed, the silica concentration in the VWRF effluent may present operational problems with the RO process. It is not anticipated that the silica in the brine would present problems for discharge to the ocean via the SMP.

2.16 Greenhouse Gases

It is now common for permitting agencies to include greenhouse gas production in their environmental analysis of a project and may be required for the proposed Project. Determining how a project might contribute and the overall effect of the individual project to Global Climate Change remains an ongoing debate. Currently there are no approved thresholds or methodologies currently available for determining the significance of a project's potential contribution to global climate change in CEQA documents. An individual project, other than a massive regional construction project associated with energy production or transportation system, does not generate sufficient GHG emissions to directly influence global climate change. The issue here related to Global Climate Change analysis is whether the project contribution towards a cumulative impact is cumulatively considerable.

To determine the significance of GHG emissions from the Project, the California Air Pollution Control Officers Association (CAPCOA) white paper entitled *CEQA & Climate Change* (CAPCOA 2008) was used as a guideline document. This document suggests that projects on a “green list” could be considered less than significant with respect to GHG emissions. Green list projects are those that are deemed a positive contribution to California efforts (e.g., Assembly Bill [AB] 32, Senate Bill [SB] 375) to reduce GHG emissions. Additional analysis will need to be done as required by the lead agency.

3 DIRECT POTABLE REUSE ALTERNATIVE

The main difference between the IPR and DPR Alternatives is a change in the Project description to eliminate injection wells and to add three 2 million gallon water storage tanks. Only changes to the environmental review above are discussed below.

3.1 Aesthetics

The three 2-million gallon storage tanks will be constructed at the VWRF west of Harbor Boulevard. Harbor Boulevard is not a designated scenic roadway. However, this area is the “gateway” to the Ventura community from the south. Even though this is in an industrial setting some visual screening may be desired or required.

3.2 Cultural/Agricultural Resources

Large liquid storage tanks can have significant foundation substructures. The proposed tanks would be in an area already disturbed and previously developed. Precautions and mitigations to protect cultural and archeological resources would be the same as discussed above.

3.3 Geology/Soils

The 2005 General Plain FEIR (City of Buenaventura 2005b) shows the VWRF as being within near potentially active faults as well as within a Liquefaction Hazard Zone. None of the tanks are within an area of defined or questionable landslide morphology, such as slopes. The design of large liquid storage tanks often requires special attention to potential seismic loading. Implementation of the General Plan (City of Buenaventura 2005a) policies of compliance with California Building Code and Alquist-Priolo legislation would reduce the risk associated with groundshaking and surface rupture to less than significant.

3.4 Hydrology

General Plan maps (City of Buenaventura 2005a) show the proposed locations of water tanks as part of the DPR alternative are all or partially within the Dam Inundation Areas for the Bouquet, Castaic, Pyramid and Matilija Dams in the upper Santa Clara River watershed.

3.5 Utilities/Public Services

Reclaimed water from the VWRF would be directly put into the existing drinking water system for the purpose of augmenting the potable supply. The DPR alternative will include proven advanced treatment technologies, including MF, RO, and AOP. The treatment efficacy of these processes is well known, however, there is ongoing research on the controls and redundancies that will be required to be protective of public health, particularly in a DPR alternative. It is likely that additional assessment and analysis will need to be completed as part of a more comprehensive CEQA process.

4 NO PROJECT ALTERNATIVE

The Do Nothing/No Project Alternative involves no new advanced treatment facilities at the VWRF and no treatment wetlands. However, as discussed in Chapter 8 of the Facilities Planning Study, the proposed Project is unique in the sense that the primary driver is the need to provide reuse opportunities to reduce the discharge flow to the SCRE. Per the Settlement Agreement, the City has agreed to reduce the amount of water entering the SCRE by 50 percent to 100 percent by diverting it to other recycled and reclaimed water uses. Therefore, a true “No Project” alternative does not exist with respect to the primary driver of diverting water from the SCRE. Consequently, while under the No Project alternative, impacts from operating the system and current land uses would continue in the same manner as current conditions, this is not a feasible alternative in the long term due to the requirements of the Settlement Agreement.

