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Indio Water Authority
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Valley Sanitary District

MSWD Mission Springs Water District

City of Coachella California

Recycled Water Program Development Feasibility Study

Regional Report

March 2018

Hazen

Recycled Water Program Development Feasibility Study Report

Indio Water Authority / Valley Sanitary District
(East Valley Reclamation Authority)

Coachella Water Authority / Coachella Sanitation District

Mission Springs Water District

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Appendix A – Cost Breakdown

Abbreviations/Acronyms

AACEI	Association for the Advancement of Cost Engineering International
ac	Acre(s)
ADD	Average day demand
AF	Acre-Feet
AFY	Acre-Feet per Year
AMSL	Above mean sea level
AOP	Advanced oxidation process
ASR	Aquifer Storage and Recovery
bgs	Below ground surface
BOR	Bureau of Reclamation
CBOD	Carbonaceous biochemical Oxygen Demand
CCI	Construction Cost Index
CCT	Chlorine contact time
CDPH	California Department of Public Health
cfs	Cubic feet per second
CIP	Capital Improvement Program/Plan
cm	Centimeter
CPC	California Plumbing Code
CPT	Cone penetrometer test
CSD	Coachella Sanitation District
CVRWMG	Coachella Valley Regional Water Management Group
CVSC	Coachella Valley Stormwater Channel
CVWD	Coachella Valley Water District
CWA	Coachella Water Authority
DDW	California State Water Resources Control Board Division of Drinking Water
DPR	Direct Potable Reuse
DSOD	Division of Safety of Dams
DU	Dwelling Unit
DWR	California Department of Water Resources
ENR	Engineering News-Record
EVRA	East Valley Reclamation Authority
ft	Foot, feet
FTE	Full time equivalent
gpd	Gallon(s) per day
gpm	Gallon(s) per minute
GRF	Groundwater Replenishment Facility
GRRP	Groundwater Replenishment Reuse Project
GRRW	Groundwater Recharge with Recycled Water
HDD	Horizontal directional drilling

HOA	Homeowner Association
HP	Horsepower
in	Inch(es)
IPR	Indirect Potable Reuse
IRWM	Integrated Regional Water Management
IWA	Indio Water Authority
JPA	Joint Powers Authority
kWh	kilowatt-hour
L	Liter(s)
MBR	Membrane bioreactor
MCL	Maximum Contaminant Level
MDD	Maximum day demand
MF	Microfiltration
mg	Milligram(s)
MG	Million gallon(s)
MGD	Million Gallon(s) per Day
Min.	Minimum
MJ	Millijoules
mL	Milliliter(s)
MPN	Most probable number
MSL	Mean sea level
MSWD	Mission Springs Water District
NPR	Non potable reuse
NTU	Nephelometric Turbidity Unit
O&M	Operation and maintenance
PFD	Process flow diagram
PS	Pump station
psi	Pounds per square inch
psig	Pounds per square inch (gauge)
PVDF	Polyvinylidene fluoride
Req'd	Required
RO	Reverse Osmosis
RW	Recycled water
RWC	Recycled water contribution
RWMP	Recycled Water Master Plan
RWTM	Recycled water transmission main
sq	Square
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
TM	Technical Memorandum
TOC	Total organic carbon

TSS	Total suspended solids
USBR	United States Bureau of Reclamation
UV	Ultraviolet
UVT	Ultraviolet Transmittance
VFD	Variable frequency drive
VSD	Valley Sanitary District
WMP	Water Master Plan
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant
µg	Microgram(s)

Executive Summary

Coachella Water Authority (CWA) / Coachella Sanitation District (CSD), Mission Springs Water District (MSWD), Indio Water Authority (IWA), and Valley Sanitary District (VSD) collectively received a Proposition 84, Integrated Regional Water Management (IRWM) Grant to complete a recycled water study to evaluate the use of recycled water throughout the Coachella Valley.

This Report has been prepared to identify and evaluate regional recycled water alternatives examining potential recycled water demand uses and wastewater supply availability from a collective and regional level with the goal of developing proposed regional recycled water projects with economies of scale and other regional benefits from coordination. The proposed regional projects can be compared against each agency's individual jurisdictional projects as presented in the Technical Memoranda (TM), TM-1 for IWA and VSD, TM-2 for MSWD and TM-3 for CWA/CSD prepared under separate covers.

The results of this regional recycled water feasibility study may be utilized to make decisions on the priority projects, prioritize next steps, identify appropriate grant funding, and prepare grant funding applications for the further planning, design and implementation of the priority projects. It should be noted that due to the approximate 20-mile distance between MSWD and the other participating agencies, regional projects that included MSWD was deemed cost prohibitive and, therefore, this regional report focus' on regional recycled water alternatives between CWA/CSD, IWA and VSD.

Project Scope

This Report specifically evaluates regional project alternatives building upon the findings from TM-1 and TM-3 included in the appendices to this report. Regional infrastructure requirements including conveyance, pumping, spreading and injection facilities are evaluated as well as an evaluation of the available wastewater quality at CSD and VSD to determine the appropriate treatment technologies for the proposed recycled water uses. A broad hydrogeological analysis was also conducted to identify opportunities for groundwater spreading and/or injection at the most effective locations. Capital as well as operations and maintenance opinions of probable costs were prepared for each alternative and each alternative was ranked based on criteria important to the participating agencies.

Project Alternatives

Working in conjunction with IWA, VSD, and CWA/CSD, potentially viable regional alternatives were developed. The concepts developed for the regional project includes sending wastewater flows from CSD to VSD; adding treatment facilities at VSD; and either recharging at VSD, serving recycled water for landscape irrigation to IWA customers, and/or a combination thereof. The benefits of this is twofold: 1) IWA has more potential recycled water demand for landscape irrigation than wastewater flow available, and more potential recycled water demand than CWA, and 2) VSD is upgradient of CWA, and recharge will benefit both IWA and CWA wells. The regional project alternatives identified are summarized in Table ES-1 as follows:

Table ES - 1: Summary Recycled Water Alternatives

Project Alternative	Description[1]
1	Status quo – “Do Nothing”
2	Surface spreading at VSD WRF
3	Deliver to recycled water customers for landscape irrigation and surface spreading at VSD WRF
4	Groundwater injection at VSD WRF
5a	Deliver to recycled water customers for landscape irrigation and surface spreading at Posse Park
5b	Deliver to recycled water customers for landscape irrigation and groundwater injection at Posse Park
6	Deliver to recycled water customers for landscape irrigation and excess to Coachella Valley Storm Channel (CVSC)

[1]All alternatives include conveying flows from CSD to VSD for further treatment

Economic Analysis

Utilizing the Cost Estimate Classification System guidelines published by the Association for the Advancement of Cost Engineering International (AACEI), a Class 4 cost estimate for each alternative was developed. The costs were escalated to February 2019 dollars and take into consideration that the project is located in the Coachella Valley. Land and right of-way costs were not included. Table ES-2 summarizes the total capital costs for each alternative and project component.

Table ES-2: Capital Cost Estimates by Alternative and Component

Alternative	Tertiary Treatment ($M)	Advanced Treatment ($M)	RW Distribution / Conveyance ($M)	Spreading Basins ($M)	Groundwater Injection ($M)	Total ($M)
1 – Status Quo	-	-	-	-	-	**-**
2 – CSD flows to VSD for Surface Spreading at VSD WRF	50.7	-	22.8	14.5	-	**88.0**
3 – CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF	50.7	-	59.3	14.5	-	**134.5**
4 – CSD flows to VSD, Groundwater Injection at VSD WRF	-	76.3	22.8	-	29.6	**128.7**
5a – CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park	50.7	-	86.5	9.8	-	**147.1**
5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park	50.7	43.8	73.4	-	15.3	**183.3**
6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC	50.7	-	69.3	-	-	**120.0**

Annual operation and maintenance (O&M) costs that included power costs, chemical costs, annual maintenance and labor were developed based on estimates at similar facilities. A life cycle analysis was then developed based on the capital and O&M estimates assuming a 30-year term at an interest rate of 1.6 percent. The lifecycle costs for each alternative are presented in Table ES-3.

Table ES-3: Lifecycle Estimates

Alternative	Annualized Capital Cost ($M)	Annual O&M Cost ($M)	Annualized Lifecycle Cost ($M)	Cost Per Acre-foot[1] ($)	Cost Differential[3] ($)
1	-	-	-	5,321[2]	-
2	3.72	2.50	6.22	617	-4,704
3	5.68	3.07	8.75	868	-4,453
4	5.44	7.77	13.20	1,309	-4,012
5a	6.21	3.13	9.34	927	-4,394
5b	7.74	5.38	13.12	1,301	-4,020
6	5.07	2.89	7.96	789	-4,532

[1] Based on wastewater flow of 9 mgd.
[2] Cost of State Water Project Supplemental Water as presented in IWA's Supplemental Water Supply Program and Fee Study.
[3] Cost Difference = (Alternative cost) – (Status Quo cost)

Alternatives Analysis and Ranking

A decision model was created to evaluate the costs and non-monetary benefits important to CWA/CSD, VSD and IWA. Selection criteria was initially established in a workshop with the agencies and weighting sheets were completed independently such that an average weighting could be distributed relative to the primary criteria's importance. The results of the criteria weighting and scoring is shown in Table ES-4. Higher scores were considered more favorable.

Table ES-4: Criteria Weighting and Scoring Summary

Rank	Score	Alternative[1]
1	82	2 –Surface spreading at VSD WRF
2	60	4 - Groundwater injection at VSD WRF
3	57.2	3 –Deliver recycled water to customers for landscape irrigation and surface spreading at VSD WRF
4	56.5	6 – Deliver recycled water to customers for landscape irrigation and excess to CVSC
5	53	1 – Status Quo
6	52	5a – Deliver recycled water to customers for landscape irrigation and surface spreading at Posse Park
7	42	5b – Deliver recycled water to customers for landscape irrigation and groundwater injection at Posse Park

Funding Opportunities

There are many grant and loan opportunities to fund the design and construction of the recycled water alternative projects identified herein. There is grant funding currently available through the California State Water Resources Control Board (SWRCB) through Proposition 1, as well as grant funding under the United States Bureau of Reclamation (USBR) WaterSMART and Title XVI Programs. Low interest loans are available as well and generally the loan rate is one half of the State of California's most recent general obligation bond rate. As of March 2017, the interest rate being offered was 1.8%. A combination of State and Federal funding is permitted. The challenge with the grant and loans are the timing of availability and their fluidity. CWA/CSD, IWA and VSD will need to determine if a regional alternative is desirable and the timeline in which the agencies wish to proceed and then immediately begin applying for grants. There should be sufficient information developed within this report to apply for further planning such as conducting a full- scale pilot study and preparation of a preliminary design report.

Conclusions

Delivering CSD flows to VSD for further treatment and recharging the groundwater via surface spreading on-site at VSD ranks the most favorably as it limits conveyance infrastructure and costs, and provides public benefits and benefits to the agencies. However, this alternative is highly dependent upon field investigations confirming the ability to percolate water at the VSD WRF and staff's experience at the WRF has indicated that the ability to percolate is low. The second ranked alternative is delivering CSD flows to VSD for further treatment and recharging the groundwater via injection on-site at VSD. VSD staff have expressed concern over constructing any new facilities at the WRF due to the neighboring tribal community. During the ranking, this was taken into consideration under the subcategory, ease of implementation. Recycled water distribution ranks less favorably as it requires more extensive conveyance infrastructure and coordination with potential customers and the recycled water use is seasonal and uncertain. Off-site facility alternatives, groundwater recharge via spreading or injection at Posse Park were lower ranking because they come at a much higher cost and complexity. Although they may potentially improve groundwater quality for some IWA and CWA production wells over time and alleviate the delays and concerns that may occur due to resistance of the neighboring tribal community with construction at the VSD WRF site. The lowest ranking alternative was Alternative 5b - deliver recycled water to customers for landscape irrigation and groundwater injection at Posse Park. This ranked the lowest due to cost and complexity to implement and the uncertainty of the recycled water customer demands. It should be noted that Alternatives 2, 3, and 5a are dependent upon field investigations confirming the ability to percolate water at a reasonable rate, hydrogeological modeling confirming that the percolated water will reach the aquifer, and the ability to acquire property of adequate area. IWA is underway with conducting soils testing and percolation testing near Posse Park.

Recycled water projects may be an expensive undertaking in comparison to the RAC. However, recycled water provides resiliency and independence and is an investment in the future and is part of long-term planning and management of the groundwater basin and making use of a valuable resource.

1. Introduction

As severe droughts in California continue and imported and local groundwater supplies are becoming taxed, water utilities are seeking alternative water supplies to meet growing water demands. Recycled water is a significant local resource that, depending on the level of treatment, may be utilized for landscape irrigation, industrial applications, and strengthening groundwater recharge.

Coachella Water Authority (CWA) / Coachella Sanitation District (CSD), Mission Springs Water District (MSWD), Indio Water Authority (IWA), and Valley Sanitary District (VSD) collectively received a Proposition 84, Integrated Regional Water Management (IRWM) Grant to complete a recycled water study to evaluate the use of recycled water throughout the Coachella Valley.

This Report has been prepared to identify and evaluate regional recycled water alternatives examining potential recycled water demand uses and wastewater supply availability from a collective and regional level with the goal of developing proposed regional recycled water projects with economies of scale and other regional benefits from coordination. The proposed regional projects can be compared against each agency's individual projects as presented in the Technical Memoranda (TM) included as appendices to this report. Three separate technical memoranda identifying and evaluating recycled water alternatives within each of the agencies individual jurisdictional areas were prepared under separate covers and are as follows:

1. TM-1 for IWA/VSD;
2. TM-2 for MSWD; and
3. TM-3 for CWA/CSD

The results of this regional recycled water feasibility study may be utilized to prioritize projects, identify appropriate grant funding, and prepare grant funding applications for the further planning, design and implementation of the priority projects. It should be noted that due to the approximate 20 mile distance between MSWD and the other participating agencies, regional projects that included MSWD was deemed cost prohibitive and, therefore, this regional report focus' on regional recycled water alternatives between CWA/CSD, IWA and VSD.

1.1 Background

From a regional perspective, water supply management is performed through Coachella Valley Water District's (CVWD) Coachella Valley Water Management Plan Update (January 2012) and the Coachella Valley Regional Water Management Group's Integrated Regional Water Management Plan (December 2010), whose goals are to optimize supply reliability, protect and improve water quality, coordinate and integrate water resources management, and to do so in a cost-effective and sustainable manner. Engineer's Reports for the Coachella Valley region are prepared on an annual basis that evaluate Water Supply and Replenishment for the entire Coachella Valley Region.

CWA and IWA produces all of its water supplies from the East Whitewater River Subbasin and is responsible for the water supply for its residents. The East Whitewater River Subbasin is not adjudicated and there are no established limitations on the rights of CWA and IWA to withdraw water. However, it is noted in DWR Bulletin 118 that groundwater management in the basin is a local responsibility and, therefore, decisions regarding basin conditions and controlled overdraft and groundwater management are the responsibility of local agencies. CWA and IWA pay a replenishment charge to Coachella Valley Water District (CVWD) in accordance with the 2009 Quantification Settlement Agreement in which CVWD entered into water transfer agreements with Metropolitan Water District (MWD) and the Imperial Irrigation District that increases CVWD's Colorado River supplies which are utilized to replenish the East Whitewater River Subbasin. For pumping groundwater CWA and IWA pays the Coachella Valley Water District (CVWD) a Replenishment Assessment Charge (RAC) at a rate of $66 per acre-foot effective July 1, 2016[1] for CVWD's Groundwater Replenishment Program (GRP). The 2010 Water Management Plan identifies recycled water as a method in which the agencies can mitigate impacts associated with new development. Currently, CWA/CSD, IWA or VSD do not produce or use recycled water in their service areas.

1.2 Project Scope

The project scope for the Recycled Water Feasibility Study includes evaluating projects specific to each individual agency's jurisdictional area as well as evaluating regional projects between two or more of the participating agencies. This Report specifically evaluates regional project alternatives building upon the work that was done in the individual technical memoranda included in the appendices. Regional conveyance facility requirements that includes transmission mains, pumping, and spreading/injection facilities are identified. Available water quality was evaluated to determine the appropriate treatment technology for the proposed recycled water use. The study also covers a broad hydrogeologic analysis to identify opportunities for groundwater spreading and/or injection at the most effective locations. Capital as well as operations and maintenance opinions of probable costs are prepared for each alternative, and each alternative was ranked based on selection criteria established in a workshop with the individual agencies.

1.3 Study Area

For the purposes of this Report, the study area encompasses MSWD's service area, IWA's service area, and CWA's service area (see Figure 1-1).

[1] Coachella Valley Water District. http://www.cvwd.org/201/East-Whitewater-River-Subbasin (accessed June 22, 2017)

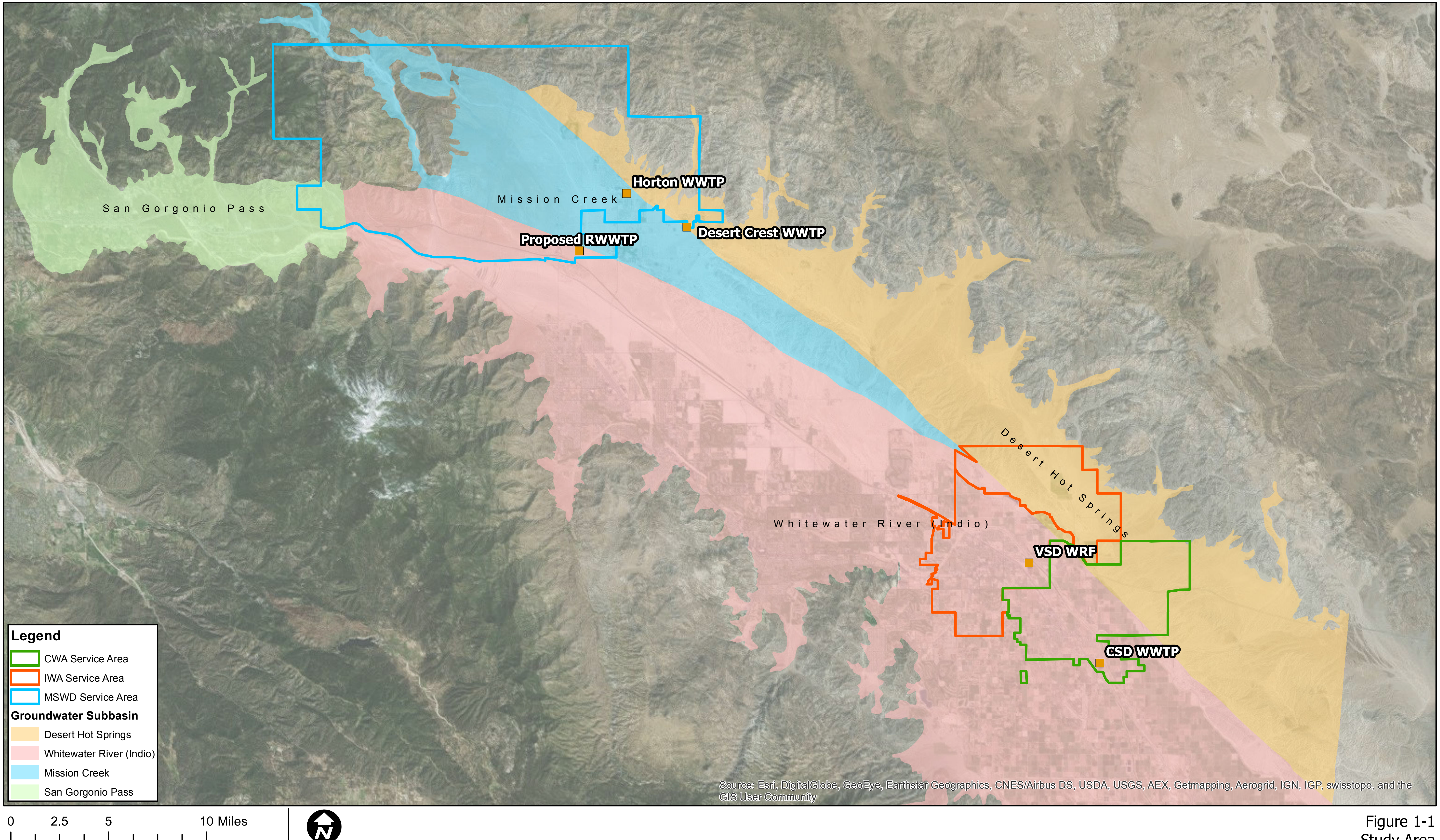

Figure 1-1
Study Area

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2. Project Alternatives

Working in conjunction with IWA, VSD, CWA/CSD, and MSWD, potentially viable regional alternatives were developed. Due to the roughly 20-mile distance between MSWD and CWA/CSD, IWA and VSD service areas, the construction of regional infrastructure to connect MSWD to the other agencies is cost prohibitive and likely impractical and has been excluded for the purposes of this Report. Therefore, this Report focuses on regional projects between CWA/CSD, IWA and VSD whose service areas are located directly adjacent to one another. It should be noted, however, that any recycled water project implemented by MSWD, be it recycled distribution, recharge, or other, would be anticipated to have some regional benefits by improving basin groundwater levels and possibly decreasing salinity.

The concepts developed for the regional project includes sending wastewater flows from CSD to VSD; adding treatment facilities at VSD; and either recharging at VSD, serving potential IWA recycled water customers, or a combination thereof. The rationale behind this configuration is twofold: 1) IWA has more potential recycled water demand for landscape irrigation than wastewater flow available, and more potential recycled water demand than CWA, and 2) VSD is upgradient of CWA, and recharge will benefit both IWA and CWA wells. Each regional alternative is briefly described below, and subsequent sections of this Report discuss the details of each alternative, including treatment, hydrogeology, conveyance and capital and operations and maintenance costs.

2.1 Alternative 1 – Status Quo

Alternative 1, maintaining the status quo or "do nothing" alternative, represents operation of the local groundwater basin (East Whitewater River (Indio) Subbasin). Although strides have been made by the CVRWMG in managing the East Whitewater River Subbasin, noting a net positive inflow into the basin during years 2009 to 2016[2], this alternative assumes that the subbasin is in a state of overdraft, and that imported water or an additional alternative source of supply will be required to supplement the region. A variety of alternative supply sources have been identified by CVWD in their 2012 WMP, including recycled water, water transfers (lease), water transfers with Delta conveyance, desalinated drain water, water transfers (purchase), and desalinated ocean water, with costs per acre-foot ranging from $400 to $1,800.

For baseline cost comparison purposes for Alternative 1 – "Status Quo", a price of $5,321 per acre-foot was utilized. This cost represents the adjusted cost of CVWD's purchase deal of a State Water Project (SWP) entitlement Table A water presented in IWA's Supplemental Water Supply Program and Fee Study, and is intended to represent the cost of securing an alternative supply. While the alternative supply cost presented in TM-3 for CWA/CSD is the 2018 Metropolitan Water District of Southern California Tier 1 Full Service Treated Volumetric Cost at $1,015 per acre-foot, the higher of the two values is presented in this Report.

[2] CVWD Engineer's Report on Water Supply and Replenishment Assessment 2017-2018.

2.2 Alternative 2 – CSD flows to VSD for Surface Spreading at VSD WRF

Alternative 2 includes the construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, and the addition of tertiary treatment and on-site recharge via spreading basins at the VSD WRF (see Figure 2-1).

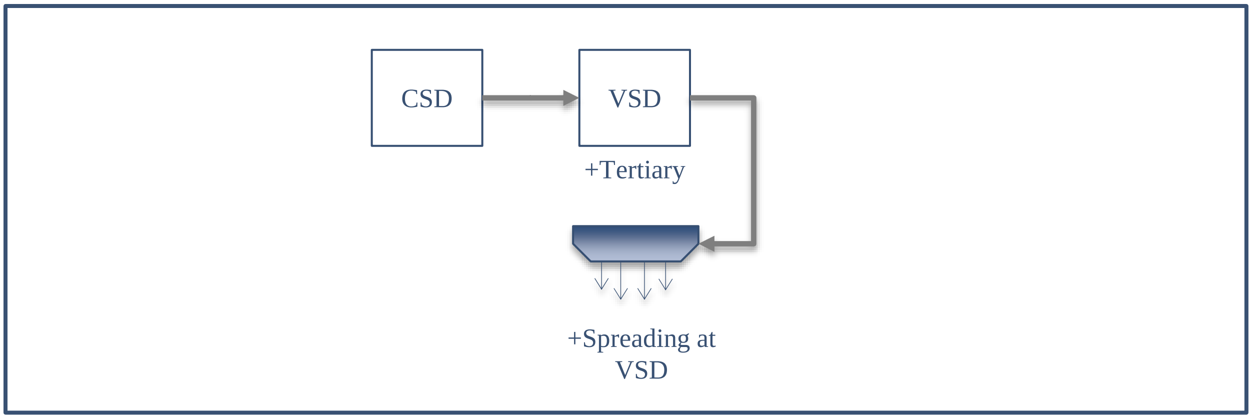


Figure 2-1 – Alternative 2

2.3 Alternative 3 – CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF

Alternative 3 includes the construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, addition of tertiary treatment at the VSD WRF, construction of a recycled water distribution system to serve IWA recycled water customers, and recharging excess flows via on-site spreading basins at the VSD WRF (see Figure 2-2).