5 REFERENCES

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APPENDIX G – COST ESTIMATES

North Decentralized Plant - Irrigation

Treatment Capital Cost Estimate

Classification	**Units**		**Extended Cost**
Flow (mgd)			2
Unit Construction cost ($ million/gal)			8
TOTAL CONSTRUCTION COSTS ($millions)			16
Engineering, Legal, Admin, Permits	30%		
TOTAL PROJECT COST ($ millions)			20.8

Recycled Water Conveyance Capital Cost Estimate

Classification	Units		Extended Cost
Total RW Pipeline ($millions)			1.8
Construction Contingency	30%		0.54
		Subtotal	2.34
General Conditions	0%		0
		Subtotal	2.34
General Contractor Overhead+Profit	10%		0.234
		Subtotal	2.574
Escalation to Midpoint	0%		0
		Subtotal	2.574
Sales Tax	8%		0.08775
TOTAL CONSTRUCTION COSTS ($millions)			2.66
Engineering, Legal, Admin, Permits			30%
TOTAL PROJECT COST ($ millions)			3.46

Treatment and Distribution	$	24
Brine Pipeline	$	-
TOTAL PROJECT COST ($ millions)	$	24

Note: Total project cost does not include wetlands and CEQA/permitting

Partial Flow Recharge/Ag supply for UWCD

Treatment Capital Cost Estimate

Classification		Quantity	Units	Unit Cost	Extended Cost
Building		24,000	SF	$ 135	$ 1,296,000
Pretreatment Strainers		1	LS	$ 450,000	$ 135,000
MF Equipment		2.4	MGD	$ 500,000	$ 1,188,000
Flow Equalization Basin		200,000	Gallon	$ 1	$ 200,000
RO Equipment		1.9	MGD	$ 750,000	$ 1,425,600
Chemical Storage/Feed System					
	Sodium Hypochlorite	1	LS	$ 120,000	$ 90,000
	Caustic Soda	1	LS	$ 250,000	$ 187,500
	Scale Inhibitor	1	LS	$ 80,000	$ 60,000
	Lime (Delivered as 35%)	1	LS	$ 250,000	$ 187,500
	Carbon Dioxide	1	LS	$ 600,000	$ 450,000
TOTAL EQUIPMENT COST					$ 5,219,600
Civil/Site Work/Yard Piping		1	10%		$ 521,960
Process Electrical		1	LS	$ 1,700,000	$ 1,700,000
Process Instrumentation		1	LS	$ 800,000	$ 800,000
SUBTOTAL					$ 8,241,560
Construction Contingency			30.0%		$ 2,472,468
				Subtotal	$ 10,714,028
General Conditions			0.0%		$ -
				Subtotal	$ 10,714,028
General Contractor Overhead+Profit			10.0%		$ 1,071,403
				Subtotal	$ 11,785,431
Escalation to Midpoint			0.0%		$ -
				Subtotal	$ 11,785,431
Sales Tax			7.5%		$ 401,776
TOTAL CONSTRUCTION COSTS					**$ 12,187,207**
Engineering, Legal, Admin, Permits			30%		$ 3,656,162
TOTAL PROJECT COST					**$ 15,843,369**

Conveyance Capital Cost

Classification		Quantity	Units	Unit Cost	Extended Cost
Pipeline(includes installation)	20" Pipeline	1			$ 13,300,000
Pump Station (includes installation, elentrical and		1.00		$ 1,000,000	$ 1,000,000
SUBTOTAL					$ 14,300,000
Construction Contingency			30.0%		$ 4,290,000
				Subtotal	$ 18,590,000
General Conditions			0.0%		$ -
				Subtotal	$ 18,590,000
General Contractor Overhead+Profit			10.0%		$ 1,859,000
				Subtotal	$ 20,449,000
Escalation to Midpoint			0.0%		$ -
				Subtotal	$ 20,449,000
Sales Tax			7.5%		$ 697,125
TOTAL CONSTRUCTION COSTS					**$ 21,146,125**
Engineering, Legal, Admin, Permits					
TOTAL PROJECT COST					**$ 27,489,963**