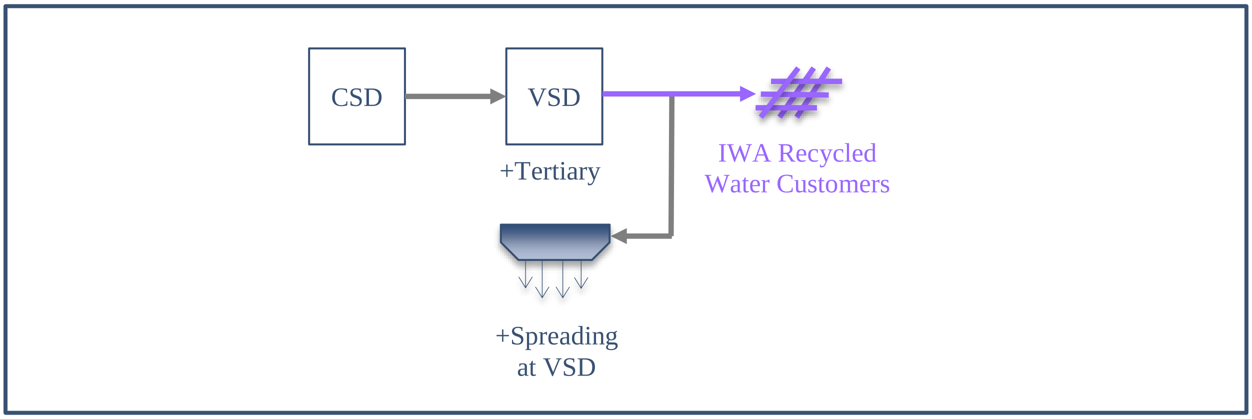


Figure 2-2 – Alternative 3

2.4 Alternative 4 – CSD flows to VSD, Groundwater Injection at VSD WRF

Alternative 4 includes the construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, addition of advanced treatment at the VSD WRF, and on-site recharge via injection wells at the VSD WRF (see Figure 2-3).

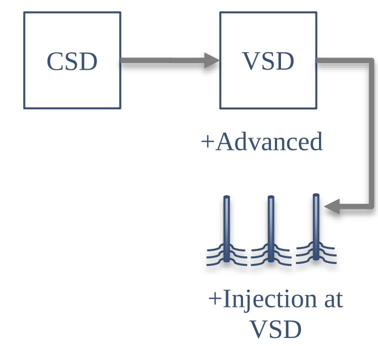


Figure 2-3 – Alternative 4

2.5 Alternative 5a – CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park

Alternative 5a includes the construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, addition of tertiary treatment at the VSD WRF, and construction of a tertiary-treated recycled water transmission main (RWTM) to convey flows to Posse Park for recharge via spreading basins. Posse Park is a City of Indio-owned property approximately 2.5 miles north of the VSD WRF (see Figure 7-4 for location of Posse Park). IWA recycled water customers conveniently located along the recycled water transmission main route will be served tertiary water with the excess being spread at Posse Park for groundwater replenishment. See Figure 2-4.

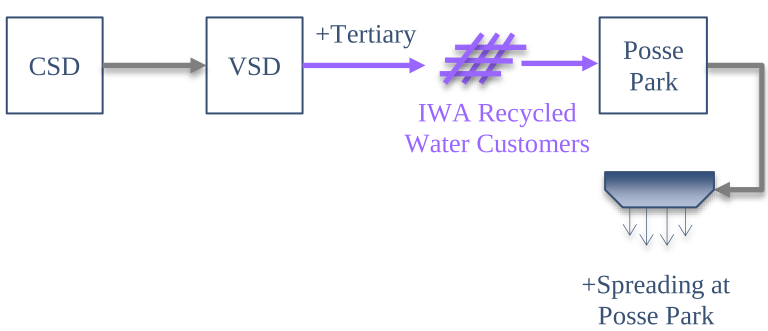


Figure 2-4 – Alternative 5a

2.6 Alternative 5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park

Alternative 5b includes the construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, addition of tertiary treatment at the VSD WRF, construction of a tertiary-treated recycled water transmission main to convey flows to Posse Park, and advanced treatment facilities for recharge at Posse Park via injection wells. IWA recycled water customers conveniently located along the recycled water transmission main route will be served tertiary water. In order to maintain constant flow to the advanced treatment facilities, excess flows during low recycled water demand periods will be discharged as secondary treated wastewater to the Coachella Valley Stormwater Channel (CVSC). In addition, close proximity of Posse Park to the Coachella Canal, operated by CVWD, could potentially offer some additional flexibility as an option to supplementing recycled water customer service or injection, although potential Coachella Canal options have not been included in this Study. See Figure 2-5.

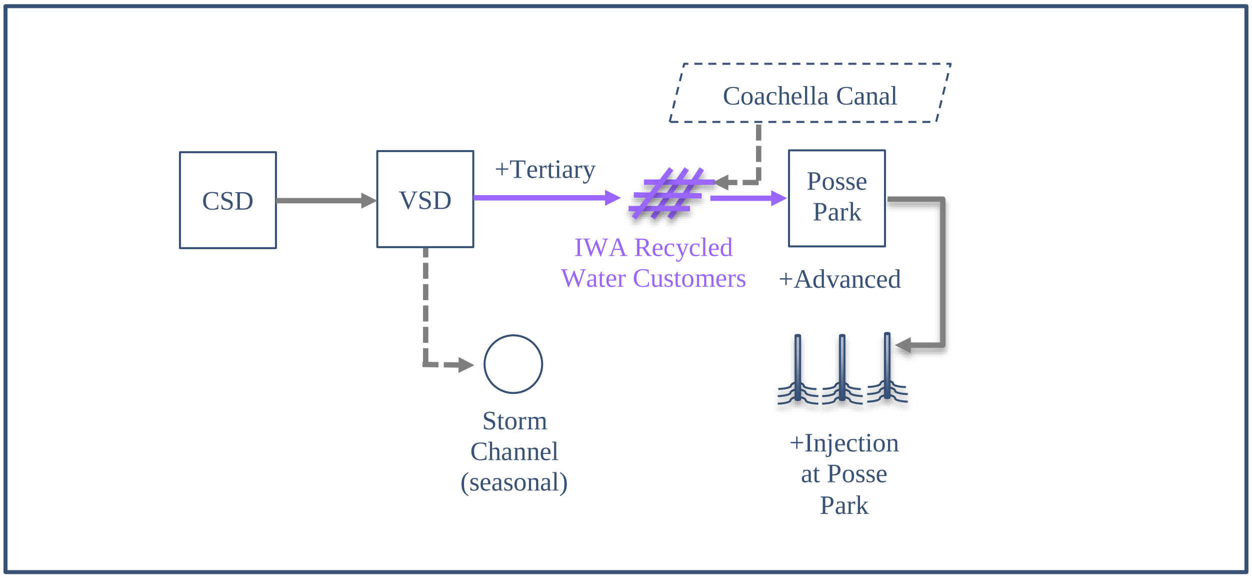


Figure 2-5 – Alternative 5b

2.7 Alternative 6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC

Alternative 6 includes construction of a regional pipeline to convey secondary-treated flows from the CSD WWTP to the VSD WRF, addition of tertiary treatment at the VSD WRF, construction of a recycled water distribution system to serve IWA recycled water customers, and discharging excess flows during low use periods as secondary treated wastewater to the CVSC. See Figure 2-6.

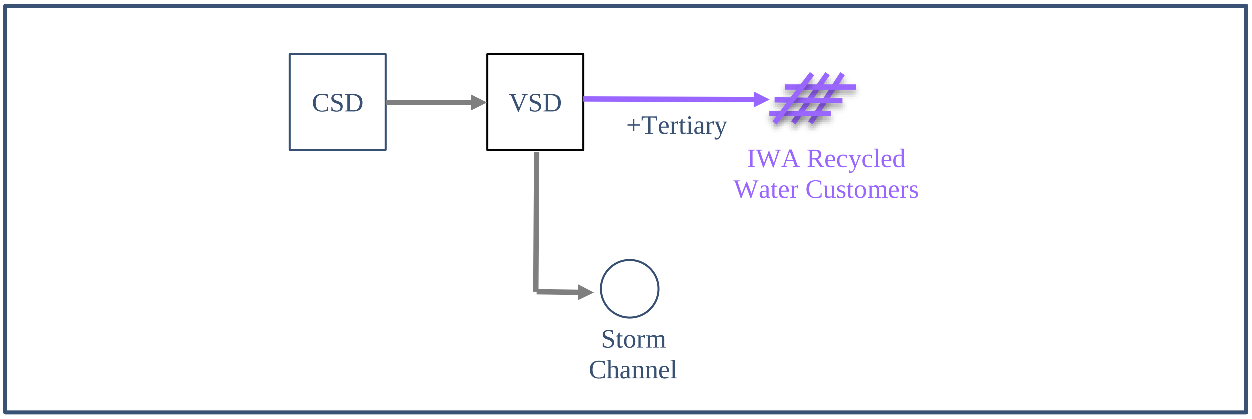


Figure 2-6 – Alternative 6

2.8 Direct Potable Reuse

Direct potable reuse (DPR) is a topic that is being discussed widely in the water reclamation industry as a potential option for recycled water use. To further evaluate DPR, the California State Water Resources Control Board's (State Water Board) Division of Drinking Water (DDW) convened an Advisory Group in 2014 on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse in accordance with the California Water Code Sections 13560-13569. The primary purpose of the Advisory Group was to advise the State Water Board and an expert panel on the feasibility of developing criteria for DPR in the State of California. The final report, *Recommendations of the Advisory Group on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse*, June 2016, may be found on the State Water Board's website[3].

Currently there are two ways of accomplishing planned DPR. These include:

1. Advanced treated water is produced at an advanced water treatment facility (AWTF) and is introduced as a raw water supply immediately upstream of a drinking water treatment facility. To date there are a few permitted projects of this type in the United States.

2. Finished water is produced at an AWTF that is also permitted as a drinking water treatment facility and the water is introduced directly into the drinking water supply distribution system. To date, DPR in this form has not been permitted in the United States.

Due to current regulatory limitations and the cost prohibitive nature of DPR (i.e., the cost to build an additional water treatment facility), DPR was not specifically evaluated as a viable alternative as part of this Study.

[3] http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/rw_dpr_criteria/app_b_ag_rpt.pdf

3. Recycled Water Quality Objectives

3.1 Regulatory Requirements

In June 2014, the California Department of Public Health (CDPH) adopted regulations for the use of recycled water, referred to as Title 22. The Title 22 regulations stipulate water quality limits and required treatment processes and applies them to non-potable applications for which recycled water may be used. These non-potable applications include various types of irrigation, recreational impoundments, toilet flushing, and industrial cooling tower use. Additionally, water quality limits and required treatment processes have been established for aquifer replenishment via spreading and injection. This application is termed indirect potable reuse (IPR).

Table 3-1 lists all non-potable applications addressed by the Title 22 regulations. The main water quality limits addressed pertain to total coliform and turbidity levels.

Table 3-1: California State Water Reuse Criteria for Selected Non-potable Applications (Title 22)

Non-potable Applications	Quality Limits	Treatment Required
Fodder Crop Irrigation	Not Specified	Secondary
Processed Food Crop Irrigation	Not Specified	Secondary
Food Crop Irrigation	2.2 total coliform/100 mL 2 NTU(1)	Secondary Coagulation Filtration Disinfection
Restricted Recreational Impoundments	2.2 total coliform/100 mL	Secondary Disinfection
Restricted Access Irrigation	23 total coliform/100 mL	Secondary Disinfection
Unrestricted Access Irrigation	2.2 total coliform/100 mL 2 NTU	Secondary Coagulation Filtration Disinfection
Toilet Flushing	2.2 total coliform/100 mL 2 NTU	Secondary Filtration Disinfection
Industrial Cooling Water	2.2 total coliform/100 mL 2 NTU	Secondary Coagulation Filtration Disinfection

(1) Nephelometric Turbidity Unit (NTU)

Table 3-2 presents specific requirements for groundwater recharge into potable aquifers, also included in the Title 22 regulations. The constraints that must be met for recycled water to be used for groundwater recharge are more extensive than those that apply to landscape irrigation or industrial uses.

Table 3-2: Draft California Regulations for Groundwater Recharge into Potable Aquifers (Title 22)

Water Quality Limits for Recycled Water	Treatment Required	Other Selected Requirements
• ≥12-log virus reduction • ≥10-log *Giardia* cyst reduction • ≥10-log *Cryptosporidium* oocyst reduction • Drinking water MCLs (except for nitrogen) • Action levels for lead and copper • ≤10 mg/L total nitrogen • TOC ≤0.5 mg/L/RWC	***Spreading*** • Oxidation • Filtration • Disinfection • Soil aquifer treatment ***Spreading with full advanced treatment*** • Oxidation • Reverse osmosis • Advanced oxidation process • Soil aquifer treatment ***Injection*** • Oxidation • Reverse osmosis • Advanced oxidation process	• Industrial pretreatment and source control program • Initial maximum RWC ≤20% for spreading tertiary treated water • Initial maximum RWC for injection based on California Department of Public Health (CDPH) review of engineering report and other information from public hearing • ≥2-month retention (response) time underground • 1-log virus reduction credit automatically given per month of subsurface retention • 10-log *Giardia* reduction and 10-log *Cryptosporidium* reduction credit given to spreading projects that have at least 6 months' retention time underground • Monitor recycled water and monitoring wells for priority toxic pollutants, chemicals with state notification levels specified by CDPH, and unregulated constituents specified by CDPH • Operations plan • Contingency plan • Spreading projects with full advanced treatment must meet the requirements for injection projects, except that after one year of operation the project sponsor may apply for a reduced monitoring frequency for any monitoring requirement

3.2 Recycled Water Quality Goals

Currently, all of the effluent from VSD's Water Reclamation Facility (WRF), approximately 5.6 MGD, is discharged to the CVSC. With the exception of an estimated minimum flow of approximately 0.5 MGD required to maintain existing riparian vegetation in the channel, the remaining effluent is available for use as recycled water. Additionally, all wastewater flows from CSD's WWTP, which is currently approximately 2.6 MGD, is available for use as recycled water.

As shown previously on Table 3-1, Title 22 regulations stipulate allowable levels of total coliform and turbidity for various non-potable water applications. Effluent data for both of these parameters is not currently available for either the VSD WRF or CSD WWTP; however, it is recommended that this data be gathered for documentation and analysis during further analysis and testing as discussed in Section 6-4. Given historical data from the region, it appears that with the addition of coagulation and filtration processes to the existing treatment train, both the total coliform and turbidity limits as required by the Title 22 regulations could be satisfied. Analysis of additional water quality data as discussed in Section 6-4 will serve to confirm this assumption and further refine the design criteria for the required treatment process upgrades. Bench scale pilot testing and FEEM (Fluorescent Excitation Emissions Matrix) Testing was conducted at each of the wastewater treatment plants and the discussion and results are included in the individual TM's under separate covers.

3.3 Types of Recycled Water Use

Title 22 regulations provide requirements for eight different non-potable applications for recycled water. Table 3-3 describes the applications in further detail and provides the minimum level of allowable treatment for each.

Table 3-3: Title 22 Non-potable Applications for Recycled Water

Non-potable Applications	Description	Minimum Level of Allowable Treatment
Irrigation		
Fodder Crop	Pasture for milk animals for human consumption	Disinfected Secondary-23[(1)]
	Fodder and fiber crops and pasture for animals not producing milk for human consumption	Undisinfected Secondary
Processed Food Crop	Food crops undergoing commercial pathogen-destroying processing before consumption by humans	Undisinfected Secondary
Food Crop	Food crops where recycled water contacts the edible portion of the crop, including all root crops	Disinfected Tertiary
	Surface-irrigated food crop, above-ground edible portion not contacted by recycled water	Disinfected Secondary-2.2[(2)]
Restricted Access	Area where public access is controlled so that areas irrigated with recycled water cannot be used freely by the public (i.e., park, playground, or school yard) and where irrigation is conducted only in areas and during periods when the golf course is not being used by golfers	Disinfected Secondary-23
Unrestricted Access	Parks and playgrounds, school grounds, residential landscaping, unrestricted-access golf courses	Disinfected Tertiary
Other	Any other irrigation uses not specifically prohibited by other provisions of the ***California Code of Regulations***	Disinfected Tertiary
Impoundments (body of water confined by an enclosure, as a reservoir)		
Restricted Recreational	Recreation limited to fishing, boating, and other non-body contact activities; and publicly accessible fish hatcheries	Disinfected Secondary-2.2
Non-Restricted Recreational	Impoundment of recycled water in which no limitations are imposed on body-contact water recreational activities	Disinfected Tertiary
Landscape	Recycled water is stored or used for aesthetic enjoyment or landscape irrigation, not intended for public contact (no decorative fountains)	Disinfected Secondary-23

Non-potable Applications	Description	Minimum Level of Allowable Treatment
Industrial Cooling/Air Conditioning		
With Cooling Tower	Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or spraying that creates a mist	Disinfected Tertiary
Without Cooling Tower	Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative condenser, or spraying that creates a mist	Disinfected Secondary-23
Other Uses		
	Flushing toilets and urinals, priming drain traps; Industrial process water that may contact workers; Structural firefighting; Decorative fountains; Commercial laundries; Consolidation of backfill material around potable water pipelines; Artificial snow making for commercial outdoor use; Commercial car washes, not heating the water, excluding the general public from the washing process	Disinfected Tertiary
	Industrial process water that will not come into contact with workers; Industrial boiler feed; Nonstructural firefighting; Backfill consolidation around non-potable piping; Soil compaction; Mixing concrete; Dust control on roads and streets; Cleaning roads, sidewalks and outdoor work areas	Disinfected Secondary-23
	Flushing sanitary sewers	Undisinfected Secondary
Groundwater Recharge (returning water to underground aquifers)		
Surface Spreading	Recycled water is deposited over an area, such as a percolation pond, and allowed to move downward from surface to aquifer over time	Allowed under special case-by-case permits by the Regional Water Quality Control Board
Injection	Artificial recovery (AR) and Aquifer Storage and Recovery (ASR) wells inject recycled water directly into the aquifer	

(1) Disinfected Secondary–23: Recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the effluent is no greater than a most probable number (MPN) of 23 per 100 milliliters.
(2) Disinfected Secondary–2.2: Recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the effluent is no greater than a MPN of 2.2 per 100 milliliters.

Investigations within the VSD WRF's service area were conducted, and information gathered indicates that the main recycled water uses for the VSD WRF's effluent are unrestricted access landscape irrigation and aquifer recharge via surface spreading or injection. The VSD WRF currently employs oxidation, secondary treatment, and disinfection treatment processes. The reclamation facility would require the addition of tertiary treatment, consisting of coagulation and filtration processes to serve some types of irrigation customers with recycled water, or to recharge the aquifer via surface spreading. The coagulation requirement is typically met with the addition of polymer, or other coagulant chemical such as alum, to the secondary clarifier effluent. While there are various types of filtration methods available, sand filters and cloth/disk filters are two reliable technologies that will be discussed in more detail in Section 6.2 of this technical memorandum. The addition of microfiltration, reverse osmosis, and advanced oxidation treatment processes would be required for the VSD WRF effluent to be used for aquifer recharge via injection. Since the effluent from CSD's WWTP undergoes similar treatment to secondary effluent quality as the VSD WRF, it is assumed for the purposes of this study that the treatment of CSD WWTP effluent would be the same processes as VSD WRF effluent.

3.4 Regulatory Requirements for Groundwater Recharge with Recycled Water

A proposed Indirect Potable Reuse (IPR) project is subject to DDW Recycled Water Regulations for Groundwater Recharge with Recycled Water (GRRW). Articles 5.1 and 5.2 apply to Groundwater Replenishment Reuse Projects (GRRPs), for which recharge is accomplished with surface application methods (i.e., spreading basins) and subsurface application methods (i.e., injection wells), respectively. Key requirements for new GRRPs that affect project feasibility include the satisfaction of pathogen reduction requirements and establishment of an appropriate response retention time based on anticipated underground retention of recharge water between the recharge facility and nearest public water supply well(s). Depending on the project goals for pathogen reduction and recycled water storage, these requirements are likely to be critical factors in evaluating the project feasibility and conceptual design of an IPR project.

3.4.1 Pathogenic Microorganism Control

Section 60320.108 (Pathogenic Microorganism Control) of the recycled water regulations states that at least three treatment processes be used to achieve 12-log enteric virus bacteria, 10-log Giardia Cyst, and 10-log Cryptosporidium reduction. No single treatment process may be credited with more than 6-log reduction, and each treatment process must be able to achieve 1-log reduction.

Underground retention of recycled water can represent one treatment process. For each month of underground retention, the recycled municipal water is credited with 1-log pathogen reduction. At a minimum, the recycled municipal water applied at a GRRP shall receive treatment that meets the definition of filtered wastewater and disinfected tertiary recycled water (pursuant to Section 603001.320).

The underground retention time of recycled water needs to be demonstrated using one of four accepted methods. These include (1) an added tracer study, (2) an intrinsic tracer study, (3) application of a calibrated numerical groundwater flow model, and (4) analytical modeling. Regardless of the method used, hydraulic conditions evaluated need to be representative of normal GRRP operations. If an added tracer is used, 1-log pathogen reduction is credited per month of underground retention time demonstrated. If an intrinsic tracer study is used, 0.67 log pathogen reduction is credited per month of underground retention time demonstrated. If a calibrated numerical groundwater flow model is used, 0.50 log pathogen reduction is credited per month of underground retention time demonstrated. Finally, if analytical modeling is used (e.g., calculation using Darcy's Law using simplifying aquifer assumptions), 0.25 log pathogen reduction is credited for each month of underground retention time demonstrated.

3.4.2 Response Retention Time

Section 60320.124 (Response Retention Time) states that recycled municipal wastewater applied at the GRRP needs to be retained underground for an appropriate period of time to allow for sufficient response time to evaluate treatment failures and implement actions (including supplying an alternative source of drinking water supply to users of a water supply well potentially impacted by the GRRP) appropriate for the protection of public health. The response retention time shall be no less than two months.

3.4.3 Monitoring Wells

Prior to operating a GRRP, two monitoring wells need to be constructed downgradient of the recharge area. One well should be located between 2 weeks and 6 months of travel through the saturated zone affected by the GRRP and 30 days or more upgradient of the nearest water supply well. A second well should be located between the first monitoring well and nearest water supply well. Each well shall be validated (with an added or intrinsic tracer test) during initial operation of GRRP operations as receiving recharge water from the GRRP.

4. Hydrogeologic Evaluation

The feasibility of implementing an IPR project along with the suitability of surface or subsurface recharge methods is dependent on a combination of hydrogeologic and operational factors. These include (1) the lithology and permeability of vadose zone and saturated zone sediments, (2) groundwater occurrence and flow, (3) distance between recharge facilities and water supply wells, (4) local production well yields, (5) groundwater quality, and (6) timing, location, and rates of recharge.

Surface recharge methods (i.e., spreading basins) are applicable where the vadose zone does not have extensive fine-grained (clay) layers that would restrict vertical migration of recharge water and form perched groundwater conditions that could reduce surface infiltration rates. Underlying aquifers should generally be unconfined and sufficiently permeable to accommodate lateral and vertical flow of the infiltrating water away from the recharge area without forming an excessive groundwater mound that interferes with the infiltration process. Depth to water is also a consideration for the implementation of surface recharge facilities, as a shallow water table can adversely impact infiltration rates.

Subsurface recharge methods (e.g., injection wells) are applicable where the vadose zone or upper saturated zone contains restrictive layers, land is limited, and/or target receiving aquifers are deep and/or confined. Injection wells can be used to bypass the vadose zone and replenish the aquifer directly.

For this Study, existing hydrogeologic information was used to characterize local hydrogeologic conditions and support the evaluation of IPR project feasibility. A three-dimensional MODFLOW groundwater flow model was constructed and applied to predict groundwater flow conditions resulting from conceptual IPR projects based on spreading basins and injection wells at Posse Park and the VSD WRF. Specifically, the model was used to estimate groundwater mounding in the vicinity of potential recharge facilities at Posse Park and the VSD WRF, subsurface flowpaths of recycled water, and subsurface retention time of recycled water between recharge facilities and nearest downgradient production wells.

Hydrogeologic conditions pertinent to recharge feasibility, key findings from groundwater model simulations, and recommendations for addressing technical knowledge gaps are described below.

4.1 Hydrogeologic Setting

The VSD WRF is located in the Thermal Subarea of the Whitewater River (Indio) Subbasin of the Coachella Valley Basin (Basin) (see Figure 4-1). The Indio Subbasin is separated from the Desert Hot Springs Subbasin to the northeast by the Banning-Mission Creek Fault, which serves as a partial barrier to groundwater flow between the subbasins. Basin fill deposits in the Study Area are comprised primarily of interbedded predominantly coarse-grained Pleistocene and Holocene alluvial fan and stream wash deposits and fine-grained lake deposits. Based on available well driller's logs, the thickness of basin fill deposits exceeds 1,400 feet in this area. Rainfall on the valley floor averages about 4 inches per year and does not contribute significantly to groundwater recharge. Accordingly, aquifers in the Study Area are fed primarily by subsurface inflows from the west-northwest and anthropogenic return flows (primarily from turf and landscape irrigation) and upstream recharge operations managed by the Coachella Valley Water District.

The degree to which the Banning-Mission Creek Fault serves as a barrier to subsurface flow is significant with respect to the potential mounding response of recharged recycled water in the vicinity of recharge facilities at Posse Park. Conceptually, if recharged water is constrained within the Indio Subbasin by the fault, mounding heights for recharge operations at Posse Park would be higher than for the same operations at the VSD WRF site. Additionally, the subsurface travel time of recycled water away from recharge facilities would be faster at Posse Park than at the VSD WRF. While additional investigation is needed to confirm the hydraulic characteristics of the Banning-Mission Creek Fault, the influence of the fault on groundwater mounding response at Posse Park is addressed in groundwater flow simulations.

4.2 Subsurface Lithology, Groundwater Occurrence and Flow

As shown on Figure 4-1, a regional Pleistocene clay aquitard (orange hatched area on Figure 4-1), based on review of well driller's logs by DWR (1964), extends across much of the Study Area. Where present, the clay aquitard is 100 to 200 feet thick and partially restricts flow between a shallow (upper) aquifer zone and deeper (lower) aquifer zone. The top of the clay aquitard occurs at approximately 300 to 400 feet below ground surface (feet-bgs).

Groundwater flows in a northwest-to-southeast direction (perpendicular to groundwater elevation contours) and occurs under unconfined conditions in the upper aquifer system and under semi-confined to confined conditions in the lower aquifer system[4]. The regional clay aquitard is mapped beneath Posse Park but is not mapped beneath the VSD WRF, indicating that locally there may be a lesser degree of confinement in the lower aquifer system and better hydraulic connection between shallow and deeper aquifers beneath the VSD WRF.

Figure 4-2 shows a 16-mile long hydrogeologic cross section (A-A') that crosses through the VSD WRF (the cross section location is shown on Figure 4-1). Posse Park is projected onto the cross section from 1.4 miles. The cross section was developed from lithologic, well construction, water level, and water quality data for IWA, CWA, and CVWD municipal production wells.

The upper left cross section on Figure 4-2 shows the depth of well screens for IWA and CWA municipal production wells, the distribution of coarse-grained (sand/gravel) and fine-grained (silt/clay) deposits identified in well driller's logs, and 2015 groundwater levels. The cross section reveals the following local hydrogeologic conditions pertinent to recharge feasibility:

- Ground surface elevation ranges from about 20 feet above mean sea level (feet msl) in the northwest to -150 feet msl in the southeast.
- While site-specific information at the VSD WRF is not available, review of well driller's logs for production wells adjacent to the VSD WRF (IWA BB, IWA 1B, and CWA 17) indicate that

[4] The degree of lower aquifer confinement is likely greater where the clay aquitard is mapped.

surficial sediments (upper 100 feet) in the vicinity are comprised predominantly of coarse-grained sand and gravel deposits with relatively thin clay lenses.

- The estimated depth to groundwater beneath Posse Park and the VSD WRF based on water level measurements in adjacent production wells is approximately 110 and 90 feet-bgs respectively.

- Where present along the cross section, the Pleistocene clay aquitard occurs between -350 and -550 feet msl and ranges in thickness from about 150 to 200 feet.

- The presence of fine-grained deposits associated with the Pleistocene clay aquitard varies in well driller's logs for the municipal production wells closest to Posse Park and the VSD WRF. Significant clay deposits are present in IWABB, 1C and IWA 1E, but are thin or non-existent in IWA 1B, CWA 11, and CWA 17. The presence of significant clay deposits in IWA 1C and IWA 1E and lack of clay deposits in CWA 11 and CWA 17 are in general agreement with the mapped extent of areas in which upper and lower aquifer zones are defined by DWR. However, the presence of clay deposits in IWA BB is not consistent with the DWR mapping. It is not known whether the lack of regional clay aquitard beneath the VSD WRF (as interpreted by DWR) was supported by additional data.

- IWA production wells are located west (upgradient and side-gradient) of Posse Park and the VSD WRF, while CWA wells are located south (downgradient) of the VSD WRF. IWA and CWA production wells on the cross section are screened in deeper aquifers, with screen intervals ranging from 500 to 1,300 feet-bgs.

- IWA BB is located approximately 1.3 miles southwest of Posse Park and represents the closest downgradient public water supply well from Posse Park. CWA 11 and CWA 17 are located approximately 0.75 miles south of the VSD WRF property and represent the closest downgradient public water supply wells from the VSD WRF site.

It should also be noted that potential recharge via spreading basin alternatives identified at the VSD WRF site as a result of hydrogeological analysis performed as part of this Study are not believed to be in conflict with the conclusions reached in the Deactivation of Biological Treatment Ponds Technical Memorandum, MWH Global, a part of Stantec, January 24, 2017. The conclusions reached therein were based upon the lack of leachable contaminants in the sludge in the biological treatment cells, not necessarily the likelihood of percolated water reaching the aquifer.

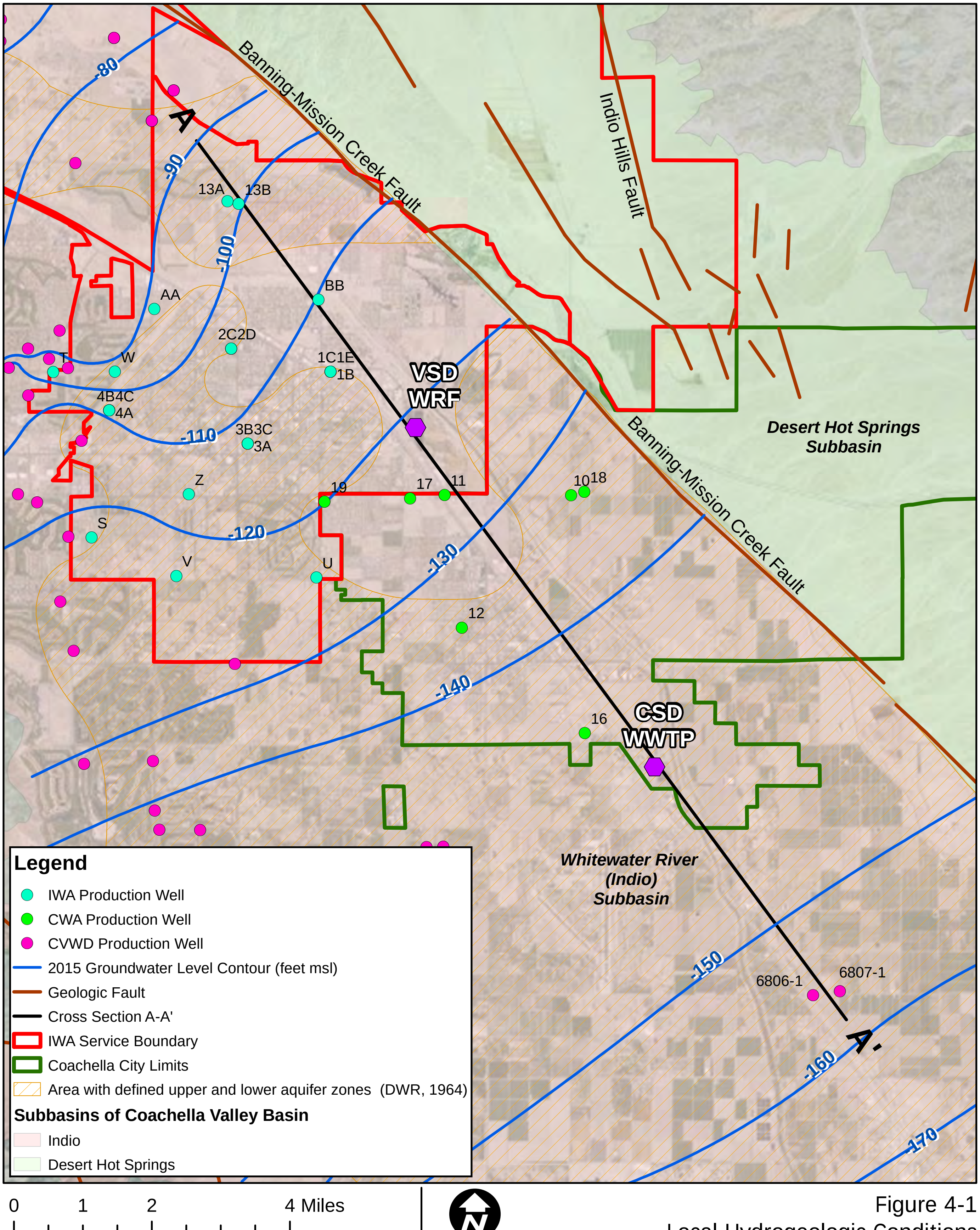
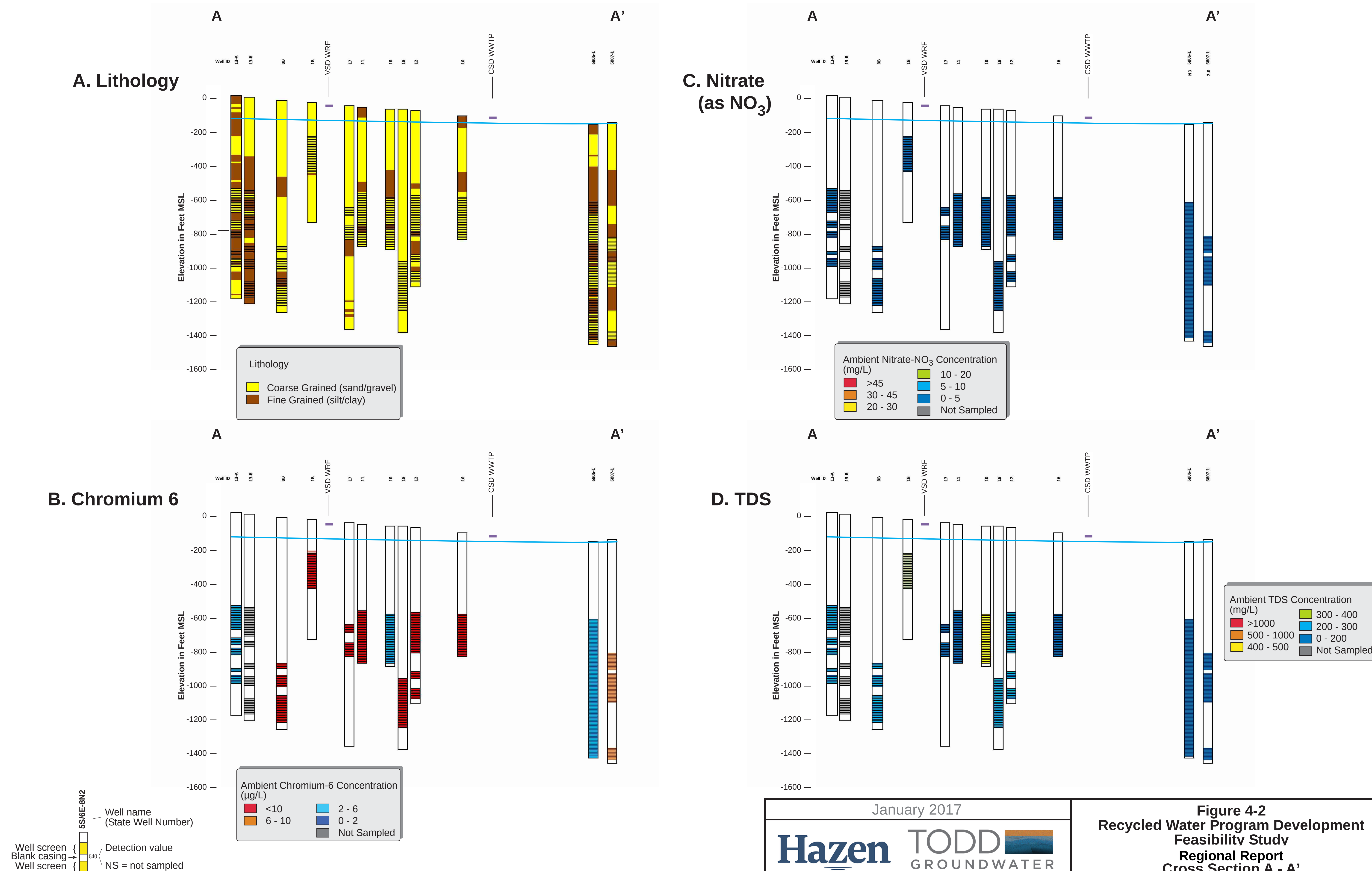


Figure 4-1
Local Hydrogeologic Conditions

Hazen TODD GROUNDWATER

Recycled Water Program Development Feasibility Study
Regional Report



January 2017

Hazen | TODD GROUNDWATER

Figure 4-2
Recycled Water Program Development Feasibility Study
Regional Report
Cross Section A - A'

4.3 Production Well Yields

Well yields of local IWA and CWA production wells provide an indication of the permeability of saturated zone sediments and potential injection well capacities. IWA production wells in the vicinity are generally constructed of 18-inch diameter steel casing and louvered screens, with some smaller diameter casings/screens associated with deeper well completions. Well yields of active IWA wells range from 1,100 to 3,350 gpm, with an average yield of about 2,300 gpm. Initial specific capacities range from 25 to greater than 100 gallons per minute per foot of drawdown (gpm/ft), with an average specific capacity of about 80 gpm/ft.

CWA 11 and CWA 17 are constructed of 10-inch and 16-inch diameter steel casing and louvered screen. The well yields of CWA 11 and 17 are 1,200 and 2,000 gpm respectively. Initial specific capacities of CWA 11 and 17 were measured at 9 and 62 gpm/ft, respectively.

IWA BB is constructed of 18-inch diameter steel screen. Wells yield is estimated at 3,000 gpm with an initial specific capacity of 40 gpm/ft.

4.4 Groundwater Quality

The upper right and two lower cross sections on Figure 4-2 show the distribution of selected groundwater quality parameters (nitrate as NO_3, chromium-6, and TDS) in municipal production well screens in the vicinity of Posse Park and the VSD WRF. Screen intervals are color-coded according to the most recent concentration for three target constituents of concern as reported between 2013 and 2015. The water quality concentrations in many local production wells exceed the primary maximum contaminant level (MCL) of 10 micrograms per liter (ug/L) for chromium-6, a naturally-occurring metal present in geologic sediments in the Basin. Nitrate concentrations in municipal production wells range from 1 to 5 mg/L as NO_3, well below the MCL of 45 milligrams per liter (mg/L). TDS concentration in municipal production wells generally range from less than 200 to 300 mg/L, below the recommended secondary MCL range of 500 to 1,000 mg/L.

4.5 Surficial Soil Layers and Infiltration Rates

Surface spreading basins require permeable surface soils to achieve high infiltration rates and reduce land requirements. The infiltration rate in surface spreading varies with the hydraulic conductivity of the vadose zone, depth to water, water quality, and other factors. Infiltration typically decreases over time due to physical, chemical, and/or biological clogging of the basin floor. Clogging can be controlled by reducing the total suspended solids (TSS) in the source water.

Sustainable infiltration rates of wastewater effluent ponds and groundwater replenishment facilities (GRFs) operated by CVWD in the central and eastern portions of the Coachella Valley range from about 2 to 3 feet per day (CVWD Water Reclamation Plant 10 and Thomas E. Levy Groundwater Replenishment Facility [GRF]). The CVWD facilities mentioned above are located along the southern margins of the basin and may have more permeable near-surface deposits compared to those at Posse Park and the VSD WRF.

A geotechnical investigation is being conducted at Posse Park that includes testing to confirm the infiltration rate of surficial soils at the park.

The approximate 20-acre area located to the south of the VSD WRF site where the former biological treatment ponds are located has been identified as a potential area for spreading in terms of percolation and in minimizing conveyance infrastructure. Infiltration rates of surface soils at the VSD WRF are not well documented. Historical VSD operations suggest that significant clay layers may exist below the ponds. However, well driller's logs show that surficial deposits (upper 100 feet) in municipal production well closest to the VSD WRF (IWA BB, IWA 1B, and CWA 17) are comprised predominantly of coarse-grained sand and gravel deposits with minor clay lenses. Additional investigation is needed to confirm shallow subsurface conditions.

4.6 Key Findings from Model Simulations

The local groundwater flow model developed for this Study was used to estimate groundwater mounding in the vicinity of potential surface recharge facilities and injection wells at Posse Park and the VSD WRF, subsurface flowpaths of recycled water, and subsurface retention time of recycled water between recharge facilities and nearest downgradient production wells. The local model was constructed on the basis of available geologic, aquifer property, and groundwater flow data and uses three layers to simulate upper and lower aquifers and the regional clay aquitard that separates the two aquifer systems over much of the region. The model was first calibrated to 2015 groundwater level conditions, then used to simulate recharge under steady-state conditions.

The local model incorporates several simplifying assumptions. The model is based on the use of steady-state groundwater flow. Estimates of aquifer thickness and hydraulic conductivity values were made for each model layer. Additionally, groundwater pumping from municipal production wells was not simulated. These input parameter assumptions yield uncertainty in model predictions. Accordingly, simulated groundwater elevations, flow rates and directions should be considered relative estimates of potential recharge system performance. The Banning-Mission Creek Fault was simulated using the horizontal flow barrier (HFB) package in MODFLOW, with an assumed low conductance of 1×10^{-7}/ft. Additional simulations incorporating site-specific aquifer characteristics and under transient flow conditions can be conducted as a part of future design phases.

For the simulation of a conceptual spreading basin project, recharge of the potential current excess flows from the VSD WRF (9 MGD) under existing effluent conditions and 18 MGD for future effluent conditions) was applied over Posse Park; the same flows were applied over the former biological treatment pond area[5] at VSD WRF. For simulation of a conceptual injection well project, 9 MGD of recycled water was injected into six injection wells screened in the lower aquifer (Model Layer 3),

[5] Assuming basin berms, side slopes, ramps, and freeboard requirements use 40 percent of the 20 acre biological pond area, 69MGD and 18 MGD would require a basin infiltration rate of approximately 2.25 and 4.50 feet per day respectively. Similar basin infiltration rates would be needed for recharging 9 MGD and 18 MGD at Posse Park, which has an area of approximately 25 acres.

equally spaced along the perimeter of the former biological ponds area[6]. A second injection well simulation was also conducted wherein 18 MGD of recycled water was injected into twelve injection wells equally spaced along the perimeter of Posse Park and the former biological ponds at VSD WRF.

Results of groundwater flow modeling for the spreading basin scenario indicate the following:

1. Given a current depth to water of 110 feet-bgs at Posse Park and 90 feet-bgs at the VSD WRF, the available subsurface storage at both sites can accommodate estimated maximum groundwater mound heights beneath simulated spreading basins for 9 MGD (90 feet at Posse Park and 65 feet at the VSD WRF). Results assume a continuous 100-foot clay aquitard beneath the VSD WRF site and across the model area. The recharge mound associated with recharge of 9 MGD should remain below the base of the spreading basins and not adversely impact surface infiltration rates in the basins. The volume of recharge would require a basin infiltration rate of 2.25 feet per day.

2. Maximum groundwater mound heights beneath simulated spreading basins for 18 MGD (160 feet at Posse Park and 120 feet at the VSD WRF) exceed the available subsurface storage at Posse Park and the VSD WRF and are likely to negatively impact long-term infiltration rates. Furthermore, the volume of recharge requires a high basin infiltration rate of 4.50 feet per day.

3. Analysis of recharge flowpaths indicate that recycled water flows radially and downgradient away from the VSD WRF, spreading out approximately 3 miles at its maximum width. Recharge flowpaths from Posse Park are constrained to the northeast by the Banning-Mission Creek Fault.

4. A significant portion of the recycled water migrates through the intervening clay aquitard and enters into the lower aquifer zone. Recycled water is expected to reach the production zone aquifer at the nearest downgradient municipal production wells. Subsurface travel times from Posse Park and VSD WRF to the nearest production wells range from about 6 to 15 years for 9 and 18 MGD recharge scenarios.

Results of groundwater flow modeling for the injection well scenarios indicate the following:

1. Given a current depth to water of 110 feet-bgs at Posse Park and 90 feet-bgs at the VSD WRF, and assuming a design injection rate of 1,042 gpm per well, the estimated maximum water level mound heights in an individual injection well are as follows:
    a. For 9 MGD, 40 feet at VSD WRF and 60 feet at Posse Park.
    b. For 18 MGD, 80 feet at VSD WRF and 120 feet at Posse Park.

[6] Equal spacing of injection wells around the site perimeter to minimize well interference during injection. Six and 18 wells each with an injection capacity of 1,042 gpm each is needed to inject 9 and 18 MGD respectively. This injection rate is reasonable, given that 1) individual well yields for IWA and CWA production wells average about 2,300 gpm, and 2) yields during injection are commonly one-half of yields during extraction. Backflushing at up to twice the injection rate is recommended. Therefore, a preliminary injection well design would be 16 to 24 inches and include a pumping system to backflush the well screens to mitigate clogging.

Accordingly, recharge of 9 MGD in injection wells at the Posse Park or the VSD WRF sites could be accommodated with no need to accommodate excess pressure buildup at the injection well head. Mounding in injection wells for the 18 MGD scenario at Posse Park would require additional pressure at the well head to overcome recharge mounding.

2. Analysis of recharge flowpaths indicate that recycled water flows radially and downgradient away from the VSD WRF, spreading out over an area approximately 4 miles at its maximum width, or about 1 mile wider than the surface spreading scenario. Simialr to the surface spreading scenarios, recharge flowpaths from Posse Park are constrained to the northeast by the Banning-Mission Creek Fault.

3. Recycled water is expected to reach the nearest downgradient municipal production well (IWA BB) from Posse Park in approximately 4 to 5 years for 9 MGD and 3 years for 18 MGD. Recycled water is expected to reach the nearest downgradient municipal production wells (CWA 11 and 17) from the VSD WRF in approximately 6 to 7 years for 9 MGD and 3 to 4 years for 18 MGD.

4.7 Hydrogeologic Conclusions

Based on the evaluation of local hydrogeologic conditions and results of groundwater flow modeling, the following conclusions can be made:

1. An IPR project of 9 MGD at Posse Park or the VSD WRF using surface spreading basins or injection wells appears to be technically feasible from a hydrogeologic mounding and travel time perspective. Assuming 12 acres of infiltrating area (60 percent of the 20-acre former biological pond area or about 50 percent of the Posse Park area), recharge of 9 MGD through spreading basins requires an infiltration rate of 2.25 feet per day or greater.

2. An IPR project would increase local groundwater storage and stabilize groundwater levels in lower production zone aquifers.

3. Given that advanced treatment of recycled water is needed for injection wells, decreased concentrations of water quality constituents of concern (e.g. TDS, nitrate, and chromium 6) would be expected. Based on the modeling results, potential water quality benefits in downgradient production wells (IWA BB for Posse Park and CWA 11 and CWA 17 for the VSD WRF) would be expected. The timing of water quality benefits ranges from 3 to 7 years after the project inception for an IPR project utilizing injection wells and from about 6 to 15 years after project inception for an IPR project utilizing spreading basins.