Treatment, Conveyance	$ 43,333,331
Brine Pipeline	$ 22,000,000
TOTAL PROJECT COST	$ 65,333,331

Note: Total project cost does not include wetlands and CEQA/permitting

Full Flow Recharge/Ag supply for UWCD

Treatment Capital Cost Estimate

Classification		Quantity	Units	Unit Cost	Extended Cost
Building		24,000	SF	$ 135	$ 3,240,000
Pretreatment Strainers		1	LS	$ 450,000	$ 450,000
MF Equipment		7.3	MGD	$ 500,000	$ 3,627,000
Flow Equalization Basin		600,000	Gallon	$ 1	$ 600,000
RO Equipment		5.8	MGD	$ 750,000	$ 4,352,400
Chemical Storage/Feed System					
	Sodium Hypochlorite	1	LS	$ 120,000	$ 120,000
	Caustic Soda	1	LS	$ 250,000	$ 250,000
	Scale Inhibitor	1	LS	$ 80,000	$ 80,000
	Lime (Delivered as 35%)	1	LS	$ 250,000	$ 250,000
	Carbon Dioxide	1	LS	$ 600,000	$ 600,000
TOTAL EQUIPMENT COST					$ 13,569,400
Civil/Site Work/Yard Piping		1	10%		$ 1,356,940
Process Electrical		1	LS	$ 4,400,000	$ 4,400,000
Process Instrumentation		1	LS	$ 2,200,000	$ 2,200,000
SUBTOTAL					$ 21,526,340
Construction Contingency			30.0%		$ 6,457,902
				Subtotal	$ 27,984,242
General Conditions			0.0%		$ -
				Subtotal	$ 27,984,242
General Contractor Overhead+Profit			10.0%		$ 2,798,424
				Subtotal	$ 30,782,666
Escalation to Midpoint			0.0%		$ -
				Subtotal	$ 30,782,666
Sales Tax			7.5%		$ 1,049,409
TOTAL CONSTRUCTION COSTS					**$ 31,832,075**
Engineering, Legal, Admin, Permits			30%		$ 9,549,623
TOTAL PROJECT COST					**$ 41,381,698**

Conveyance Capital Cost

Classification		Quantity	Units	Unit Cost	Extended Cost
Pipeline(includes installation)	20" Pipeline	1			$ 13,300,000
Pump Station (includes installation, elentrical and instrumentation		1.00		$ 1,000,000	$ 1,000,000
SUBTOTAL					$ 14,300,000
Construction Contingency			30.0%		$ 4,290,000
				Subtotal	$ 18,590,000
General Conditions			0.0%		$ -
				Subtotal	$ 18,590,000
General Contractor Overhead+Profit			10.0%		$ 1,859,000
				Subtotal	$ 20,449,000
Escalation to Midpoint			0.0%		$ -
				Subtotal	$ 20,449,000
Sales Tax			7.5%		$ 697,125
TOTAL CONSTRUCTION COSTS					**$ 21,146,125**
Engineering, Legal, Admin, Permits			30%		$ 6,343,838
TOTAL PROJECT COST					**$ 27,489,963**

Treatment, Conveyance	$ 68,871,660
Brine Pipeline	$ 22,000,000
TOTAL PROJECT COST	$ 90,871,660

Note: Total project cost does not include wetlands and CEQA/permitting

Mound Basin IPR (3.6 mgd)