4. Estimated travel times of recycled water to the nearest downgradient municipal production wells indicate that an IPR project using either spreading basins or injection wells would satisfy the subsurface retention time needed to receive maximum pathogen log-reduction credits (i.e., 6-log reduction credit for 6 months subsurface retention time demonstrated with an added tracer test or for 1 year subsurface retention time demonstrated with an intrinsic tracer test).

5. Available vadose zone storage beneath Posse Park and the VSD WRF are not adequate to accommodate recharge rates of 18 MGD. Additionally, in order to achieve 18 MGD through spreading basins, an infiltration rate of about 4.50 feet per day or greater would be required. Simulation of an 18 MGD IPR project (using twelve 1,042-gpm injection wells equally spaced around the perimeter of the VWD WRF biological ponds) indicates that maximum mound height in an individual injection well would be about 80 feet, which can be accommodated without additional pressure needed at the injection well head. Injection of 18 MGD at Posse Park would result in mound height of about 120 feet, requiring additional injection pressure at the well head.

Conclusions are based on evaluation of available hydrogeology for the Study Area. The following additional data collection and evaluation tasks are recommended to support design, costing, and implementation of an IPR project at the VSD WRF site:

1. A field program involving a combination of cone penetrometer tests (CPTs) and drilling of soil borings at Posse Park and the former biological pond area is recommended to confirm whether the lithologic distribution of vadose zone sediments is favorable for recharge using surface spreading basins. Soil borings could be drilled using the hollow-stem auger method. Small-diameter monitoring wells could be installed in the borings to facilitate performance monitoring during infiltration tests and monitoring of long-term operation of the future recharge facilities.

2. Long-term infiltration tests (up to 30 days) should be conducted either at Posse Park and, in or adjacent to the former biological ponds at the VSD WRF site to confirm surface infiltration rates. Should infiltration testing be conducted within the former biological ponds, the upper 5 feet of sediment and debris should be removed prior to testing. Soils should be excavated to create a temporary test basin with sufficient area to minimize the effect of lateral spreading of recharge water (e.g., 25 feet x 25 feet). During the test, the discharge rate and ponded water level should be measured and converted to a vertical infiltration rate.

3. Refined groundwater flow and solute transport modeling could be conducted to further evaluate and optimize recharge (and recovery) operations and provide support for DDW GRRP permit requirements.

4. The biological ponds and a portion of the VSD WRF are located adjacent to a residence on reservation land. It should be noted that the travel times associated with a groundwater recharge project at the VSD WRF could potentially be impacted by the presence of a potential existing or future private well on said reservation land.

5. Reuse Opportunities

5.1 Indirect Potable Reuse

A proposed regional IPR project would involve the treatment of wastewater generated from the CSD WWTP (that is conveyed to VSD WRF) and wastewater generated at VSD WRF for subsequent groundwater recharge and storage of the recycled water in the groundwater system. The primary objective of an IPR project is to replenish the groundwater basin, provide storage and seasonal to long-term banking with or without recovery of the recycled water by extraction wells.

5.2 Groundwater Recharge

While knowledge gaps of site hydrogeologic conditions remain, an IPR project at the VSD WRF and Posse Park using injection wells appears to be technically feasible. An IPR project at the VSD WRF with spreading basins may be feasible pending confirmation of the sustainable infiltration capacity of surficial sediments and the extent and thickness of clay deposits in the vadose zone field investigations. Soil testing and percolation testing was recently completed near Posse Park and those results are pending.

5.2.1 Cost Considerations for IPR Project using Spreading Basins

To maximize infiltration rates in basin-type facilities, shallow basins are preferred (Bouwer, 2002). Although deeper basins provide more head on the basin floor, this has been shown to actually reduce infiltration rates due to compressibility of the clogging layer and other processes. Shallow basins also facilitate drying of basins for maintenance.

Infiltration basins are often constructed in an interconnected series that allows for continuous operation if individual basins need to be dried for maintenance. Maintenance often involves drying the basins and reworking the shallow surficial sediments to increase basin floor permeability (scarification).

In designing and constructing new spreading basins, the following project components are typically considered:

- Earthwork (to remove debris and re-contour basins)
- Berm roads
- Bank stabilization (rip-rap)
- Access ramps (concrete)
- Turnouts and distribution pipelines
- Flow control valves and flowmeters
- Electrical instrumentation
- Land acquisition
- Engineering and permitting, pilot testing, CEQA compliance, construction management

Refer to Section 8 for more detailed cost information.

5.2.2 Cost Considerations for IPR Project using Injection Wells

Injection wells are typically a more expensive recharge facility option compared to surface spreading basins primarily because of the depth of drilling needed to reach and sufficiently screen across permeable sediments in the production zone aquifer. In addition, injection wells require advanced wastewater treatment to prevent premature well clogging and have higher construction and maintenance costs compared to spreading basins. In developing a cost estimate for the construction of an injection well, the following project components are typically considered:

- Test injection well/monitoring well drilling, construction, and hydraulic testing
- Injection well drilling, construction, development, and hydraulic testing
- Turnouts and distribution pipelines
- Flow control valves and flowmeters
- Well pump for backflushing
- Electrical instrumentation
- Land acquisition
- Permitting and environmental compliance

A preliminary cost estimate to drill, install, equip, and test an injection well is approximately $1.5 million per well. This estimate assumes a well casing and screen diameter of 16 inches and a well depth of 1,000 feet to sufficiently screen across permeable sediments in the lower production zone aquifer to provide 1,000 gpm injection capacity. The cost estimate does not include engineering, permitting, and environmental review costs. Refer to Section 8 for more detailed cost information.

5.3 Non-potable Reuse

Non-potable reuse consists of the use of recycled water for irrigation purposes, driven by large turf irrigation users such as golf courses, polo clubs, parks, and homeowner's associations (HOAs). Irrigation water use typically varies seasonally with peak use during the summer months and minimum use during the winter months. Non-potable reuse systems must be able to accommodate these variations in demand.

5.3.1 Potential Recycled Water Customers

As discussed in TM-1, potential recycled water customers for IWA were previously identified in the 2011 Recycled Water Master Plan (RWMP). The potential demand totaled 15,974 AFY with a corresponding maximum day demand of 28.53 MGD. In addition to that demand, two proposed master-planned developments Grand Valley and Stonewater with a total estimated average demand of 1,647 AFY, and a maximum day demand of 2.94 MGD were identified. Combined, this represents a total potential recycled water demand of 17,621 AFY for average day demand, and 31.47 MGD for maximum day demand in and around IWA's and VSD's service areas. In comparison, CWA has an estimated potential recycled water demand under existing conditions of 619 AFY, with a maximum day demand of 1.08 MGD.

As previously stated in the IWA 2011 RWMP, there is not enough wastewater flows available from VSD to serve all IWA recycled water demands identified, even more so, when accounting for the minimum discharge of approximately 0.5 MGD to the CVSC. For that reason, only the first phase of potential IWA customers identified in the 2011 RWMP could be served at this time using only VSD flows. This presents an opportunity for regional coordination and economies of scale in using CSD's wastewater to serve areas within IWA's service area where potential recycled water demands are greater and more concentrated.

6. Wastewater Treatment Process Selection

6.1 Description of Existing Wastewater Treatment Plant

In 2015 and 2016, the VSD WRF treated approximately 5.6 million gallons per day (MGD). With a minimum discharge of approximately 0.5 MGD required to the CVSC to maintain the existing riparian vegetation, this leaves approximately 5.1 MGD of average daily flow for recycled water use. By the buildout year 2030, the VSD WRF is expected to reach a total capacity of 12 MGD. Assuming the discharge of approximately 0.5 MGD to CVSC remains the same, approximately 11.5 MGD of average daily flow for recycled water will be available by 2030. During the same period in 2015 and 2016, the CSD WWTP treated approximately 2.6 million gallons a day (MGD). By the time the CSD WWTP is fully built out, the plant is expected to reach a total capacity of 6 MGD.

For the Regional Facility, a flow of 9 MGD is assumed for existing conditions based on the current flows available from VSD's WRF and CSD's WWTP of 5.6 MGD and 2.6 MGD, respectively. This 9 MGD corresponds to the first phase of the Regional Facility. The buildout flow for the Regional Facility is assumed to be 18 MGD based on the buildout capacities of VSD's WRF and CSD's WWTP of 12 MGD and 6 MGD, respectively.

Since VSD WRF has a current larger plant capacity, and the potential recycled water customers are more concentrated in the IWA and VSD service areas, it was determined that a regional facility should reside at the VSD WRF.

The existing VSD WRF liquids handling system is comprised of influent pumps, screening, grit removal, primary sedimentation basins, secondary treatment, oxidation ponds, a biological treatment unit, and disinfection. The WRF effluent is treated to secondary quality via an activated sludge treatment process including aeration basin with selectors, and secondary clarifiers. Disinfection is achieved with chlorine through a Chlorine Contact Tank (CCT3). Disinfected water is dechlorinated with sodium bi-sulfate before being discharged to the CVSC. During peak events, flows can also be diverted through oxidation ponds. These ponds currently act as a parallel secondary treatment system with the activated sludge system. A second Chlorine Contact Tank, CCT2, allows disinfection of pond effluent before discharging to the CVSC.

A process flow diagram and site plan showing the existing facilities for the VSD WRF is provided and shown in Figure 6-1 and Figure 6-2, respectively.

Discharge flow and water quality data from the VSD WRF's effluent for the period between January 31, 2015 and May 31, 2016 is presented in the Recycled Water Program Development Feasibility Study Technical Memorandum No. 1 Indio Water Authority / Valley Sanitary District (East Valley Reclamation Authority). The data shows average monthly flows at the facility range from 5.1 MGD in the dry season to 6.4 MGD during the wet weather months. Average monthly carbonaceous biochemical oxygen demand (CBOD) and total suspended solids (TSS) values from the plant effluent are 15.1 and 8.6 mg/L respectively. Additionally, bacteria monitoring yielded average monthly counts for E.coli of 2.5

MPN/100mL and Fecal Coliform of 3.1 MPN/100mL. Monthly total dissolved solids (TDS) averages were obtained from January through October of 2015. The average value recorded during that period was 449.0 mg/L.

Discharge flow and water quality data from the CSD WWTP effluent for the period between January 31, 2014 and December 31, 2015 is presented in the Recycled Water Program Development Feasibility Study Technical Memorandum No. 3 Coachella Water Authority / Coachella Sanitation District. The data shows average monthly flows at the facility range from 2.2 MGD in the dry season to 2.8 MGD during the wet weather months. Average monthly biochemical oxygen demand (BOD) and total suspended solids (TSS) values from the plant effluent sample location EFF-001C are 5.47 and 2.7 mg/L respectively. Additionally, bacteria monitoring yielded average monthly counts for E.coli of 2.1 MPN/100mL and Fecal Coliform of 2.1 MPN/100mL (data provided from January 2014 through May 2015). Two total dissolved solids (TDS) readings were obtained from June and December 2015, with the average of these being 435.0 mg/L.

The quality of effluent from CSD WWTP is similar to the effluent at VSD's WRF. Therefore, the treatment processes would be similar.

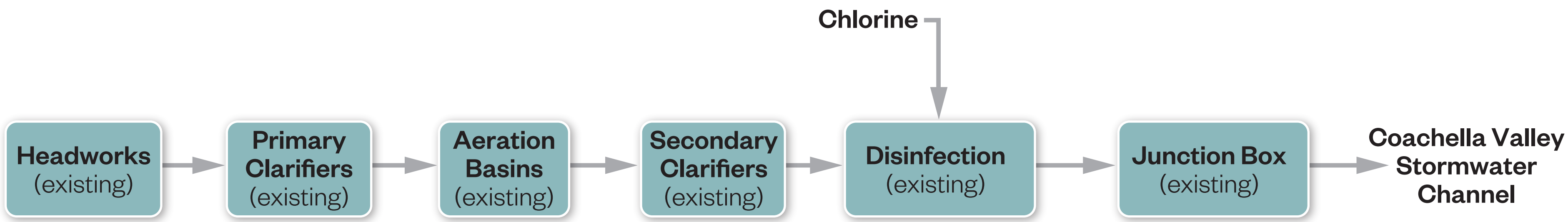


Figure 6-1
VSD WRF - Existing VSD WRF Process Treatment Schematic

Figure 6-2
VSD WRF Existing Facility Site Layout

6.2 Recycled Water Treatment Alternatives

The recycled water treatment alternatives evaluated in this section include uses for irrigation, surface spreading, as well as groundwater injection. In order to produce recycled water that meets Title 22 requirements (for landscape irrigation, surface spreading or injection), several treatment alternatives have been identified, which all include coagulation, tertiary filtration and disinfection. With the addition of tertiary level treatment, the VSD WRF would be able to provide recycled water to irrigation customers as well as recharge via spreading and percolation. In order to meet groundwater recharge requirements via injection, microfiltration and reverse osmosis followed by advanced oxidation processes is required.

For tertiary filtration, the alternatives evaluated include sand filters, cloth filters, microfiltration, and membrane bioreactors (MBR), while the groundwater injection alternative includes microfiltration followed by reverse osmosis (MF/RO). All alternatives will require disinfection as the final treatment step. For tertiary treatment and groundwater recharge via spreading, chlorine disinfection is required. For ground water recharge via injection, advanced oxidation is required. The alternatives were developed based on conventional Title 22 treatment requirements as well as any potential future treatment plant effluent requirements. A brief description of each process and the recommended design criteria for these alternatives are further described in the following sections.

6.2.1 Tertiary Filtration

Tertiary filters remove suspended solids from secondary effluent by passing it through a filter media that can be fine sand, dual media (anthracite/sand), or cloth. These are discussed below in more detail in the following sections.

6.2.1.1 Sand Filtration

Sand bed filters work by providing the particulate solids with many opportunities to be captured on the surface of a sand grain. Sand filters are available either as standalone package units or in a modular concrete design. The backwash can be intermittent or continuous depending on the design. Most sand filters operate with an upflow, counter-current flow pattern. For planning purposes, the assumed design criteria for sand filtration are summarized in Table 6-1. This will need to be verified during preliminary design.

Table 6-1: Sand Filtration Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flowrate	MGD	9	18
Filter media		Sand	Sand
Filtration rate	gpm/sq. ft	3.0	3.0
Total Sand Filtration surface area	Sq.ft	2,085	4,170
Cell Size	Sq.ft	400	400
Number of units		7	12
Backwash (continuous or intermittent)		Intermittent	Intermittent

6.2.1.2 Cloth Filtration

Cloth filters use a woven media to capture and filter out particles in the wastewater. A typical configuration is to have the cloth media on discs with an inside-out flow pattern. Cloth media filters are also available as standalone package units or in a modular concrete design and are typically low-head systems with automatic backwash capabilities. For planning purposes, the assumed design criteria for cloth filtration are summarized in Table 6-2.

Table 6-2: Cloth Filtration Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
Filter media		Cloth	Cloth
Average Filtration rate	gpm/sq. ft	3.0	3.0
Total Disk Filtration surface area	Sq.ft	2,085	4,170
Total Number of Disks	ft	45	90
Number of Disk Filtration Units		4	7

6.2.2 Micro Filtration

Micro filtration (MF) is a pressure-driven process that provides a near absolute barrier to suspended solids and microorganisms. MF membranes have a pore size ranging from 0.01 to 1.0 microns. Using MF for tertiary filtration also provides greater flexibility for future groundwater recharge since it is required as a pretreatment for reverse osmosis. The MF system has been preliminarily sized such that it can be used for either standalone tertiary treatment or as the pretreatment step before reverse osmosis. For planning purposes, the assumed design criteria are summarized in Table 6-3.

Table 6-3: Micro Filtration Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
Membrane Type		Hollow fiber	Hollow fiber
Membrane Material		Polyvinylidene fluoride (PVDF)	Polyvinylidene fluoride (PVDF)
Pore Size	Micron	0.04	0.04
Filtration flux rate	gallons/sq. ft day	28	28
Recovery	%	90	90
Number of duty trains		6	12
Total number of train		5	10
Flow per train	MGD	1.48	1.48

6.2.3 Membrane Bioreactor

The MBR process is a biological process that consists of membranes installed in membrane tanks and submerged in mixed liquor to separate solids and produce a high-quality effluent. The MBR process has the advantage of being able to achieve nutrient removal and also provides greater flexibility for future groundwater recharge since it is required as a pretreatment for reverse osmosis. Membranes used in this application have typical pore sizes in the range of 0.04 microns to 0.4 microns. While the MBR process is typically a higher cost alternative, it has advantages over tertiary filtration that include more flexibility for future groundwater recharge since it is considered pre-treatment for advanced treatment and any RO system downstream of an MBR would not require microfiltration. MBR would be a substitute for the existing activated sludge and secondary clarifier system, and new filters required for tertiary. For planning purposes, the assumed design criteria are summarized in Table 6-4.

Table 6-4: Membrane Bioreactor Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
Membrane Type		Hollow fiber	Hollow fiber
Membrane Material		Polyvinylidene fluoride (PVDF)	Polyvinylidene fluoride (PVDF)
Pore Size	Micron	0.04	0.04
Filtration flux rate	gallons/sq. ft day	30	30
Number of trains		6	12
Cassettes per train		5	5
Redundancy	%	25	25

6.2.4 Reverse Osmosis

High-pressure membrane processes such as RO are typically used for the removal of dissolved constituents including both inorganic and organic compounds. RO is considered a “high-pressure” process because it operates from 75 to 1,200 psig, depending upon the total dissolved solids (TDS) concentration of the feed water. During the RO process, the mass-transfer of ions through membranes is diffusion-controlled. The feed water is pressurized, forcing water through the membranes, concentrating the dissolved solids that cannot travel through the membrane. Consequently, these processes can remove salts, hardness, synthetic organic compounds, disinfection-by-product precursors, etc. Some of the major concerns with the RO process are the higher energy usage as well as the management of the concentrated brine stream, particularly for inland facilities such as VSD where a regional brine line for disposal has not yet been constructed. For this facility, there are limited options for brine disposal. Brine disposal would consist of on-site evaporation ponds or there may be potential for regional evaporation ponds. For either option, the brine could be further concentrated through a secondary RO pass or thermal evaporative processes to increase finished water production and decrease brine volume, effectively reducing the size of the evaporation ponds. For planning purposes, the assumed design criteria are summarized in Table 6-5.

Table 6-5: Reverse Osmosis Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
Membrane Type		Hollow Fiber	Hollow Fiber
Membrane Material		Polyvinylidene fluoride (PVDF)	Polyvinylidene fluoride (PVDF)
Pore Size		Non-porous	Non-porous
Filtration flux rate	gallons/sq. ft day	11	11
Recovery	%	80	80
Number of Duty units		6	12
Total number of Units		5	10
Flow per unit	MGD	1.33	1.33

6.2.5 Disinfection Alternatives

This section outlines some of the disinfection alternatives that are used for tertiary and advanced treatment including chlorine, and advanced oxidation (UV and peroxide) respectively.

6.2.5.1 Chlorine Disinfection

Chlorine has been one of the more common methods for disinfection of wastewater effluent. The move from gaseous chlorine to liquid hypochlorite solutions has reduced the risk associated with chlorine disinfection. Currently the VSD WRF uses chlorine disinfection and for the Title 22 tertiary requirements, this would also be the most cost effective. For planning purposes, the assumed design criteria for new disinfection facilities is summarized in Table 6-6.

Table 6-6: Chlorine Disinfection Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
Chemical name		Sodium Hypochlorite (NaOCl)	Sodium Hypochlorite (NaOCl)
Percent Active Chemical	%	10.25	10.25
Estimated Chlorine Dose	mg/L	5 - 10	5 - 10
Detention Time at peak flow	mins	90	90
Chlorine Contact Tank Dimensions	L(ft) x W(ft) x D(ft)	139 x 12 x 10	139 x 12 x 10
Number of Channels		3	6
Number of Passes per Channel		3	3

6.2.5.2 Advanced Oxidation

Advanced oxidation processes, in a very broad sense, refers to a set of chemical treatment procedures designed to remove organic (and sometimes inorganic) materials in water and wastewater by oxidation through reactions with hydroxyl radicals. These treatment procedures typically include ozone (O_3), hydrogen peroxide (H_2O_2) and/or UV light disinfection. The most common and cost effective is UV disinfection with hydrogen peroxide. When coupled, these provide an advanced oxidation system in which hydroxyl radicals are produced that attack and destroy many micro-constituents. For planning purposes, the assumed design criteria are summarized in Table 6-7.

Table 6-7: Advanced Oxidation Design Criteria

Criteria	Units	2017 Flowrate	2030 Flowrate
Flow rate	MGD	9	18
UV Dose	MJ/sq.cm	110	110
UVT	%	65	65
Estimated Hydrogen Peroxide Dose	mg/L	5 - 10	5 - 10

6.3 Wastewater Treatment Infrastructure Improvements

This section outlines the infrastructure improvements that are required for each alternative identified in Section 6.2. For each alternative, a process flow diagram and site layout is provided that identifies the space requirements for each treatment option. It should be noted that these layouts are at a preliminary concept level stage and could change based on further knowledge of the wastewater quality through full scale pilot testing which is further discussed in the TM's prepared under separate covers. These layouts show the general footprints based on recent vendor information. The footprints were developed for each unit operation based on an assumed existing system capacity of 9 MGD and 2030 flows which are projected to be approximately 18 MGD. Additionally, it should be noted that the site layouts presented, follow the phasing plan identified by the VSD Facility Master Plan completed by MWH in September 2015. Any improvements noted in the subsequent sections would be constructed upon the completion of all solids handling facility upgrades and the decommissioning of both North and South Cells, and Ponds 2 and 3.

6.3.1 Tertiary Filtration (Alternatives 2, 3, 5a, and 6)

Tertiary filtration facilities are associated with Alternatives 2, 3, 5a, and 6, which could consist of either sand or cloth filters and would require the construction of several units based on the design criteria in Section 6.2.1 above. A secondary effluent pump station would be required to pump effluent to the new tertiary filters and disinfection system. A recycled water pump station and recycled water storage tank would also be required to provide irrigation water to customers. The new filtration facilities are proposed for construction on the southern side of the facility in the decommissioned South Cell, and the recycled water storage tank and pump station in decommissioned Pond 3. A preliminary process flow diagram and conceptual site layout of the tertiary filtration system is presented in Figure 6-3 and Figure 6-4, respectively.

6.3.2 Tertiary Microfiltration

The tertiary microfiltration system would be based on the design criteria in Section 6.2.2. A secondary effluent pump station would be required to pump effluent to the new tertiary microfilters. The permeate could then be pumped from the microfiltration tank to the disinfection system and recycled water storage tank. A recycled water pump station located on the south side of the facility in decommissioned Pond 3 would be required to provide irrigation water to customers. A preliminary process flow diagram and conceptual site layout of the microfiltration system is presented in Figure 6-5 and Figure 6-6 respectively.