Treatment Capital Cost Estimate

Classification	Quantity	Units	Unit Cost	Extended Cost
Building	24,000	SF	$ 135	$ 2,268,000
Pretreatment Strainers	1	LS	$ 450,000	$ 270,000
MF Equipment	4.5	MGD	$ 500,000	$ 2,250,000
Flow Equalization Basin	380,000	Gallon	$ 1	$ 380,000
RO Equipment	3.6	MGD	$ 750,000	$ 2,700,000
Chemical Storage/Feed System				
Sodium Hypochlorite	1	LS	$ 120,000	$ 120,000
Caustic Soda	1	LS	$ 250,000	$ 250,000
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Lime (Delivered as 35%)	1	LS	$ 250,000	$ 250,000
Carbon Dioxide	1	LS	$ 600,000	$ 600,000
AOP (UV/H2O2) Equipment	3.60	MGD	$ 410,000	$ 1,476,000
TOTAL EQUIPMENT COST				$ 10,644,000
Civil/Site Work/Yard Piping	1	10%		$ 1,064,400
Process Electrical	1	LS	$ 3,400,000	$ 3,400,000
Process Instrumentation	1	LS	$ 1,700,000	$ 1,700,000
SUBTOTAL				$ 16,808,400
Construction Contingency		30.0%		$ 5,042,520
			Subtotal	$ 21,850,920
General Conditions		0.0%		$ -
			Subtotal	$ 21,850,920
General Contractor Overhead+Profit		10.0%		$ 2,185,092
			Subtotal	$ 24,036,012
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 24,036,012
Sales Tax		7.5%		$ 819,410
TOTAL CONSTRUCTION COSTS				**$ 24,855,422**
Engineering, Legal, Admin, Permits		30%		$ 7,456,626
TOTAL PROJECT COST				**$ 32,312,048**

Conveyance and Injection Capital Cost

Classification	Quantity	Units	Unit Cost	Extended Cost
Pipeline				$ 5,872,400
Pump Station	3.60	MGD		$ 540,000
Injection Wells	3	LS	$ 2,000,000.0	$ 6,000,000
Extraction Well	1		$ 3,450,000	$ 3,450,000
TOTAL EQUIPMENT COST				$ 15,862,400
Civil/Site Work/Yard Piping	1	0%		$ -
Process Electrical and Instrumentation	1	0%		$ -
SUBTOTAL				$ 15,862,400
Construction Contingency		30.0%		$ 4,758,720
			Subtotal	$ 20,621,120
General Conditions		0.0%		$ -
			Subtotal	$ 20,621,120
General Contractor Overhead+Profit		10.0%		$ 2,062,112
			Subtotal	$ 22,683,232
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 22,683,232
Sales Tax		7.5%		$ 773,292
TOTAL CONSTRUCTION COSTS				**$ 23,456,524**
Engineering, Legal, Admin, Permits		30%		$ 7,036,957
TOTAL PROJECT COST				**$ 30,493,481**

Treatment, Conveyance and Injection	$ 62,805,529
Brine Pipeline	$ 22,000,000
TOTAL PROJECT COST	$ 84,805,529

Note: Total project cost does not include wetlands and CEQA/permitting

Mound Basin IPR (6.3 mgd)

Treatment Capital Cost Estimate

Classification	Quantity	Units	Unit Cost	Extended Cost
Building	24,000	SF	$ 135	$ 3,240,000
Pretreatment Strainers	1	LS	$ 450,000	$ 450,000
MF Equipment	7.9	MGD	$ 500,000	$ 3,960,000
Flow Equalization Basin	660,000	Gallon	$ 1	$ 660,000
RO Equipment	6.3	MGD	$ 750,000	$ 4,752,000
Chemical Storage/Feed System				
Sodium Hypochlorite	1	LS	$ 120,000	$ 120,000
Caustic Soda	1	LS	$ 250,000	$ 250,000
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Lime (Delivered as 35%)	1	LS	$ 250,000	$ 250,000
Carbon Dioxide	1	LS	$ 600,000	$ 600,000
AOP (UV/H2O2) Equipment	6.34	MGD	$ 410,000	$ 2,597,760
TOTAL EQUIPMENT COST				$ 16,959,760
Civil/Site Work/Yard Piping	1	10%		$ 1,695,976
Process Electrical	1	LS	$ 5,500,000	$ 5,500,000
Process Instrumentation	1	LS	$ 2,700,000	$ 2,700,000
SUBTOTAL				$ 26,855,736
Construction Contingency		30.0%		$ 8,056,721
			Subtotal	$ 34,912,457
General Conditions		0.0%		$ -
			Subtotal	$ 34,912,457
General Contractor Overhead+Profit		10.0%		$ 3,491,246
			Subtotal	$ 38,403,702
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 38,403,702
Sales Tax		7.5%		$ 1,309,217
TOTAL CONSTRUCTION COSTS				**$ 39,712,920**
Engineering, Legal, Admin, Permits		30%		$ 11,913,876
TOTAL PROJECT COST				**$ 51,626,795**