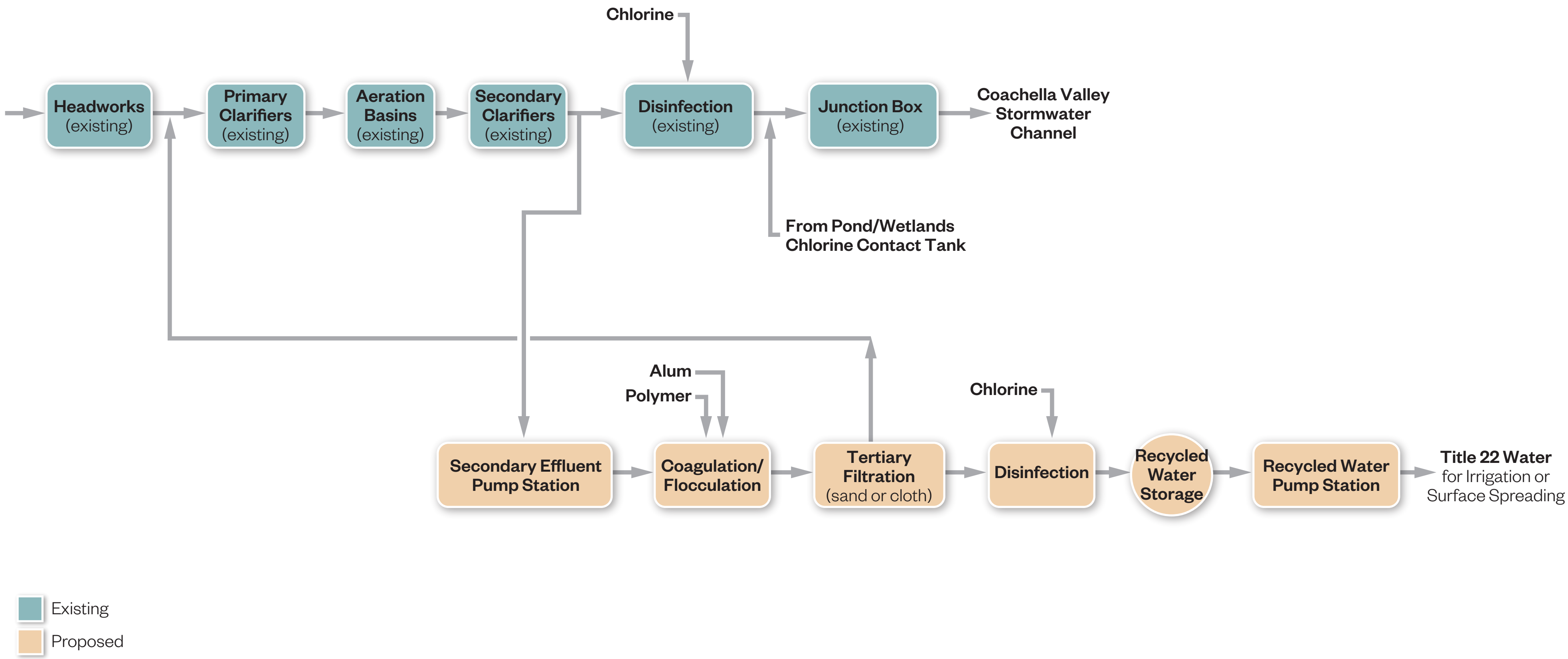


Figure 6-3
VSD WRF - Tertiary Filtration PFD

Figure 6-4
VSD WRF Preliminary Tertiary Filtration Site Layout

Recycled Water Program Development Feasibility Study
Regional Report

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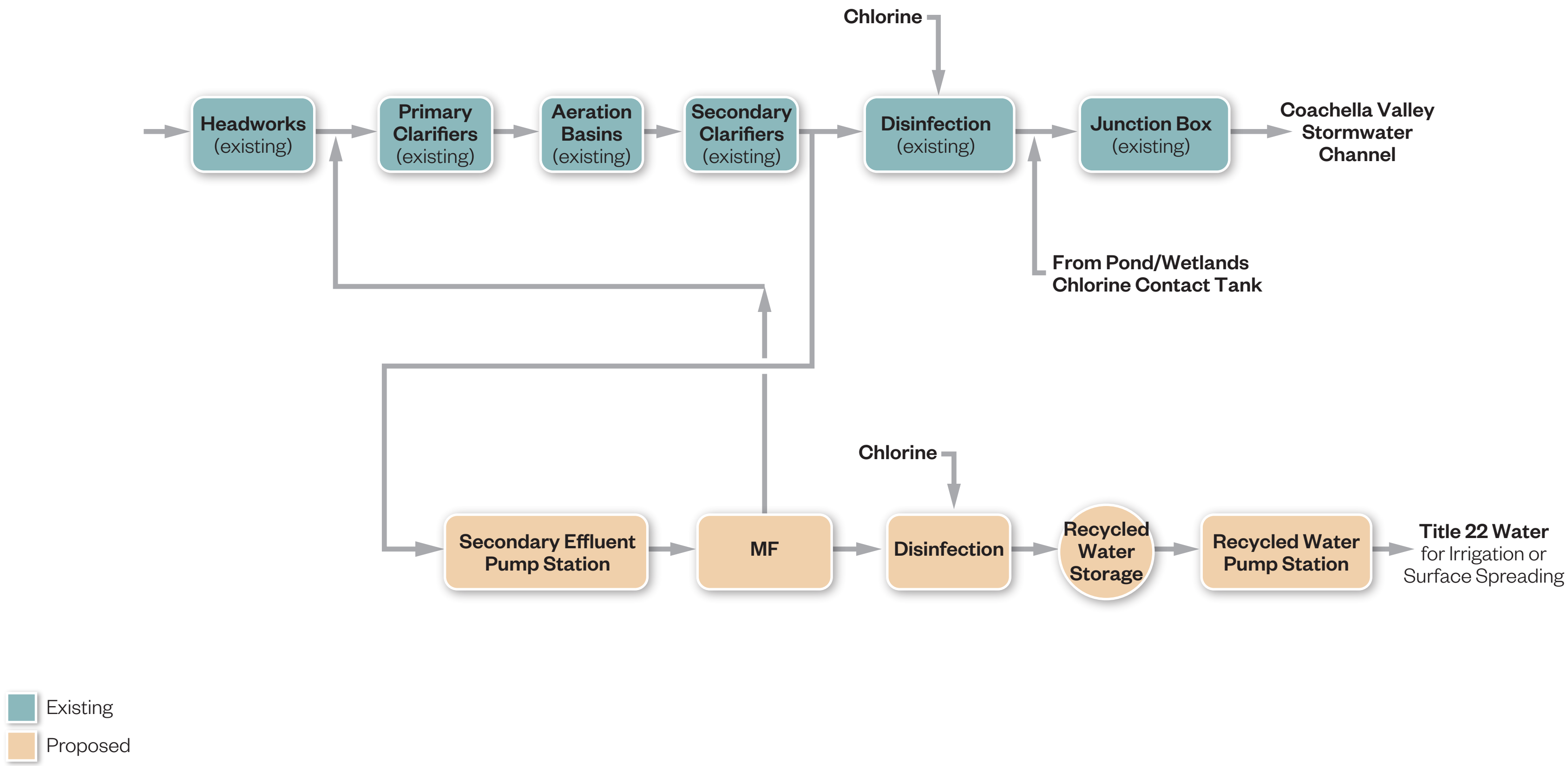

Figure 6-5
VSD WRF - Tertiary MicroFiltration PFD

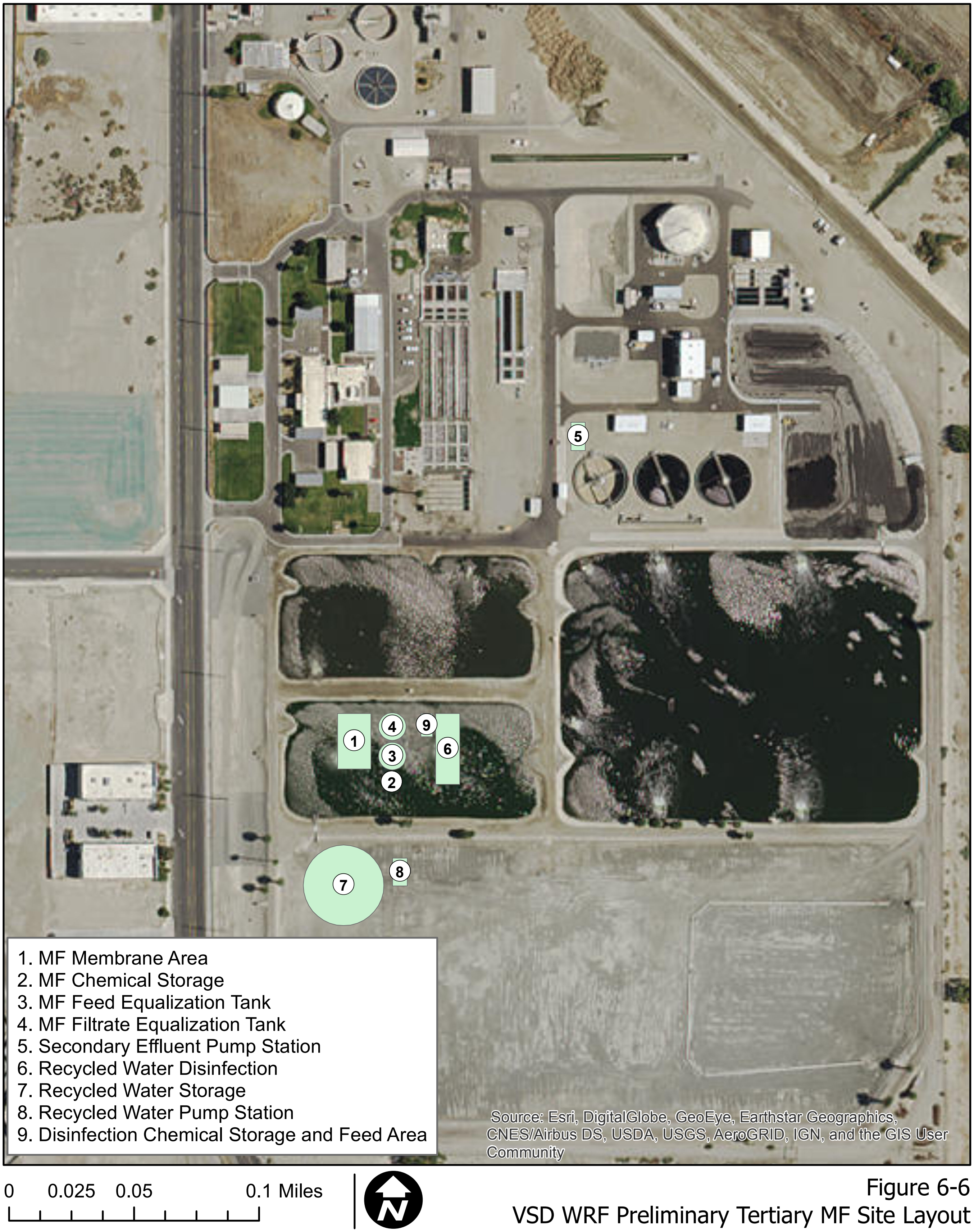

Figure 6-6
VSD WRF Preliminary Tertiary MF Site Layout

6.3.3 Membrane Bioreactor

The MBR system would be based on the design criteria presented in Section 6.2.3. If MBR were selected as the preferred treatment, the new MBR facilities would be constructed in the decommissioned South Cell. The membrane permeate would be pumped from the membrane tank to the disinfection system and recycled water pump station proposed in decommissioned Pond 3, also located on the south side of the facility. A preliminary process flow diagram and conceptual site layout of the membrane bioreactor system is presented in Figure 6-7 and Figure 6-8, respectively. Since the MBR process can also be a pre-treatment process to the RO system, it would be possible to use the MBR treatment if groundwater injection was being implemented at the VSD WRF or at Posse Park.

6.3.4 Advanced Treatment (Alternatives 4 and 5b)

Advanced water treatment (AWT) facilities are associated with Alternatives 4 and 5b and would be designed to treat wastewater for groundwater injection at the VSD WRF or Posse Park. This advanced treatment system would consist of the unit operations for MF/RO and UV/AOP as described previously. A break tank would be provided before the RO unit to ensure a stable influent flow. After RO treatment, the RO permeate would be pumped to the UV/AOP and stabilization processes. Then, the finished water would be pumped to storage or to injection wells at the plant or Posse Park. A preliminary process flow diagram and conceptual site layout of the advanced treatment system is presented in Figure 6-9 and Figure 6-10, respectively.

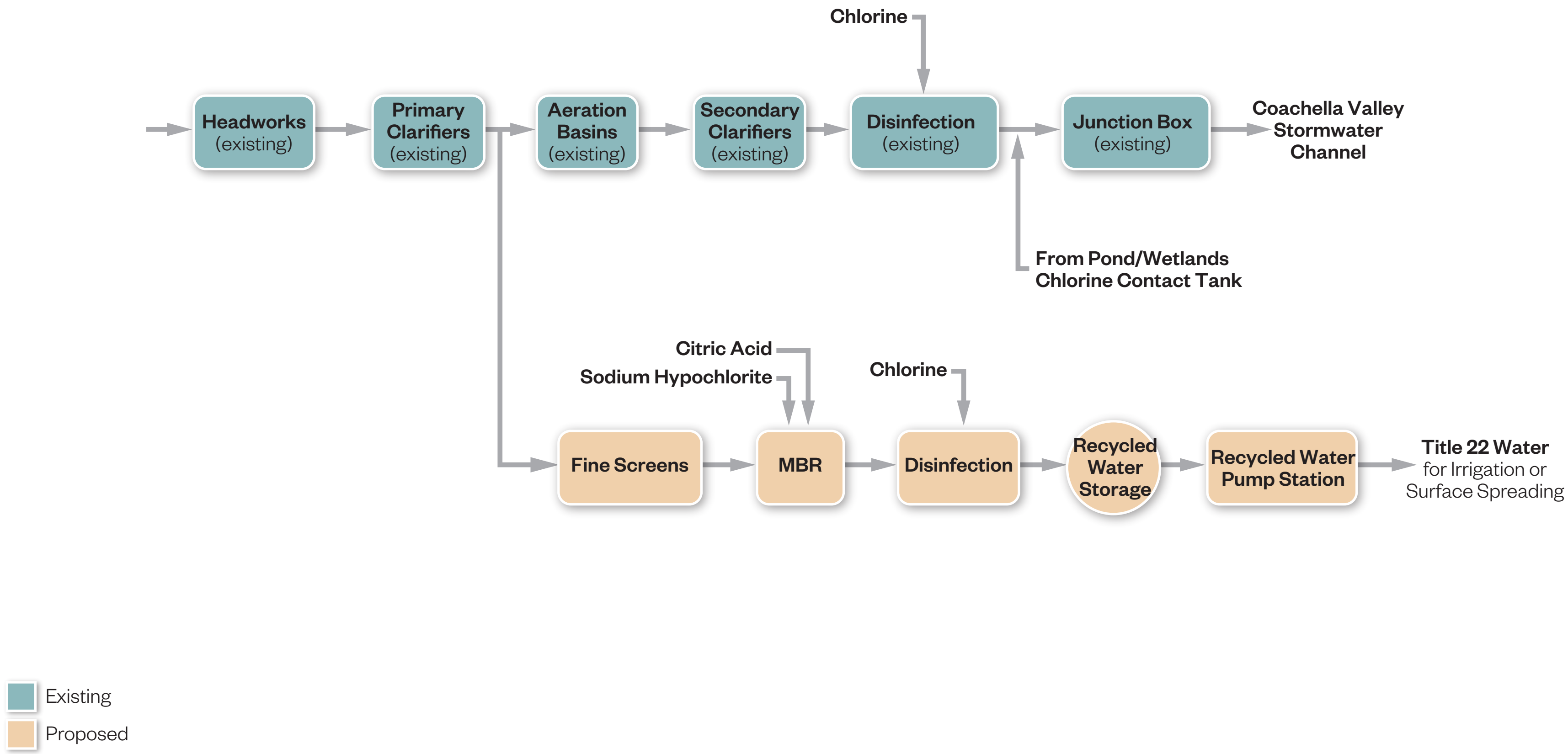

Figure 6-7
VSD WRF - MBR PFD

0 0.025 0.05 0.1 Miles

Figure 6-8
VSD WRF Preliminary Tertiary MBR Site Layout

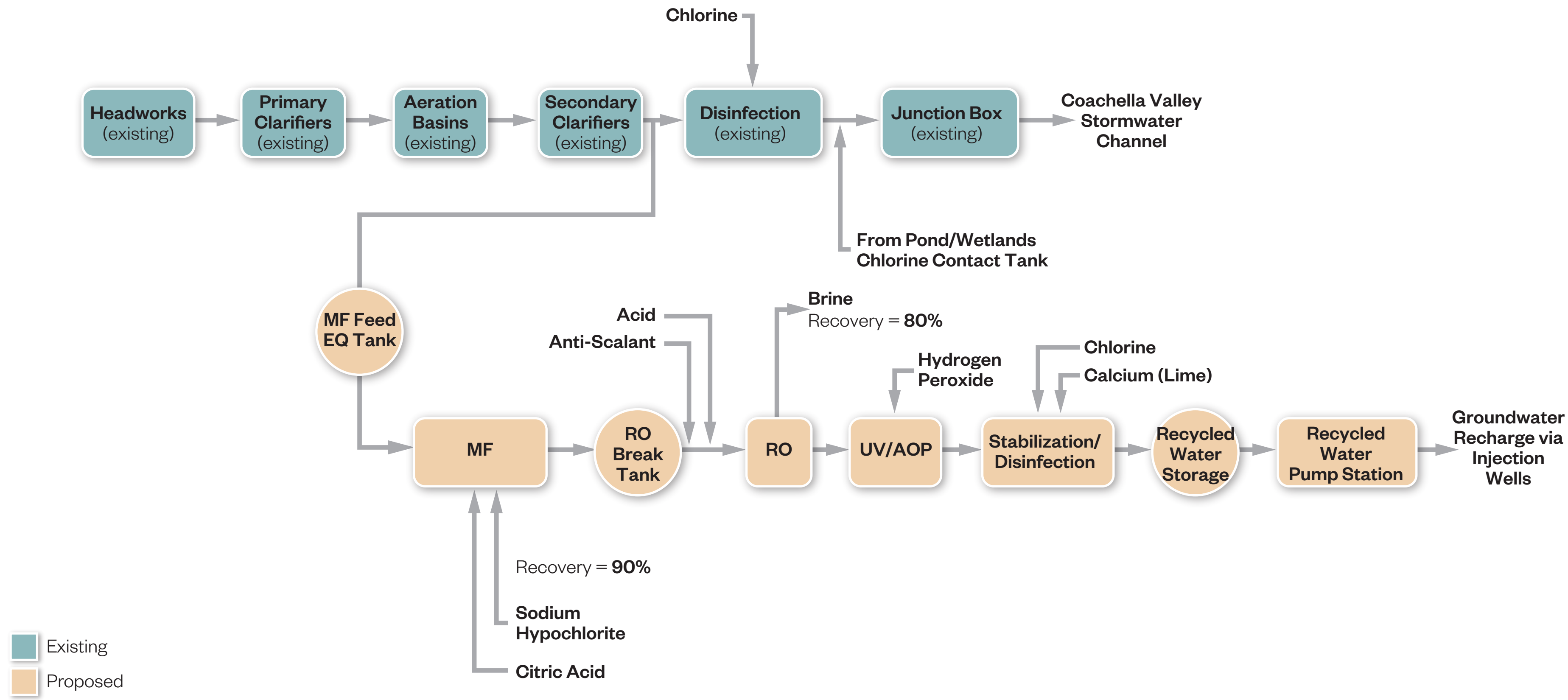

Figure 6-9
VSD WRF - Advanced Treatment System PFD

Figure 6-10
VSD WRF Preliminary Advanced Treatment Site Layout

6.4 Further Analyses

One component of the scope of work for this feasibility study was to conduct a two-month pilot study, which was to assist in getting the priority project(s) identified in this study closer to implementation. However, the pilot study was to be conducted only at the Coachella Sanitary District, which would not benefit all the agencies participating in the study, and there were not adequate funds to conduct multiple pilot studies. As discussed in detail in Section 10 of the individual technical memoranda included in the appendices to this report, a bench scale pilot study was conducted at each of the respective WWTP’s. Groundwater recharge via spreading at the VSD WRF was identified as a possible and the most cost-effective alternative for a regional project. However, percolation testing and soil borings bill be needed in or near the existing evaporation ponds on the VSD site to confirm the hydrogeological findings. IWA is in the process of conducting soils testing for percolation at the Posse Park site.

If the percolation tests show that groundwater recharge via spreading is not a viable alternative and the agencies desire to implement the next most cost-effective alternative, which is groundwater recharge via injection, it is recommended that a full-scale pilot study be conducted utilizing a blend of the wastewater effluents from both VSD WRF and CSD WWTP. This will help further determine if some or all the filtration alternatives under consideration are indeed viable for this specific wastewater quality and assist in establishing design criteria. Pilot testing typically should be conducted over a 6-month period for the information to be conclusive. This greatly effects the projected cost estimates for the advanced treatment processes, chemical storage, and feed systems as a more conservative approach must be taken without additional wastewater quality information. Assumptions were made in determining the design criteria presented herein.

7. Conveyance and Recharge

This section details the conveyance criteria and infrastructure requirements for each recycled water alternative presented in Section 2. Each of the alternatives have been evaluated independently for conveyance system requirements, each of which is described in further detail herein.

7.1 Recycled Water Infrastructure Criteria

The recycled water infrastructure consists of the conveyance facilities necessary to deliver recycled water to its point of use. Main facilities may consist of pumps, pipelines, storage tanks, and valving, all which make up the recycled water transmission and distribution system. The criteria for establishing the size, hydraulic gradient, and redundancy for these facilities are presented in the following subsections. In order to develop one set of criteria for the regional projects, the more conservative criteria between IWA, VSD and CWA/CSD has been utilized. These criteria were utilized in the development of the proposed regional recycled water project alternatives.

7.1.1 Pipeline Sizing Criteria

Pipelines are typically sized to limit internal velocities to protect internal pipe linings, minimize hydraulic transients, and minimize head losses. Larger transmission mains, which typically span long distances, are typically subject to more stringent head loss criteria as any amount of head loss accumulated over long distances can have large impacts in terms of pumping requirements. Minimizing head loss results in lesser pumping requirements, which in turn results in lower energy consumption and operational cost savings. Pipelines are also sized based on industry standard diameters. The criteria utilized for sizing of pipelines is presented in Table 7-1.

Table 7-1: Pipeline Sizing Criteria

Item	Criteria	Demand Condition
Maximum velocity (12" and smaller)	7 ft/s	Peak Hour Demand
Maximum velocity (16" and greater)	5 ft/s	Peak Hour Demand
Maximum Head loss	5 ft / 1,000 ft	Peak Hour Demand
Hazen-Williams Roughness Coefficient "C"	130	N/A
Acceptable Pipe Diameters	8", 10", 12", 14", 16", 20", 24", 30", 36", 42", 48"	N/A

7.1.2 Distribution System Criteria

As mentioned previously, potential IWA recycled water customers and demands have been established in the 2011 RWMP. Demands identified therein exceed the available wastewater flows, even when VSD and

CSD flows are combined. While there may be additional potential customers in Grand Valley and Stonewater as discussed in TM-3, recycled water distribution will still be limited by the availability of wastewater flows, and it is assumed that recycled water service to those developments would require an equal offset in demands served from those originally identified in the 2011 RWMP. This Study does not attempt to revisit the work that has been previously completed. The recycled water customers, distribution system facilities, and costs (costs have been scaled to current) from the 2011 RWMP have been utilized for the alternatives identified herein that provides recycled water service to customers and are utilized for comparison purposes.

7.1.3 Pumping Criteria

The proposed regional project alternatives include sending secondary-treated wastewater from the CSD WWTP to the VSD WRF, and tertiary-treated flows from the VSD WRF to Posse Park. Pumping will be required based upon the relative facility elevations and total dynamic head (TDH) requirements. Pump stations are typically designed to be able to meet the design flow with the largest pump out of service, referred to as “firm” capacity, which allows for routine pump maintenance. The design flow will be based upon the maximum daily flow for the CSD WWTP and VSD WRF. The criteria are summarized in Table 7-2.

Table 7-2: Pump Sizing Criteria

Item	Criteria[1]
Firm Pump Capacity	Maximum Daily Flow w/ Largest Pump Out of Service
Emergency Back-up Power Requirements	Permanent Generator

The need for variable frequency drive (VFD) pumps is indicated in subsequent sections.

7.1.4 Surface Spreading Basin Sizing Criteria

Surface spreading basin area and gross area requirements are based on the soil infiltration rate and the actual utilizable spreading area. Infiltration rates at the VSD WRF and Posse Park are currently unknown, although VSD personnel have indicated that the percolation rates at VSD WRF are slow and IWA is currently conducting percolation and soils testing at Posse Park. For purposes of this report, it has been estimated that percolation occurs at a rate of 1 foot per day. Actual values may be established with field investigations. Of the gross area of a site, a portion of it will be occupied for the construction of spreading basin berms, side slopes, ramps, and for freeboard requirements. Based on general construction and grading industry standards, it is estimated that 60 percent of the gross area will be considered as actual spreading area. See Table 7-3 for a summary of the spreading basin criteria.

Table 7-3: Spreading Basin Criteria

Item	Criteria
Infiltration Rate	1 foot per day[1]
% Utilizable Area[2]	60%

[1] Assumed.

[2] Percent of gross area available for spreading.

7.1.5 Groundwater Injection Criteria

Recharge via injection wells is typically utilized when a confining unit prevents or inhibits recharge via spreading from reaching the production aquifer, or due to lack of available land for the construction of spreading basins. On a basic level, an injection well typically consists of a casing with screening, annular seal, inductor pipe, and some form of injection flow control and telemetry. Depending on the available driving head, injection pump stations may also be required if the available gravity head is insufficient. In addition, injection wells can foul prematurely due to undesired injection of air and the corrosive nature of recycled water. To combat this, above grade air valves and downhole flow control valves to hold the column of water can be used in addition to the provision of a submersible pump for back flushing. A summary of the injection well criteria is provided in Table 7-4.

Table 7-4: Injection Well Criteria

Item	Criteria
Injection Well Capacity (ea)[1]	1.5 MGD
Backflush Pump Capacity (ea)[2]	3 MGD
Downhole Flow Control Valve Driving Head Req'd (ft)[3]	50 ft

[1] Per Section 4 of this Report.

[2] Backflush pump capacity = 2 x Injection Well Capacity.

[3] Per Baski Medium Head InFlex FCV, 10-3/4" Housing O.D., 1,550 gpm injection capacity.

7.2 Conveyance Infrastructure Improvements

7.2.1 Alternative 2 - CSD flows to VSD for Surface Spreading at VSD WRF

To convey secondary treated effluent from the CSD WWTP to VSD WRF requires the construction of an 8-mile regional pipeline. The secondary effluent would then subsequently be treated to tertiary levels and spread on-site (see Figure 7-1). It has been assumed for purposes of this Report, that the pipeline would be sized to accommodate the 2030 CSD flow of 6 MGD as indicated in Table 7-5.

Table 7-5: Regional Pipeline Sizing

Component	Design Flow (MGD)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Regional CSD/VSD Pipeline	6	9.3	5	18.5	20

A regional pump station would also be required to convey CSD's flows since the CSD WWTP is located at a lower elevation than the VSD WRF. The regional pump station would be sized initially for CSD's existing flow of approximately 3 MGD, with the ability to expand by adding additional pumps up to a 2030 flow of 6 MGD. Providing pumps with VFDs will assist in minimizing equalization storage by matching variable flows.

Table 7-6: Regional Pump Station Parameters

Condition	No. Duty Pumps	No. Stand-by Pumps	Pump Capacity per Ea (gpm)	Min HP Req'd Per Pump	PS Firm Capacity (MGD)	VFD?	Back-up Power Req'd
Existing	1	1	2,100	150	3.0	Yes	Emergency generator
Year 2030	2	1	2,100	150	6.0	Yes	Emergency generator

Recharge via spreading basins is typically accomplished by applying recharge water over land or impoundments where water can percolate into the ground and subsequently recovered by pumping. Major factors in determining a spreading system include the underlying aquifer characteristics, permeability of the soil, available area, topography, and water quality.

The approximate 20-acre area located to the south of the VSD WRF site where the former biological treatment ponds were located has been identified as a potential area for spreading in terms of percolation and in minimizing conveyance infrastructure. Based on conversations with VSD staff, VSD is currently exploring the option of abandoning the former biological treatment ponds in place. If the area is to be repurposed for spreading, it will require excavation and disposal of any accumulated solids. This area is triangular shaped, generally flat, gently sloping down from west to east and from north to south, and conducive to spreading via the basin method, provided that recommended field explorations confirm adequate infiltration.

Based on an assumed infiltration rate of 1 foot per day and an estimated utilizable area of 60 percent, on-site spreading at the VSD WRF would be limited to approximately 3.9 MGD, which would not be sufficient to accommodate the combined existing flows of CSD and VSD. To be able to spread the combined CSD and VSD existing flows of 9 MGD, an infiltration rate of approximately 2.3 feet per day would be required, and 4.6 feet per day would be required for the year 2030 combined flow of 18 MGD. What these values suggest is that combining flows regionally to spread at VSD would likely be infeasible due to percolation rate limitations. Even if additional off-site spreading locations could be obtained, it would still likely be inadequate as it could require upwards of 100 acres or more depending on the percolation rate, if at all feasible due to the presence of the aquitard. Percolation rates needed to accommodate existing and 2030 flows are presented in Table 7-7. Note that these are not actual percolation rates, which would need to be determined via field testing.

Table 7-7: Spreading Percolation Rate Requirements

Gross Area (ac)	Perc Rate (ft/d)	Flow (MGD)[1]	Notes
20	1.0	3.9	Assumed perc rate of 1 ft/d
20	2.3	9.0	Perc rate needed to accommodate existing regional flows
20	4.6	18.0	Perc rate needed to accommodate year 2030 regional flows

[1] Based on 60% utilization of the gross area for surface spreading.

Key spreading basin considerations include ensuring that the impoundment is not classified as a dam per the Division of Safety of Dams (DSOD), berm roads parallel to natural contour lines, equipment access ramps to harrow basin bottoms and/or remove accumulated sediment to increase basin floor permeability (scarification), bank stabilization, ability to take basins offline or rotate basins for drying or other maintenance purposes, freeboard for wind and rainwater, flow control and metering, and an outfall for basin overflows. Spreading majority of flows during the cooler months also naturally helps reduce the impact from evaporation. A conceptual layout of a spreading basin has been prepared (see Figure 7-2) with these considerations in mind. Major infrastructure includes the spreading basins, gravity pipeline system from the recycled water reservoir to the spreading basins with two separate outfalls for basin operation flexibility. In addition, an overflow pipeline that can send flows directly from the recycled water reservoir to the stormwater channel will be needed to bypass the spreading basins, or, if VSD WRF effluent exceeds spreading basin capacity. To achieve gravity flow, it is assumed that a new deeper outfall will need to be constructed at the stormwater channel. Spreading basin pipelines have been sized based on a combined 2030 flow of 18 MGD, summarized in Table 7-8.

Table 7-8: Spreading Basin Pipeline Sizing

Component	Design Flow (MGD)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Outfall to Recharge Basins	18	27.9	5	32.0	36
Overflow Line to Stormwater Channel	18	27.9	5	32.0	36

Recharge via spreading basins is generally the simplest recharge method and more cost effective in terms of capital and operations and maintenance (O&M), although it occupies the largest footprint and is dependent upon soil percolation.

A summary of the conveyance facilities required for Alternative 2 is provided below:

- Regional pipeline
- Regional pump station
- On-site spreading basins

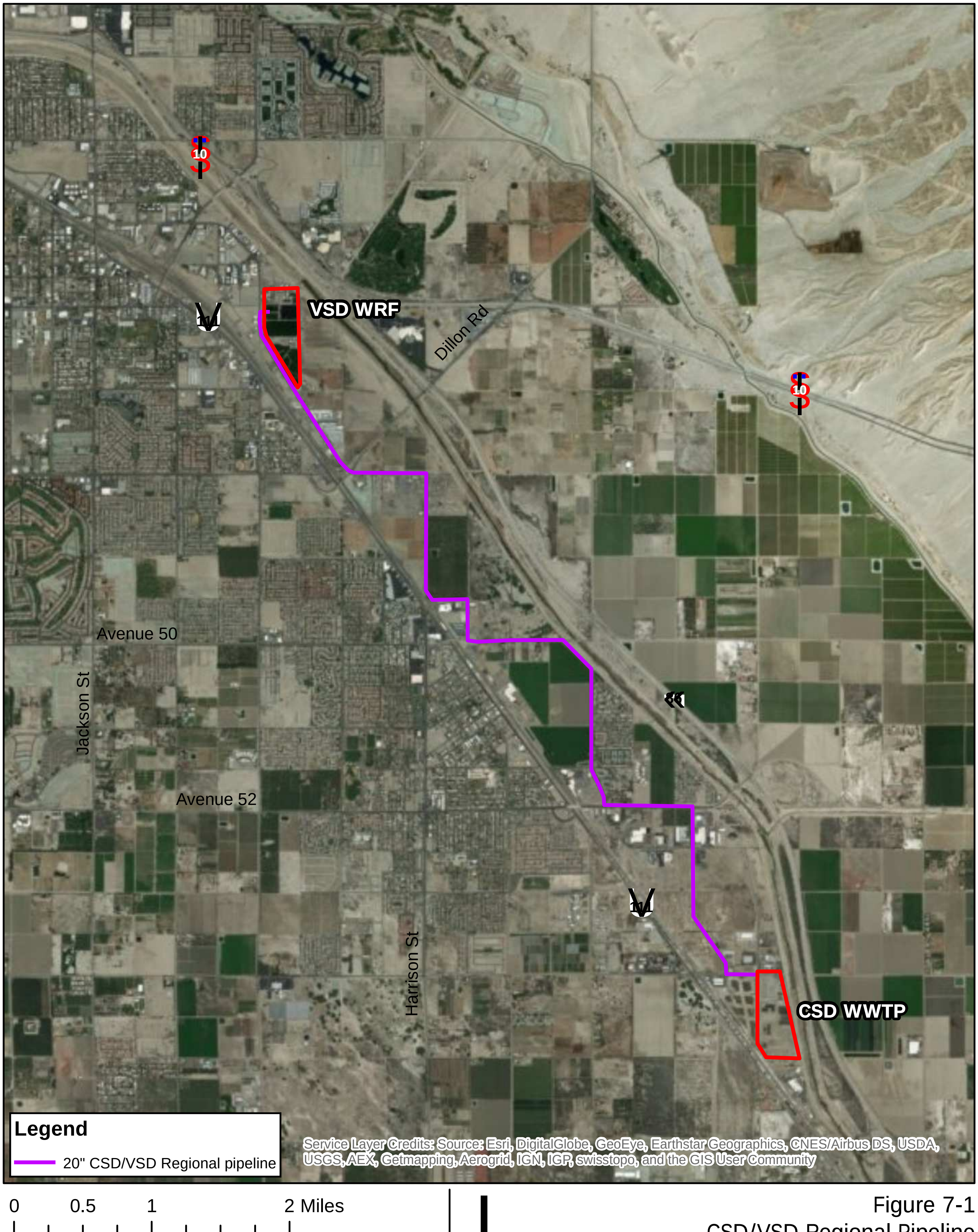

Figure 7-1
CSD/VSD Regional Pipeline

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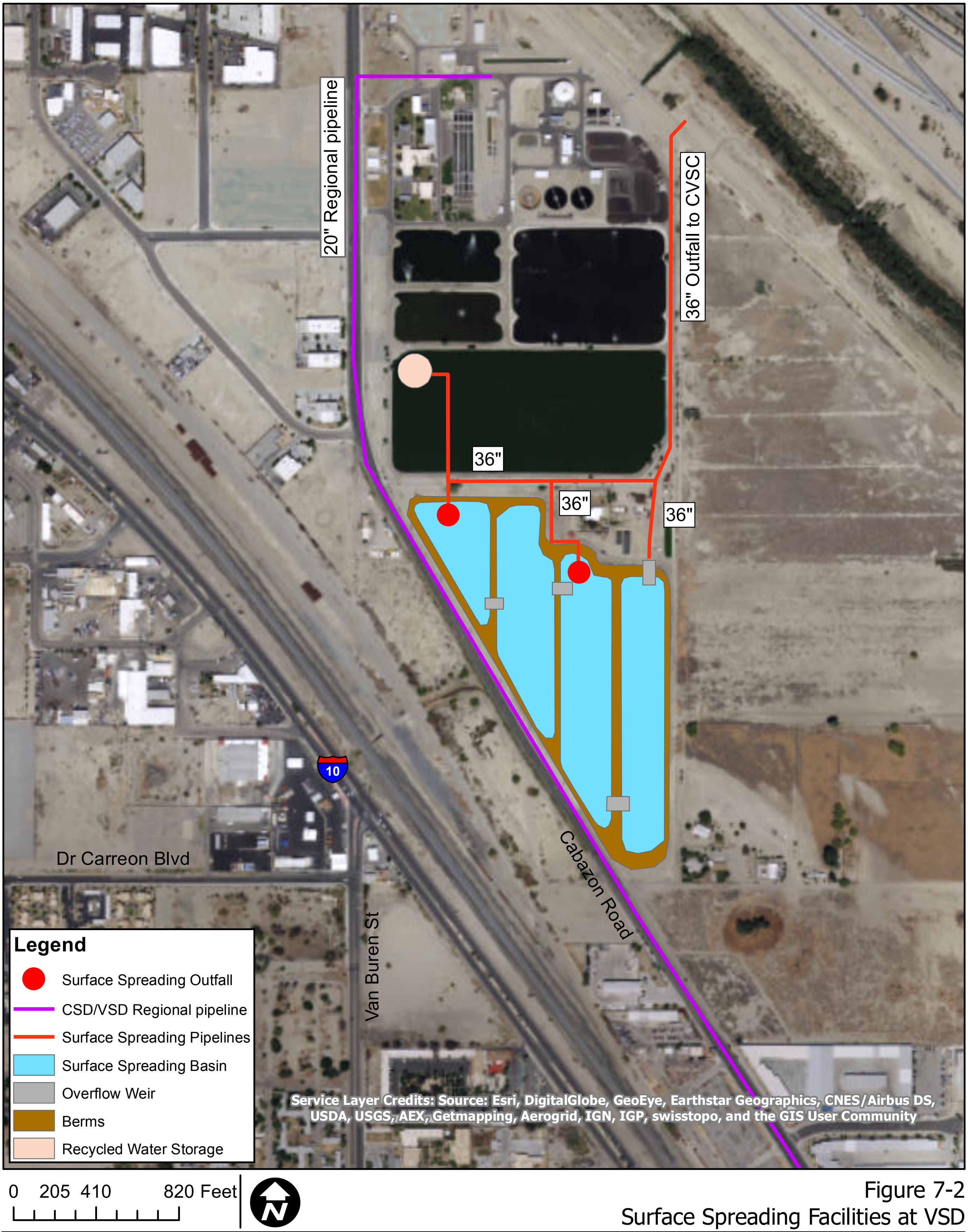

Figure 7-2
Surface Spreading Facilities at VSD

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7.2.2 Alternative 3 - CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF

Alternative 3 includes the regional pipeline, pump station, and spreading basin infrastructure described under Alternative 2 with the addition of service to recycled water customers. While there would, on average, be less flow available to spread when serving recycled water customers, flows available for spreading could still be as high as 7.2 MGD during the winter months (demand during the lowest winter month is approximately 26 percent of the average demand). Therefore, for the purposes of this Study, the infrastructure is considered equivalent between the two alternatives.

Direct delivery of recycled water to customers is achieved via a pressurized distribution system consisting primarily of pumps, pipelines, and storage reservoirs. A recycled water distribution system was originally developed for the customers identified in a Market and Demand Assessment, which was most recently updated in the 2016 IWA RW Feasibility Study (Carollo, 2016). In addition to the recycled water customers identified in the previous 2016 study, TM-3 established the RW distribution system requirements needed to support the addition of proposed Grand Valley and Stonewater developments.

For this alternative, Phase 2 costs from the 2016 IWA RW Feasibility Study (Carollo, 2016) have been utilized and escalated to current dollars based on Engineering News-Record (ENR) cost indexes for Los Angeles from January 2014 to December 2016. Phase 2 of the 2016 RW Feasibility Study requires approximately 10.5 MGD during maximum day demand and most closely represents the RW distribution system and recycled water customers that could be constructed if there is a regionally available recycled water supply of 9 MGD (Phase 1 only consists of 6 MGD of maximum day demand). Costs for facilities required to construct the RW distribution systems for Grand Valley and Stonewater have not specifically been considered here, as it is assumed that any systems constructed to serve these developments would be directly offset by removing corresponding facilities from Phase 2 in the 2016 study based on the availability of wastewater flows.

A summary of the Alternative 3 conveyance facilities required is provided below:

- Regional pipeline
- Regional pump station
- On-site spreading basins
- RW distribution system (Phase 2 from 2016 feasibility study)

7.2.3 Alternative 4 - CSD flows to VSD, Groundwater Injection at VSD WRF

This alternative includes the regional pipeline and pump station described under Alternative 2 with the infrastructure for injection on-site at the VSD WRF. The injection wells would be developed in phases as the wastewater flows increase as follows:

- Existing Conditions – 9 MGD design capacity, 6 injection wells @ 1.5 MGD each
- Year 2030 – 18 MGD design capacity, 12 injection wells @ 1.5 MGD each

The first phase would be located on-site at the VSD WRF where the former biological treatment ponds are located. To optimize injection performance, the injection wells are spread out along the site perimeter. The injection system also includes a bypass line to the stormwater channel to discharge excess flows, or, in the event that the injection system becomes inactive. It is assumed that the existing stormwater channel outfall would be utilized for the injection system bypass discharge. This system is depicted in Figure 7-3 with a summary of pipeline sizing in Table 7-9. While the VSD WRF site could accommodate up to 12 MGD of injection, accommodating the total year 2030 flows of 18 MGD would require acquiring an additional site that could accept at least 6 MGD of injection. Costs for acquiring an additional site have not been included in this Study.

Figure 7-3
VSD Injection Well Facilities

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Table 7-9: Injection Transmission System Sizing

Component	Design Flow (MGD)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Transmission Piping[1]	6	9.3	5	18.5	20
Bypass Line to Stormwater Channel	18	27.9	5	32.0	36

[1] Note that the 6 MGD design flow accommodates a total flow of 12 MGD due to the looped piping network.

Based on the groundwater mounding information provided by Todd Groundwater, available head provided by the effluent reservoir, and the estimated headlosses for piping, fittings, and valving including the downhole flow control valve, it is estimated that a low-head injection pump station will be required to achieve well injection rates and handle periodic injection well fouling. This injection pump station could be phased in as VSD WRF capacity and injection water increases over time. Providing pumps with VFDs will help to minimize equalization storage by matching variable flows. A summary of the injection pump station parameters is provided in Table 7-10.

Table 7-10: Injection Pump Station Parameters

Condition	No. Duty Pumps	No. Stand-by Pumps	Pump Capacity per Ea (gpm)	Min HP Req'd Per Pump	PS Firm Capacity (MGD)	VFD?	Back-up Power Req'd
Existing	2	1	2,100	30	6.0	Yes	Connection for Emergency generator
Year 2030	4	1	2,100	30	12.1	Yes	Connection for Emergency generator

Due to the propensity of injection wells to foul, a submersible backflushing pump will also be included for each injection well, capable of backflushing at least two times the injection rate. The backflush pump parameters are as listed in Table 7-11.

Table 7-11: Backflush Pump Parameters

Type	Pump Capacity (gpm)	VFD?	Min HP Req'd Per Pump
Submersible	2,100	No	100

A separate backflushing piping system will be required to dispose of the backflush water. It is assumed that the backflush piping will connect to the bypass line that discharges to the stormwater channel, although the backflush could potentially be routed to the head of the VSD WRF if the flows and water quality can be accommodated. A summary of the backflush transmission system sizing assuming only one injection well is backflushed at a time is provided in Table 7-12.

Table 7-12: Backflush Transmission System Sizing

Component	Design Flow (gpm)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Backflush Piping	2,100	4.7	7	11.1	12

As injection in the southern VSD WRF area is hydrogeologically limited to approximately 12 MGD, if any additional injection is to be performed, additional sites will need to be identified either in the northern VSD WRF area, or by acquiring additional land. While recharge via injection wells is generally more capital and O&M intensive, it provides a higher recharge capacity with a smaller footprint when compared to spreading basins.

A summary of the Alternative 4 conveyance facilities required is provided below:

- Regional pipeline
- Regional pump station
- On-site injection facilities including injection wells, injection pump station, piping, and backflush pumps

7.2.4 Alternative 5a - CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park

This alternative includes the regional pipeline and pump station described under Alternative 2 and an additional tertiary treated recycled water transmission main to convey flows from the VSD WRF to Posse Park for off-site spreading (see Figure 7-4 and Figure 7-6). This transmission main is sized for the year 2030 combined CSD/VSD peak dry weather flow of 18 MGD (see Table 7-13).

Table 7-13: RW Transmission Main Sizing

Component	Design Flow (MGD)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
RWTM	18	27.9	5	32.0	36

Alternative 5a also includes spreading basins sized similarly to Alternative 2 as Posse Park has an available area comparable to the area where the former biological ponds are located; however, Posse Park does not have close access to the CVSC for overflow provisions; therefore, any overflow must be routed off-site via sewer or storm drain. For delivery of recycled water to customers for landscape irrigation, it is assumed that Phase 2 from the Recycled Water Feasibility Study (Carollo, 2016) will be constructed and those costs have been utilized (escalated to bring current). It is more likely that Phase 1 from the 2016 Recycled Water Feasibility Study (Carollo, 2016) in combination with service to Grand Valley and Stonewater would be constructed due to their proximity to Posse Park.

Pumping will be required to convey the flows from the VSD WRF to Posse Park. Since customers will also be served from the recycled water transmission main prior to reaching Posse Park, the recycled water pump station must add additional head to pressurize the recycled water transmission main. A 9.5 MGD pump station has already been accounted for in the 2016 Recycled Water Feasibility Study. Therefore, additional costs have not been incorporated as part of this Study.

A summary of the Alternative 5a conveyance facilities required is provided below:

- Regional pipeline
- Regional pump station
- Tertiary transmission main
- RW distribution system (Phase 2 from 2016 Feasibility Study)
- Spreading facilities at Posse Park

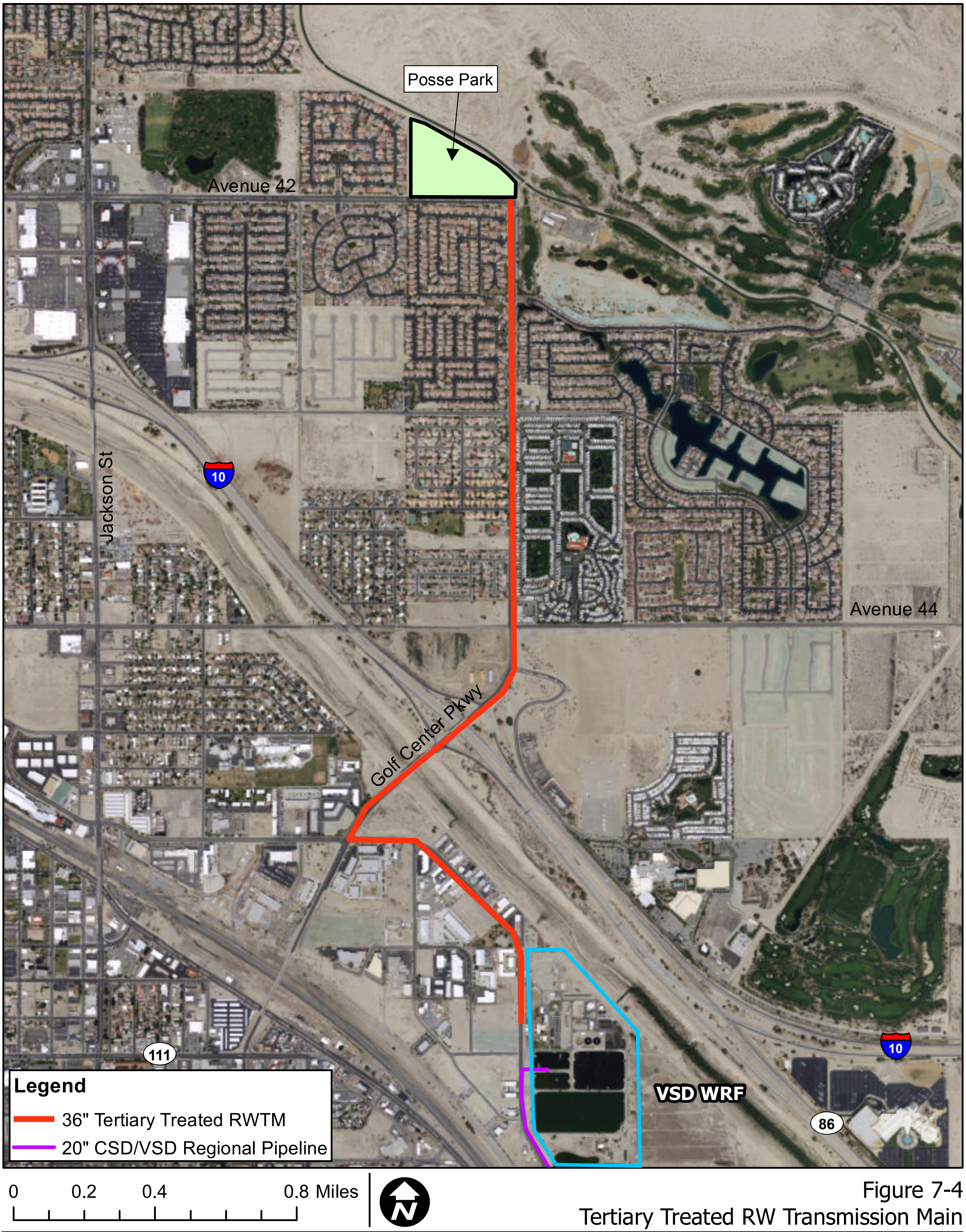

Figure 7-4
Tertiary Treated RW Transmission Main

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Figure 7-5
Surface Spreading at Posse Park

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7.2.5 Alternative 5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park

Alternative 5b includes the regional CSD/VSD pipeline and pump station described under Alternative 2, and the tertiary treated recycled water transmission main to convey flows from the VSD WRF to Posse Park as described under Alternative 5a for advanced treatment and injection. While not all flows will be utilized for injection, the recycled water transmission main has been sized to convey the full 2030 combined CSD/VSD flows of 18 MGD.