Conveyance and Injection Capital Cost

Classification	Quantity	Units	Unit Cost	Extended Cost
Pipeline				$ 5,872,400
Pump Station	6.34	MGD		$ 950,400
Injection Wells	5	LS	$ 2,000,000.0	$ 10,000,000
Extraction Well	1		$ 3,450,000	$ 3,450,000
TOTAL EQUIPMENT COST				$ 20,272,800
Civil/Site Work/Yard Piping	1	0%		$ -
Process Electrical and Instrumentation	1	0%		$ -
SUBTOTAL				$ 20,272,800
Construction Contingency		30.0%		$ 6,081,840
			Subtotal	$ 26,354,640
General Conditions		0.0%		$ -
			Subtotal	$ 26,354,640
General Contractor Overhead+Profit		10.0%		$ 2,635,464
			Subtotal	$ 28,990,104
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 28,990,104
Sales Tax		7.5%		$ 988,299
TOTAL CONSTRUCTION COSTS				**$ 29,978,403**
Engineering, Legal, Admin, Permits		30%		$ 8,993,521
TOTAL PROJECT COST				**$ 38,971,924**

Treatment, Conveyance and Injection	$ 90,598,719
Brine Pipeline	$ 22,000,000
TOTAL PROJECT COST	$ 112,598,719

Note: Total project cost does not include wetlands and CEQA/permitting

DPR (3.6 mgd)

CAPTIAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Building	24,000	SF	$ 135	$ 2,268,000
Pretreatment Strainers	1	LS	$ 450,000	$ 270,000
MF Equipment	4.5	MGD	$ 500,000	$ 2,250,000
Flow Equalization Basin	380,000	Gallon	$ 1	$ 380,000
RO Equipment	3.6	MGD	$ 750,000	$ 2,700,000
Chemical Storage/Feed System				
Sodium Hypochlorite	1	LS	$ 120,000	$ 120,000
Caustic Soda	1	LS	$ 250,000	$ 250,000
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Lime (Delivered as 35%)	1	LS	$ 250,000	$ 250,000
Carbon Dioxide	1	LS	$ 600,000	$ 600,000
AOP (UV/H2O2) Equipment	3.60	MGD	$ 410,000	$ 1,476,000
TOTAL EQUIPMENT COST				$ 10,644,000
Civil/Site Work/Yard Piping	1	10%		$ 1,064,400
Process Electrical	1	LS	$ 3,400,000	$ 3,400,000
Process Instrumentation	1	LS	$ 1,700,000	$ 1,700,000
SUBTOTAL				$ 16,808,400
Construction Contingency		30.0%		$ 5,042,520
			Subtotal	$ 21,850,920
General Conditions		0.0%		$ -
			Subtotal	$ 21,850,920
General Contractor Overhead+Profit		10.0%		$ 2,185,092
			Subtotal	$ 24,036,012
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 24,036,012
Sales Tax		7.5%		$ 819,410
TOTAL CONSTRUCTION COSTS				**$ 24,855,422**
Engineering, Legal, Admin, Permits		30%		$ 7,456,626
TOTAL PROJECT COST				**$ 32,312,048**

Conveyance Capital Cost

Classification	Quantity	Units	Unit Cost	Extended Cost
Pipeline				$ 4,637,100
Pump Station	3.60	MGD		$ 540,000
STORAGE (2 x 2.5 MGD) + EQ BASIN				$ 3,250,000
TOTAL EQUIPMENT COST				$ 8,427,100
Civil/Site Work/Yard Piping				
Process Electrical and Instrumentation				
SUBTOTAL				$ 8,427,100
Construction Contingency		30.0%		$ 2,528,130
			Subtotal	$ 10,955,230
General Conditions		0.0%		$ -
			Subtotal	$ 10,955,230
General Contractor Overhead+Profit		10.0%		$ 1,095,523
			Subtotal	$ 12,050,753
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 12,050,753
Sales Tax		7.5%		$ 410,821
TOTAL CONSTRUCTION COSTS				**$ 12,461,574**
Engineering, Legal, Admin, Permits		30%		$ 3,738,472
TOTAL PROJECT COST				**$ 16,200,046**