To maintain consistent flows to the advanced treatment facilities, baseline flows of 1.8 to 5.4 MGD has been assumed and three injection wells would be constructed with a total injection capacity of 4.5 MGD. This could be expanded to up to six injection wells, or a total injection capacity of 9.0 MGD under 2030 conditions.

An injection system network has been developed off-site at Posse Park based on 2030 flows. The system would be developed in two phases as follows:

- Existing Conditions – 4.5 MGD design capacity, 3 injection wells @ 1.5 MGD each
- Year 2030 – 9.0 MGD design capacity, 6 injection wells @ 1.5 MGD each

To optimize injection performance, the injection wells are spaced out along the site perimeter. In the event that the injection system becomes inactive, excess secondary treated wastewater could be offloaded to the CVSC at the VSD WRF or CSD WWTP while customers continue to be served. This system is depicted in Figure 7-6 with a summary of pipeline sizing in Table 7-14.

Figure 7-6
Injection at Posse Park

Table 7-14: Injection Transmission System Sizing

Component	Design Flow (MGD)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Transmission Piping	4.5	7.0	5	16.0	16

[1] Note that the 4.5 MGD design flow accommodates a total flow of 9 MGD due to the looped piping network.

Based on the groundwater mounding information provided by Todd Groundwater, available head provided by the effluent reservoir, and the estimated headlosses for piping, fittings, and valving including the downhole flow control valve, it is estimated that a low-head injection pump station will be required to achieve well injection rates and account for periodic injection well fouling. This injection pump station could be phased in as wastewater availability increases over time. A summary of the injection pump station parameters is provided in Table 7-15.

Table 7-15: Injection Pump Station Parameters

Condition	No. Duty Pumps	No. Stand-by Pumps	Pump Capacity per Ea (gpm)	Min HP Req'd Per Pump	PS Firm Capacity (MGD)	VFD?	Back-up Power Req'd
Existing	1	1	3,125	30	4.5	Yes	Connection for Emergency generator
Year 2030	2	1	3,125	30	9.0	Yes	Connection for Emergency generator

Due to the propensity of injection wells to foul, a submersible backflushing pump has also been included for each injection well, capable of backflushing at least two times the injection rate as indicated in Table 7-16.

Table 7-16: Backflush Pump Parameters

Type	Pump Capacity (gpm)	VFD?	Min HP Req'd Per Pump
Submersible	2,100	No	100

A separate backflushing piping system will be required to dispose of the backflush water. Since Posse Park does not have close access to the CVSC, an on-site impoundment must be provided to capture injection well backflushing flows. Alternatively, the backflush flows could be piped off-site via sewer or storm drain. A summary of the backflush transmission system sizing assuming only one injection well is backflushed at a time is provided in Table 7-17.

Table 7-17: Backflush Transmission System Sizing

Component	Design Flow (gpm)	Design Flow (cfs)	Max Allowable Velocity (ft/s)	Req'd Min. Dia. (in)	Selected Dia (in)
Backflush Piping	2,100	4.7	7	11.1	12

For determining the distribution system sizing and associated costs to serve potential landscape irrigation customers, it is assumed that Phase 1 from the Recycled Water Feasibility Study (Carollo, 2016) will be constructed as its maximum day demand of 6.0 MGD closely aligns with the remaining recycled water that would be available after taking into account water for injection. As previously mentioned, any service to Grand Valley and Stonewater is assumed to be offset with a corresponding reduction in service from Phase 1 and, therefore, is assumed to have no impact on costs. Due to the close proximity to the Coachella Canal, there is the potential to connect the recycled water transmission main to the Canal for exchanges or to add supplemental flows to meet recycled water customers peak seasonal demands and/or increase the injection rates. However, this was not specifically included in this evaluation.

Pumping will be required to convey the flows from the VSD WRF to Posse Park. Since customers will also be served from the recycled water transmission main, the recycled water pump station must add additional head to pressurize the recycled water transmission main for service to landscape irrigation customers. A 6.0 MGD pump station has already been accounted for in the 2016 Feasibility Study and, therefore, additional costs have not been incorporated as part of this Study.

While recharge via injection wells is generally more capital and O&M intensive, it provides a higher recharge capacity with a smaller footprint when compared to spreading basins.

A summary of the Alternative 5b conveyance facilities required is provided below:

- Regional pipeline
- Regional pump station
- Tertiary transmission main
- RW distribution system (Phase 2 from 2016 Feasibility Study)
- Injection facilities at Posse Park

7.2.6 Alternative 6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC

Alternative 6 includes the same infrastructure as described in Alternative 3 excluding the spreading basins. Excess flows would be discharged as secondary treated effluent to the CVSC, which is similar to current operations.

A summary of the Alternative 6 conveyance facilities required is provided below:

- Regional pipeline
- Regional pump station
- RW distribution system (Phase 2 from 2016 feasibility study)

8. Economic Analysis

8.1 Opinion of Probable Costs

This section presents the opinions of probable costs for the alternatives including the capital and associated O&M costs. These costs reflect the alternatives at the study-level stage, which can be used to evaluate project feasibility and for cost-comparative purposes. In general, the probable costs are based on previous experience, current available information from trusted sources, project location, and project-specific conditions. It should be noted that costs presented herein may differ from previous studies potentially due to changes in costs over time, assumptions, and contingency factors.

8.1.1 Capital Costs

Conceptual costs were developed for each alternative. The Cost Estimate Classification System guidelines published by the Association for the Advancement of Cost Engineering International (AACEI) is used to define the level of accuracy of these estimates. Costs are considered Class 4 for study or feasibility use and 1-15% level of project definition. The accuracy range is normally considered plus 50% and minus 30% for this level of estimate.

The probable costs have been prepared for guidance in project evaluation and comparison from the information available at the time the estimates were prepared. Actual project costs will depend on criteria such as actual labor, equipment and material costs, competitive market conditions, actual site conditions, final project scope, and other variables. Proximity of this preliminary cost estimate to actual costs will depend on how close the assumptions of this estimate match final project conditions. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help assure proper project evaluation and adequate funding.

Probable construction costs for the alternatives were developed using quantity take-offs and a material unit cost approach when possible. In some cases, facility capacity or footprints were used to obtain costs. In the case of the recycled water distribution system infrastructure, costs from the Recycled Water Feasibility Study (Carollo, 2016) were utilized by escalating costs in accordance with the Engineering News-Record (ENR) Construction Cost Indices (CCI). The direct and indirect markups and additional project costs presented below are applied to all alternatives. Project assumptions are provided in Table 8-1.

Table 8-1: Process Assumptions for Cost Development

Alternative	Cost Assumptions
Tertiary Treatment	• Conventional treatment consisting of a secondary effluent pump station, coagulation, sand filters, chlorine contact tank and storage. • Total capacity assumed is 9 MGD.
Advanced Treatment	• Advanced treatment assumes effluent pump station, microfiltration, reverse osmosis, UV advanced oxidation processes, electric service upgrade and storage. • Total capacity for Alternative 4 is assumed to be 9 MGD. • Total capacity for Alternative 5b is assumed to be 4.5 MGD (average available flow taking into account customer demands)
Recycled Water Distribution/Conveyance	• Recycled Water Feasibility Study (Carollo, 2016) costs escalated from January 2014 (ENR CCI of 10736) to December 2016 (ENR CCI of 11555). • Any service to Grand Valley and/or Stonewater will be a direct offset in costs from the Recycled Water Feasibility Study (Carollo, 2016).
Spreading Basins	• Surface spreading at VSD considers using existing basins with limited rework of existing soils. • Surface spreading at Posse Park considers installing new basins. • Overflow can be accommodated by the existing storm drain or sewer.
Groundwater Injection	• Includes groundwater injection wells only (no recovery). • Injection requires pressurization. • Existing production wells will be used for recovery.

A contingency has been included in these cost estimates based on the level of project definition and as a provision for unforeseeable, additional costs within the reasonable bounds of a similar project scope. Other project cost factors and construction cost markups used in the estimates are noted in Table 8-2. Indirect costs associated with engineering design, environmental, permitting, and construction management have not been included.

Table 8-2: Project Cost Factors

Component	Cost Factor
Other Project Cost Factors[1]	
Equipment Installation	0 – 30%
Process Mechanical (Piping, valves, appurtenances, etc.)	10 - 25%
Overall Site Work	5 - 10%
Structural/Building Systems	5 - 60%
HVAC/Plumbing	0 - 5 %
Instrumentation and Control	10 - 20%
Electrical	15 - 30%
Construction Cost Markups	
Escalation	9%
Overhead	10%
Profit	10%
Bond/Insurance	3%
General Conditions	10%
Scope Contingency	35%

[1] "Other Project Cost Factors" for conveyance facilities set at 0 as unit cost represents installed cost.

Additional considerations for cost adjustments were as follows:

- Cost estimates are for the project located in the Coachella Valley, California to be consistent with current market prices (i.e., labor) in the area.
- The cost estimates were escalated to February 2019 dollars (assumed earliest reasonable start of construction).
- A Market Adjustment Factor normally would be applied to compensate for fluctuations in material and labor prices driven by the national and global market. Since the market is currently generally stable, this factor was not included in the cost estimates.
- Land and/or right-of-way costs were not included in the cost estimates for this screening.

Table 8-3 summarizes the capital costs for each project cost component. Figure 8-1 shows these costs graphically. Other than Alternative 1 – “Status Quo” or “Do Nothing” alternative, Alternative 2 has the lowest capital cost of the alternatives considered.

Table 8-3: Capital Cost Estimates by Alternative and Component

Alternative	Tertiary Treatment ($M)	Advanced Treatment ($M)	RW Distribution / Conveyance ($M)	Spreading Basins ($M)	Groundwater Injection ($M)	Total ($M)
1 – Status Quo	-	-	-	-	-	**-**
2 – CSD flows to VSD for Surface Spreading at VSD WRF	50.7	-	22.8	14.5	-	**88.0**
3 – CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF	50.7	-	59.3	14.5	-	**134.5**
4 – CSD flows to VSD, Groundwater Injection at VSD WRF	-	76.3	22.8	-	29.6	**128.7**
5a – CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park	50.7	-	86.5	9.8	-	**147.1**
5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park	50.7	43.8	73.4	-	15.3	**183.3**
6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC	50.7	-	69.3	-	-	**120.0**

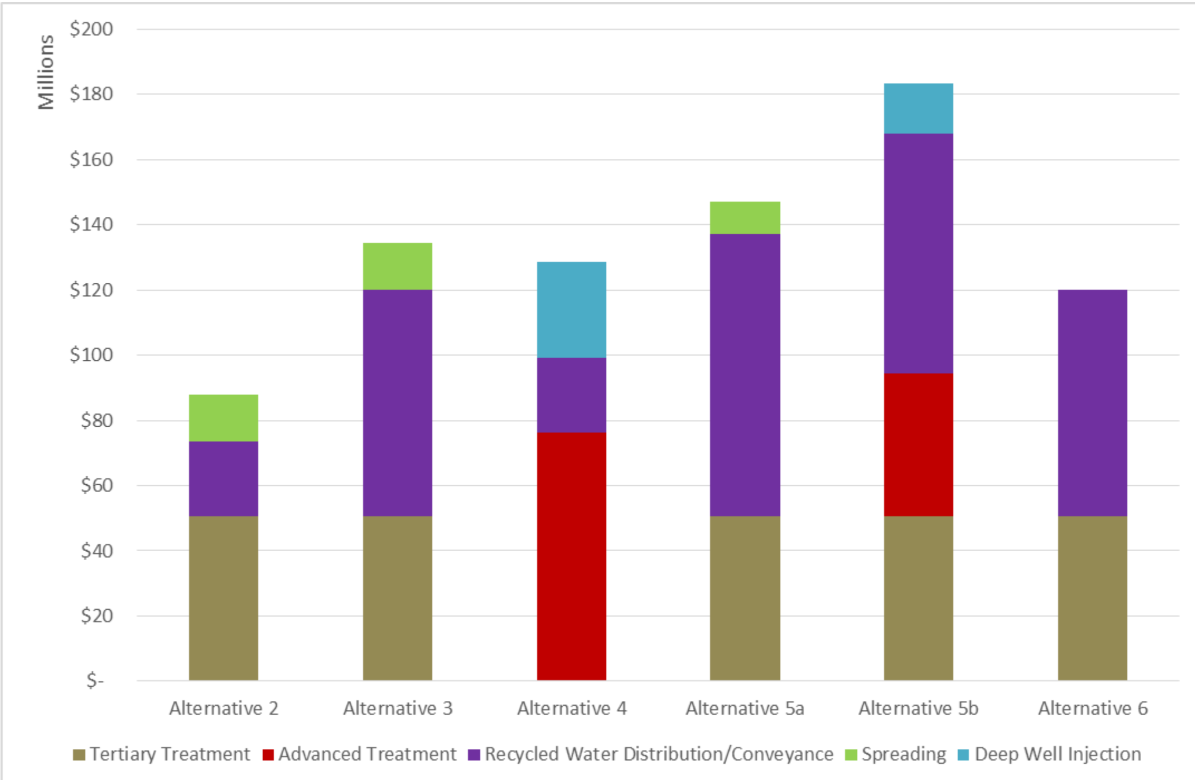


Figure 8-1: Capital Cost Graphical Comparisons

8.1.2 O&M and Lifecycle Estimates

Assumptions in developing the estimated annual O&M costs including power costs, chemical costs, labor, and annual maintenance are presented in Table 8-4. These values are discretionary and are based on review of estimates at similar facilities and engineering judgement.

The whole or partial number of additional full-time equivalent (FTE) plant staff required to operate and maintain a treatment process was specific for each alternative. This does not constitute a staffing plan and should be reviewed by the operating agency based on agency policies and resources prior to finalizing. Salary estimates were based on the U.S. Bureau of Labor Statistics average salary for a Water Operator in the State of California and an assumed burdened rate of 1.6 ($65,500*1.6 = $105,000). The power cost is assumed as 11.41 cents per kilowatt-hour (kWh) based on the current energy rate sheet published by Imperial Irrigation District for Municipal Services.

Table 8-4: Annual O&M Cost Basis Assumptions

O&M Function	Tertiary Treatment	Advanced Treatment	Recycled Water Distribution	Spreading Basins	Groundwater Injection
Staffing (FTE)	2	2	2	1	1
Power	$0.1141/kWh				
Annual Maintenance (Plant)	2%				
Annual Maintenance (Non-plant Infrastructure)	0.05%				
Chemicals	Annual chemical demand plus deliveries				

A life cycle analysis was developed based on the capital and O&M estimates. The annualized capital cost assumes a 30-year term at an interest rate of 1.6 percent. A contingency of 35-percent is included with the O&M costs. The life cycle costs for each alternative are based on a maximum plant flow of 9 MGD at VSD and 4.5 MGD at Posse Park (after recycled water delivery to customers for landscape irrigation demands).

For comparison purposes for Alternative 1 – “Status Quo”, a price of $5,321 per acre-foot was utilized. This cost represents the adjusted cost of CVWD’s purchase deal of a State Water Project (SWP) entitlement Table A water presented in IWA’s Supplemental Water Supply Program and Fee Study, and is intended to represent the cost of securing an alternative supply. While the alternative supply cost presented in TM-3 for CWA/CSD is the 2018 Metropolitan Water District of Southern California Tier 1 Full Service Treated Volumetric Cost at $1,015 per acre-foot, the higher of the two values is presented in this Report. Table 8-5 lists the life cycle estimates developed at a conceptual level.

Table 8-5: Lifecycle Estimates

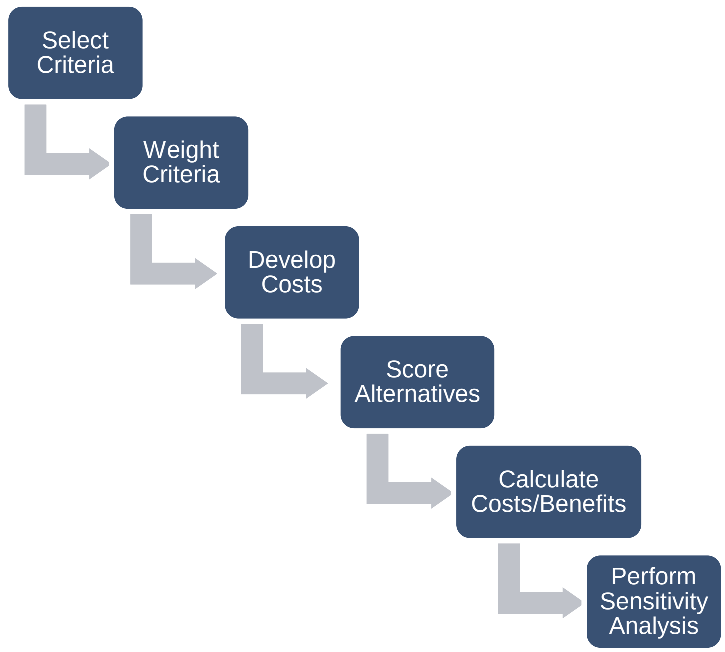
Alternative	Annualized Capital Cost ($M)	Annual O&M Cost ($M)	Annualized Lifecycle Cost ($M)	Cost Per Acre-foot ($)	Cost Differential[2] ($)
1 – Status Quo[1]	-	-	-	5,321[1]	-
2 – CSD flows to VSD for Surface Spreading at VSD WRF	3.72	2.50	6.22	617	-4,704
3 – CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF	5.68	3.07	8.75	868	-4,453
4 – CSD flows to VSD, Groundwater Injection at VSD WRF	5.44	7.77	13.20	1,309	-4,012
5a – CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park	6.21	3.13	9.34	927	-4,394
5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park	7.74	5.38	13.12	1,301	-4,020
6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC	5.07	2.89	7.96	789	-4,532

[1] Estimated price to purchase State Water Project Water for a permanent transfer; Indio Water Authority Supplemental Water Supply Program and Fee Study, Table 4.1.
[2] Cost Difference = (Alternative cost) – (Status Quo cost).

9. Alternatives Analysis

A decision model was created to evaluate the costs and non-monetary benefits of each alternative. The objective is to identify the preferred approach that meets the goals and objectives of the feasibility study. The evaluation process included engagement with the project team consisting of correspondence, workshops, and review between the stakeholders to define and select the alternatives, determine selection criteria, assign weightings of the criteria, review scoring methodologies and scores for each criterion of each alternative, and review the costs and decision model results. The decision process included the following steps:

1. Select decision criteria representing important non-monetary benefits or attributes of an alternative that are independent, provide differentiation, and are measurable.
2. Weight the decision criteria to prioritize importance of the individual criterion to the decision process.
3. Develop cost estimates (capital, O&M, and life cycle) for each alternative.
4. Develop a quantitative or qualitative score for each alternative with respect to each decision criterion.
5. Calculate the cumulative scores of each alternative based on the product of the weighting assigned to the criterion and the score/costs.
6. Perform sensitivity analyses to evaluate the impact of criteria weighting relative to the scores for each alternative.



9.1 Selection Criteria

Selection criteria was initially established by IWA, VSD and CWA in a workshop to represent factors of importance to these utilities, provide differentiation among alternatives, and avoid redundancy in definition that could lead to double counting of benefits. Note that other selection criteria were identified and discussed, but were ultimately eliminated because they were either duplicative with other criteria, or did not offer differentiation among the potential alternatives under consideration. The criteria were discussed again and finalized in a subsequent workshop.

Once selection criteria were set, IWA, VSD and CWA were asked to complete weighting sheets separately to distribute points relative to the primary criteria's importance. An average of these weightings is used for the decision analysis. Table 9-1 provides the actual weightings submitted by VSD/IWA, CWA, and the average.

Table 9-1: Criteria Weightings

Criteria	VSD/IWA	CWA	Average
Costs	22.5%	50%	36%
Operability	10.5%	0%	5%
Project Implementation	8.5%	20%	14%
Groundwater Benefits	8.5%	0%	4%
Funding Opportunities	20%	10%	15%
Agency Benefits	30%	20%	25%
TOTAL	**100%**	**100%**	**100%**

In addition, subcriteria were determined to better define the criteria and aide in the scoring. Initially, all subcriteria within a criteria category were considered to have equal weighting and could be adjusted during the sensitivity analysis if preferred. Table 9-2 lists the selected primary criteria, subcriteria, definitions of the criteria as it relates to IWA, VSD and CWA, and the scoring methodology used for this analysis.

Table 9-2: Criteria Definitions and Scoring Methodologies

Selection Criteria	Subcriteria	Definitions	Scoring Methodology
Operability	Staffing	Staffing levels to operate and maintain	Additional full-time equivalent (FTE) staff required for each alternative component
	Operations Certification	Qualifications required to operate the alternative components	Expected level of operator certification required in the operating permit
	Ease of Operations	O&M complexity and risk for failures / loss of service	The number of process and infrastructure components that must be controlled at all times to achieve consistent operations
Project Implementation	Ease of Implementing	Constructability considerations	Complexity of construction including sequencing, external factors, permits, public involvement, etc.
	Timelines	Time required to implement an alternative	Factors include permitting, piloting, public participation, size and complexity.
Public Benefits	Water Quality Improvements	Ability to improve the quality of the drinking water supply	Likeliness that recharge will improve water quality (e.g., chromium, nitrates, etc.) at IWA production wells
	Groundwater Protection	Ability to recharge aquifer and prevent overdrafting	Likeliness that recharge will prevent need to utilize more costly imported water
Funding Opportunities	Grants	Available funding of the capital program through grants	Potential that project will qualify for current grant programs in California
Agency Benefits	Groundwater Credits	Ability to recharge aquifer and potentially reduce costs paid to the RAC	Flow rates for injection or surface spreading
	Independence	Reliance on other agencies for water resources, operations, and waste management	Number of agencies required to construct, operate, or maintain the project components. This includes waste hauling or disposal to off-site facilities.
	Resilience	Diversification of the water portfolio	Will this alternative provide another long-term water resource that augments current supplies
Costs	Capital	Capital costs	Normalized capital costs not accounting for grants
	O&M	O&M costs	Normalized annual O&M costs
	Life Cycle	Life cycle costs	Normalized 20-year life cycle costs

9.2 Alternative Scoring

A benefit score was generated for each alternative relative to the primary selection criteria and subcriteria. Criteria for each alternative were scored in a similar manner. Scores were generated using engineering analysis and judgement and, when possible, quantifiable scoring methodologies were used to impart objectivity to the analysis. Alternatives were scored based on a 1 to 5 scale, with 1 being the worst and 5 being the best. Higher scores are considered more favorable. See Table 9-3 and Table 9-4 for a summary of the scoring results.

Table 9-3: Criteria Weighting and Scoring Table

Criteria	Weight	Subcriteria	Weight	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5a	Alt 5b	Alt 6
Operability	10.5%	Staffing	33%	5	4	3	2	2	2	3
		Operations Certification	33%	5	3	3	2	3	1	3
		Ease of Operations	34%	5	3.5	3	2	2.5	2	3
		Weighted Subtotal	**100%**	**5.3**	**3.7**	**3.2**	**2.1**	**2.6**	**1.8**	**3.2**
Project Implementation	8.5%	Ease of Implementing	50%	1	4	2	3	2	2	3
		Timelines	50%	5	3	2	3	2	1	4
		Weighted Subtotal	**100%**	**8.6**	**1.0**	**5.7**	**8.6**	**5.7**	**4.3**	**1.0**
Public Benefits	8.5%	Water Quality Improvements	50%	1	5	2	4	3	3	1
		Protection	50%	1	5	3	4	3	3	2
		Weighted Subtotal	**100%**	**0.9**	**4.3**	**2.1**	**3.4**	**2.6**	**2.6**	**1.3**
Funding Opportunities	20.0%	Grant Priorities	100%	1	4	3	4	3	3	2
		Weighted Subtotal	**100%**	**3**	**12**	**9**	**12**	**9**	**9**	**6**
Agency Benefits	30.0%	Groundwater Credits	33%	1	5	3	5	3	3	1
		Independence	33%	1	5	4	4	3	3	2
		Resilience	34%	1	4	3	4	3	3	2
		Weighted Subtotal	**100%**	**5**	**23**	**17**	**22**	**15**	**15**	**8**
Costs	22.5%	Capital	33%	5	4	2.5	3	2	1	4
		O&M	33%	5	4	3	1	3	2	4
		Life Cycle	34%	2.5	4	3	1	2	1	3.5
		Weighted Subtotal	**100%**	**30**	**29**	**21**	**12**	**17**	**10**	**28**
		WEIGHTED TOTALS	**100%**	**53**	**82**	**57.2**	**60**	**52**	**42**	**56.5**

Table 9-4: Criteria Weighting and Scoring Summary

Rank	Score	Alternative[1]
1	82	2 –Surface spreading at VSD WRF
2	60	4 - Groundwater injection at VSD WRF
3	57.2	3 –Deliver recycled water to customers for landscape irrigation and surface spreading at VSD WRF
4	56.5	6 – Deliver recycled water to customers for landscape irrigation and excess to CVSC
5	53	1 – Status Quo
6	52	5a – Deliver recycled water to customers for landscape irrigation and surface spreading at Posse Park
7	42	5b – Deliver recycled water to customers for landscape irrigation and groundwater injection at Posse Park

[1]All alternatives assume secondary treated wastewater flows from CSD would be conveyed to VSD for further treatment.