Treatment, Conveyance and Injection	$ 48,512,094
Brine Pipeline	$ 22,000,000
TOTAL PROJECT COST	$ 70,512,094

Note: Total project cost does not include wetlands and CEQA/permitting

North decentralized plant - DPR

Treatment Capital Cost Estimate

Classification	Quantity	Units	Unit Cost	Extended Cost
Building	24,000	SF	$ 135	$ 1,296,000
Pretreatment Strainers	1	LS	$ 450,000	$ 135,000
MF Equipment	2.3	MGD	$ 500,000	$ 1,125,000
Flow Equalization Basin	190,000	Gallon	$ 1	$ 190,000
RO Equipment	1.8	MGD	$ 750,000	$ 1,350,000
Chemical Storage/Feed System				
Sodium Hypochlorite	1	LS	$ 120,000	$ 90,000
Caustic Soda	1	LS	$ 250,000	$ 187,500
Scale Inhibitor	1	LS	$ 80,000	$ 60,000
Lime (Delivered as 35%)	1	LS	$ 250,000	$ 187,500
Carbon Dioxide	1	LS	$ 600,000	$ 450,000
AOP (UV/H2O2) Equipment	1.80	MGD	$ 410,000	$ 738,000
TOTAL EQUIPMENT COST				$ 5,809,000
Civil/Site Work/Yard Piping	1	10%		$ 580,900
Process Electrical	1	LS	$ 1,800,000	$ 1,800,000
Process Instrumentation	1	LS	$ 900,000	$ 900,000
SUBTOTAL				$ 9,089,900
Construction Contingency		30.0%		$ 2,726,970
			Subtotal	$ 11,816,870
General Conditions		0.0%		$ -
			Subtotal	$ 11,816,870
General Contractor Overhead+Profit		10.0%		$ 1,181,687
			Subtotal	$ 12,998,557
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 12,998,557
Sales Tax		7.5%		$ 443,133
TOTAL CONSTRUCTION COSTS				**$ 13,441,690**
Engineering, Legal, Admin, Permits		30%		$ 4,032,507
TOTAL PROJECT COST				**$ 17,474,197**

MBR Package Plant

Treatment Capital Cost Estimate

Classification	Quantity	Units	Unit Cost	Extended Cost
TOTAL PROJECT COST				**$ 20,800,000**

Conveyance Capital Cost

Classification	Quantity	Units	Unit Cost	Extended Cost
Pipeline				$ 647,000
Pump Station	1.80	MGD		$ 270,000
STORAGE (2 x 1.5 MGD) + EQ BASIN				$ 1,625,000
TOTAL EQUIPMENT COST				$ 1,895,000
Civil/Site Work/Yard Piping				
Process Electrical and Instrumentation				
SUBTOTAL				$ 1,895,000
Construction Contingency		30.0%		$ 568,500
			Subtotal	$ 2,463,500
General Conditions		0.0%		$ -
			Subtotal	$ 2,463,500
General Contractor Overhead+Profit		10.0%		$ 246,350
			Subtotal	$ 2,709,850
Escalation to Midpoint		0.0%		$ -
			Subtotal	$ 2,709,850
Sales Tax		7.5%		$ 92,381
TOTAL CONSTRUCTION COSTS				**$ 2,802,231**
Engineering, Legal, Admin, Permits		30%		$ 840,669
TOTAL PROJECT COST				**$ 3,642,901**

Treatment, Conveyance and Injection	$ 41,917,097
Brine Pipeline	$ -
TOTAL PROJECT COST	$ 41,917,097

Note: Total project cost does not include wetlands and CEQA/permitting