9.3 Conclusions

As shown in Table 9-4, delivering CSD flows to VSD for further treatment and recharging the groundwater via surface spreading on-site at VSD ranks the most favorably as it limits conveyance infrastructure and costs, and provides public benefits and benefits to the agencies. However, this alternative is highly dependent upon field investigations confirming the ability to percolate water at the VSD WRF and staff's experience at the WRF has indicated that the ability to percolate is low. The second ranked alternative is delivering CSD flows to VSD for further treatment and recharging the groundwater via injection on-site at VSD. VSD staff have expressed concern over constructing any new facilities at the WRF due to the neighboring tribal community. During the ranking, this was taken into consideration under the subcategory, ease of implementation. Recycled water distribution ranks less favorably as it requires more extensive conveyance infrastructure and coordination with potential customers and the recycled water use is seasonal and uncertain. Off-site facility alternatives, groundwater recharge via spreading or injection at Posse Park were lower ranking because they come at a much higher cost and complexity. Although both groundwater recharge options may potentially improve groundwater quality for some IWA and CWA production wells over time. The lowest ranking alternative was Alternative 5b - deliver recycled water to customers for landscape irrigation and groundwater injection at Posse Park. This ranked the lowest due to cost and complexity to implement and the uncertainty of the recycled water customer demands. Alternatives 2, 3, and 5a are dependent upon field investigations confirming the ability to percolate water at a reasonable rate, hydrogeological modeling confirming that the percolated water will reach the aquifer, and the ability to acquire property of adequate area. IWA is underway with conducting soils testing and percolation testing near Posse Park.

Recycled water projects may be an expensive undertaking in comparison to the current RAC. However, recycled water provides independence and resiliency against drought. Development of a recycled water project is an investment in the future and is part of long-term planning and management of the groundwater basin and making use of a local valuable resource.

10. Grant Opportunities and Funding Options

One component of this feasibility study was to identify the available grants and funding options for the recycled water alternative projects identified. The challenge with grant and loans are the uncertainty due to meeting qualifications, timing and their fluidity and availability. Briefly summarized below, are the grants and loans that are currently available for recycled water projects. This is not intended to be a comprehensive list but a snapshot in time as to what is currently available that is relevant to the alternatives identified. Due to the volume of applications received and awarded, the amount of monies available changes and we cannot predict if these monies will be available when the alternatives discussed herein are ready for implementation. Further evaluation will be needed as IWA, VSD and CWA make decisions on whether to move forward with a regional project. A description of the funding opportunities available are briefly described below.

10.1 California State Water Resources Control Board

The California State Water Resources Control Board (SWRCB) provides funding for planning, design and construction of recycled water projects that augment or offset fresh water supplies. The Division of Financial Assistance administers the Water Recycling Funding Program (WRFP). The primary sources of funding for water recycling projects are as follows:

1. Proposition 1 is the Water Quality, Supply, and Infrastructure Improvement Act of 2014. Proposition 1 funding authorized $7.545 billion in general obligation bonds for water projects and is administered under five programs including Small Community Wastewater ($260M), Water Recycling ($625M), Drinking Water ($260M), Stormwater ($200M) and Groundwater Sustainability ($800M). Of most relevance to the recycled water project alternatives presented herein, and explained in more detail below, are the Water Recycling, Small Community Wastewater, and Groundwater Sustainability Programs.

    a. Water Recycling – Provides grants and loans for the planning and construction of water recycling projects. Grants may be provided for studies to determine the feasibility of using recycled water and selecting a preferred alternative to augment or offset potable water from local or State supplies. Grants for planning will cover 50 percent of eligible costs up to a maximum of $75,000 and a 50 percent match from the agency is required. Grants for construction of recycled water projects are available and projects may receive funds up to 35 percent of construction costs up to a maximum of $15 Million. Low interest loans may be obtained for the balance not covered by the construction grants and they are funded under the Clean Water State Revolving Fund (CWSRF), discussed below, or State bond funded. As of October 2017, there were executed agreements to fund 28 recycled water projects with project costs totaling more than $1.69 billion of which $222M in grants will be dispersed and $945M will be funded utilizing low interest loans.

       As of January 2018, on line applications are still being accepted by the State Water Resources Control Board for Planning Grants under the Water Recycling Funding Program for planning, Clean Water State Revolving Fund for planning, construction and implementation and the Water Recycling Funding Program for construction.

b. Small Community Wastewater – The small community wastewater program includes an annual appropriation of $8M. Under this program, planning grants for recycled water projects are available to communities that serve a population less than 20,000 where the average median household income (MHI) is less than 80 percent of the Statewide MHI. The maximum grant amount can be 100 percent of the total project cost up to a maximum of $500,000 per project. Construction grants are also available under this program to fund recycled water projects up to a maximum of $6M per project. Qualifying under this construction grant program is dependent on the average MHI and it must be shown that the wastewater rates are at least 1.5 to 2 percent of the average MHI. This would need further evaluation to determine if IWA/VSD would qualify under this program.

2. Clean Water State Revolving Fund (CWSRF) Program provides low interest financing for planning, design and construction of recycled water projects. Generally, the loan rate is one half of the State of California's most recent general obligation bond rate and the terms of the loan are for the lesser of 30 years or the expected useful life of the asset. In many cases, agencies may utilize a combination of funding sources to complete projects. As of March 2017, the interest rate being offered by DFA was 1.8%.

10.2 United States Department of the Interior - Bureau of Reclamation

1. WaterSMART Water and Energy Efficiency Grants program provides a 50/50 cost share to water and irrigation districts, Tribes, States and other entities that deliver water or power. Awards are through a competitive process with focus on projects that can be completed in 24 months and will help sustain water supplies in the western United States. These grants may be leveraged with other non-Federal funding sources. Funding opportunities for fiscal year 2018 are currently being developed.

2. Title XVI Water Reclamation and Reuse grants provide funding for planning, design and construction of water recycling and reuse projects on a project specific basis. New funding opportunities are released annually. For a project to be funded for design and/or construction, a feasibility study that meets the requirements under Title XVI Directives and Standards WTR 11-01 must be completed. The Federal cost share for Title XVI projects is typically limited by law to not more than 25 percent of the total cost of planning, design, and construction up to a maximum of $20 million.

10.3 Public-Private Partnerships

Traditionally public agencies have utilized available funding methods such as grants, loans, user fees, taxes and municipal bonds. However, some state and local agencies are turning to innovative financing programs such as public-private partnerships (PPPs or P3s) to help fund and manage infrastructure that has traditionally been provided by the public sector. Under PPP's, a government entity contracts with a private firm to design, finance, construct, operate and maintain an infrastructure asset on behalf of the public sector. The advantages of a PPP is that it provides a source of cash flow for the public agency and access to capital that may not otherwise be available. There are a number of standard models for private participation in the water sector including management contracts, leases and concession as well as hybrid models. However, careful consideration needs to be taken when developing the agreements such that they reflect acceptable risk to both parties. Several articles (U.S. Department of the Treasury, April 2015 and KPMG, 2011) that discuss the details and risks associated with utilizing private financing are included in the individual TM's under separate covers.

10.4 Conclusions

Grant and loans are currently available to fund planning, design and construction of the alternatives discussed herein. It is anticipated that, if a regional project is deemed preferred, there is enough detail developed for the alternatives described herein that IWA, VSD and CWA can and should apply for a combination of grant funding under both State and Federal Proposition 1 and Title XVI respectively and, if necessary, apply for low interest loans under the CWSRF. When reviewing grant applications, State and Federal agencies look favorably on agencies that partner to implement recycled water programs. One of the most important items in qualifying for grants is the ability to show a well-defined project and that the agency(ies) have the means and the dedication to implement the project. It is recommended that once a decision is made on the project to implement, a plan and schedule be prepared to conduct a pilot study, preliminary design report and environmental documents.

Appendix A: Cost Breakdown

Regional Facility at VSD (9 mgd)

	Alternative 2	Alternative 3	Alternative 4	Alternative 5a	Alternative 5b	Alternative 6
Tertiary Treatment	$ 50,723,000	$ 50,723,000		$ 50,723,000	$ 50,723,000	$ 50,723,000
Advanced Treatment			$ 76,312,000		$ 43,829,734	
Recycled Water Distribution/Conveyance	$ 22,754,885	$ 69,251,962	$ 22,755,002	$ 86,542,761	$ 73,411,479	$ 69,252,000
Spreading	$ 14,470,115	$ 14,470,038		$ 9,762,239		
Deep Well Injection			$ 29,568,998		$ 15,279,521	
Total Construction Cost	***$ 88,000,000***	***$ 134,500,000***	***$ 128,700,000***	***$ 147,100,000***	***$ 183,300,000***	***$ 120,000,000***
Annualized capital cost (1.6%, 30 years)	***$ 3,716,402***	***$ 5,680,183***	***$ 5,435,238***	***$ 6,212,304***	***$ 7,741,097***	***$ 5,067,821***
Cost per Acre-foot	$ 617	$ 868	$ 1,309	$ 927	$ 1,301	$ 789

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
1	*6 MGD Secondary Effluent Pump Station*	*9*	*EA*	*$ 376,600*	*$ 3,389,400*	
		Subtotal:			**$ 3,389,400**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 338,940*	
		Subtotal:			**$ 3,728,340**	
	Escalation at 3.5% annually	*9%*			*$ 334,843*	
		Subtotal:			**$ 4,063,183**	
	Contractor Overhead	*10%*			*$ 406,318.30*	
		Subtotal:			**$ 4,469,501**	
	Contractor Profit	*10%*			*$ 446,950.13*	
		Subtotal:			**$ 4,916,451**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 4,916,451**	
	Bond and Insurance	*3%*			*$ 147,493.54*	
		Subtotal:			**$ 5,063,945**	
	Design Contingency	*35%*			*$ 1,772,380.75*	
		Subtotal:			**$ 6,836,326**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 6,837,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
Coagulation						
1	*Polymer Metering Pump Skid (2 pumps per skid)*	*1*	*EA*	*$ 6,200*	*$ 8,060*	*Includes installation factor of 30%*
2	*PE Polymer Storage Tank (4500 gallons)*	*1*	*EA*	*$ 10,530*	*$ 13,689*	*Includes installation factor of 30%*
3	*Concrete Slab (18-inches thick)*	*120*	*CY*	*$ 550*	*$ 66,000*	*Includes underlay, formwork, rebar, concrete*
4	*Concrete Containment Walls(12-inches thick)*	*30*	*CY*	*$ 1,150*	*$ 34,500*	*Includes underlay, formwork, rebar, concrete*
	Subtotal:				**$ 122,249**	
	Other Indirect Factors:					
	Equipment Installation Cost	0%			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	25%			$ 30,562	As percent of total cost. If not included in the unit cost above
	Site Civil	10%			$ 12,225	As percent of total cost. Including site preparation and improvements
	Structural	30%			$ 36,675	As percent of total cost
	HVAC/Plumbing	5%			$ 6,112	As percent of total cost
	Electrical	20%			$ 24,450	As percent of total cost
	Instrumentation and Controls	15%			$ 18,337	As percent of total cost
	General Conditions (Div01)	10%			*$ 25,061*	
	Subtotal:				**$ 275,671**	
	Escalation at 3.5% annually	9%			*$ 24,758*	
	Subtotal:				**$ 300,430**	
	Contractor Overhead	10%			*$ 30,042.96*	
	Subtotal:				**$ 330,473**	
	Contractor Profit	10%			*$ 33,047.26*	
	Subtotal:				**$ 363,520**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 363,520**	
	Bond and Insurance	3%			*$ 10,905.59*	
	Subtotal:				**$ 374,425**	
	Design Contingency	35%			*$ 131,048.90*	
	Subtotal:				**$ 505,474**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 506,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
Sand Filtration						
1	*Parkson Continuous Upflow - 9 mgd*	*1*	*LS*	*$ 2,400,000*	*$ 3,120,000*	*Includes installation factor of 30%*
	Subtotal:				**$ 3,120,000**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*25%*			$ 780,000	As percent of total cost. If not included in the unit cost above
	Site Civil	*10%*			$ 312,000	As percent of total cost. Including site preparation and improvements
	Structural	*40%*			$ 1,248,000	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*15%*			$ 468,000	As percent of total cost
	Instrumentation and Controls	*15%*			$ 468,000	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 639,600*	
	Subtotal:				**$ 7,035,600**	
	Escalation at 3.5% annually	*9%*			*$ 631,869*	
	Subtotal:				**$ 7,667,469**	
	Contractor Overhead	*10%*			*$ 766,746.88*	
	Subtotal:				**$ 8,434,216**	
	Contractor Profit	*10%*			*$ 843,421.56*	
	Subtotal:				**$ 9,277,637**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 9,277,637**	
	Bond and Insurance	*3%*			*$ 278,329.12*	
	Subtotal:				**$ 9,555,966**	
	Design Contingency	*35%*			*$ 3,344,588.21*	
	Subtotal:				**$ 12,900,555**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 12,901,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
1	*Microfiltration 3 mgd*	*1*	*LS*	*$ 2,730,000*	*$ 3,549,000*	*Includes installation factor of 30%*
		Subtotal:			**$ 3,549,000**	
	Other Indirect Factors:					
	Architectural	*0%*			$ 3,022,500	Building Cost
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*20%*			$ 709,800	As percent of total cost. If not included in the unit cost above
	Site Civil	*5%*			$ 177,450	As percent of total cost. Including site preparation and improvements
	Structural	*5%*			$ 177,450	As percent of total cost
	HVAC/Plumbing	*5%*			$ 177,450	As percent of total cost
	Electrical	*15%*			$ 532,350	As percent of total cost
	Instrumentation and Controls	*15%*			$ 532,350	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 887,835*	
		Subtotal:			**$ 9,766,185**	
	Escalation at 3.5% annually	*9%*			*$ 877,103*	
		Subtotal:			**$ 10,643,288**	
	Contractor Overhead	*10%*			*$1,064,328.82*	
		Subtotal:			**$ 11,707,617**	
	Contractor Profit	*10%*			*$1,170,761.70*	
		Subtotal:			**$ 12,878,379**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 12,878,379**	
	Bond and Insurance	*3%*			*$ 386,351.36*	
		Subtotal:			**$ 13,264,730**	
	Design Contingency	*35%*			*$4,642,655.52*	
		Subtotal:			**$ 17,907,386**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 17,908,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
Chlorine Contact Time						
1	*Excavation*	*3910*	*CY*	*$ 60*	*$ 234,600*	*Includes excavation, backfill (imported fill), disposal, shallow excavation, no shoring, no dewatering*
2	*Concrete Slabs*	*3650*	*CY*	*$ 550*	*$ 2,007,500*	*Includes underlay, formwork, rebar, concrete*
3	*Concrete Walls*	*1633*	*CY*	*$ 1,150*	*$ 1,877,950*	*Includes underlay, formwork, rebar, concrete*
4	*Tank Coating*	*40340*	*SF*	*$ 20*	*$ 806,800*	*Interior surface area only. Cost assumes two coats*
5	*Handrail*	*542*	*LF*	*$ 150*	*$ 81,300*	*Aluminum, 3 bar with toeboard*
6	*Weir gate*	*6*	*EA*	*$ 20,000*	*$ 120,000*	
7	*Sodium Hypochlorite Metering Pump Skid (2 pumps per skid)*	*1*	*EA*	*$ 10,000*	*$ 10,000*	
8	*PE Sodium Hypochlorite Storage Tank (7800 gallons)*	*1*	*EA*	*$ 18,720*	*$ 18,720*	
9	*Chemical Storage Area: Concrete Slab (18-inches thick)*	*84*	*CY*	*$ 550*	*$ 46,200*	*Includes underlay, formwork, rebar, concrete*
10	*Chemical Storage Area: Concrete Containment Walls(12-inches thick)*	*29*	*CY*	*$ 1,150*	*$ 33,350*	*Includes underlay, formwork, rebar, concrete*
		Subtotal:			**$ 5,001,820**	
	Other Indirect Factors:					
	Equipment Installation Cost	20%			$ 1,000,364	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	10%			$ 500,182	As percent of total cost. If not included in the unit cost above
	Site Civil	10%			$ 500,182	As percent of total cost. Including site preparation and improvements
	Structural	10%			$ 500,182	As percent of total cost
	HVAC/Plumbing	0%			$ -	As percent of total cost
	Electrical	10%			$ 500,182	As percent of total cost
	Instrumentation and Controls	10%			$ 500,182	As percent of total cost
	General Conditions (Div01)	10%			*$ 850,309*	
		Subtotal:			**$ 9,353,403**	
	Escalation at 3.5% annually	5%			*$ 495,326*	
		Subtotal:			**$ 9,848,729**	
	Contractor Overhead	10%			*$ 984,872.91*	
		Subtotal:			**$ 10,833,602**	
	Contractor Profit	10%			*$ 1,083,360.20*	
		Subtotal:			**$ 11,916,962**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 11,916,962**	
	Bond and Insurance	3%			*$ 357,508.86*	
		Subtotal:			**$ 12,274,471**	
	Design Contingency	35%			*$ 4,296,064.86*	
		Subtotal:			**$ 16,570,536**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 16,571,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
Reverse Osmosis						
1	*RO System - 4.24 mgd flow based on a 6 mgd Tertiary Facility*	*1*	*LS*	*$ 5,400,000*	*$ 7,020,000*	*Includes installation factor of 30%*
2	*Sulfuric Acid Metering Pump Skid (2 pumps per skid)*	*1*	*EA*	*$ 5,600*	*$ 7,280*	*Includes installation factor of 30%*
3	*PE Sulfuric Acid Storage Tank (11,900 gallons)*	*1*	*EA*	*$ 32,500*	*$ 42,250*	*Includes installation factor of 30%*
4	*Concrete Slab (18-inches thick)*	*91*	*CY*	*$ 550*	*$ 50,050*	*Includes underlay, formwork, rebar, concrete*
5	*Concrete Containment Walls(12-inches thick)*	*27*	*CY*	*$ 1,150*	*$ 31,050*	*Includes underlay, formwork, rebar, concrete*
	Subtotal:				**$ 7,150,630**	
	Other Indirect Factors:					
	Equipment Installation Cost	0%			$ 2,945,000	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	20%			$ 1,430,126	As percent of total cost. If not included in the unit cost above
	Site Civil	10%			$ 715,063	As percent of total cost. Including site preparation and improvements
	Structural	5%			$ 357,532	As percent of total cost
	HVAC/Plumbing	5%			$ 357,532	As percent of total cost
	Electrical	20%			$ 1,430,126	As percent of total cost
	Instrumentation and Controls	15%			$ 1,072,595	As percent of total cost
	General Conditions (Div01)	10%			*$ 1,545,860*	
	Subtotal:				**$ 17,004,463**	
	Escalation at 3.5% annually	9%			*$ 1,527,174*	
	Subtotal:				**$ 18,531,637**	
	Contractor Overhead	10%			*$1,853,163.72*	
	Subtotal:				**$ 20,384,801**	
	Contractor Profit	10%			*$2,038,480.09*	
	Subtotal:				**$ 22,423,281**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 22,423,281**	
	Bond and Insurance	3%			*$ 672,698.43*	
	Subtotal:				**$ 23,095,979**	
	Design Contingency	35%			*$8,083,592.81*	
	Subtotal:				**$ 31,179,572**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 31,180,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
UV Peroxide						
1	*In Channel UV Disinfection System - 6mgd*	*1*	*LS*	*$ 787,500*	*$ 1,023,750*	*Includes installation factor of 30%*
	Peroxide Dosing and Storage (inluded in the cost above)				*$ -*	
		Subtotal:			**$ 1,023,750**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*25%*			$ 255,938	As percent of total cost. If not included in the unit cost above
	Site Civil	*20%*			$ 204,750	As percent of total cost. Including site preparation and improvements
	Structural	*60%*			$ 614,250	As percent of total cost
	HVAC/Plumbing	*5%*			$ 51,188	As percent of total cost
	Electrical	*30%*			$ 307,125	As percent of total cost
	Instrumentation and Controls	*20%*			$ 204,750	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 266,175*	
		Subtotal:			**$ 2,927,925**	
	Escalation at 3.5% annually	*9%*			*$ 262,958*	
		Subtotal:			**$ 3,190,883**	
	Contractor Overhead	*10%*			*$ 319,088.26*	
		Subtotal:			**$ 3,509,971**	
	Contractor Profit	*10%*			*$ 350,997.08*	
		Subtotal:			**$ 3,860,968**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 3,860,968**	
	Bond and Insurance	*3%*			*$ 115,829.04*	
		Subtotal:			**$ 3,976,797**	
	Design Contingency	*35%*			*$ 1,391,878.93*	
		Subtotal:			**$ 5,368,676**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 5,369,000**	

Hazen

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
1	*Recycled Water Storage Tank - 9 mgd*	*1*	*LS*	*$ 4,925,000*	*$ 4,925,000*	*Includes installation factor of 30%*
		Subtotal:			**$ 4,925,000**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*10%*			$ 492,500	As percent of total cost. If not included in the unit cost above
	Site Civil	*10%*			$ 492,500	As percent of total cost. Including site preparation and improvements
	Structural	*5%*			$ 246,250	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*10%*			$ 492,500	As percent of total cost
	Instrumentation and Controls	*5%*			$ 246,250	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 689,500*	
		Subtotal:			**$ 7,584,500**	
	Escalation at 3.5% annually	*9%*			*$ 681,166*	
		Subtotal:			**$ 8,265,666**	
	Contractor Overhead	*10%*			*$ 826,566.56*	
		Subtotal:			**$ 9,092,232**	
	Contractor Profit	*10%*			*$ 909,223.21*	
		Subtotal:			**$ 10,001,455**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 10,001,455**	
	Bond and Insurance	*3%*			*$ 300,043.66*	
		Subtotal:			**$ 10,301,499**	
	Design Contingency	*35%*			*$ 3,605,524.65*	
		Subtotal:			**$ 13,907,024**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 13,908,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

MSWD, IWA, VSD, CWA

20050-002

Conceptual Level Estimate

Estimator:	*A. Briggs*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
1	*Evaporation Ponds*	*1*	*AC*	*$ 500,000*	*$ 500,000*	*Includes installation factor of 30%*
		Subtotal:			**$ 500,000**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*5%*			$ 25,000	As percent of total cost. Including site preparation and improvements
	Structural	*5%*			$ 25,000	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 55,000*	
		Subtotal:			**$ 605,000**	
	Escalation at 3.5% annually	*9%*			*$ 54,335*	
		Subtotal:			**$ 659,335**	
	Contractor Overhead	*10%*			*$ 65,933.52*	
		Subtotal:			**$ 725,269**	
	Contractor Profit	*10%*			*$ 72,526.87*	
		Subtotal:			**$ 797,796**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 797,796**	
	Bond and Insurance	*3%*			*$ 23,933.87*	
		Subtotal:			**$ 821,729**	
	Design Contingency	*35%*			*$ 287,605.30*	
		Subtotal:			**$ 1,109,335**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 1,110,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 2 – CSD FLOWS TO VSD FOR SURFACE SPREADING AT VSD WRF

Estimator:	*S. Valdez*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	
	On-site Facilities					
	Spreading Basins	*968,000*	*CY*	*$ 5*	*$ 4,840,000*	*20 acres*
	36" Outfall and Overflow Piping	*4,622*	*LF*	*$ 505*	*$ 2,334,110*	
	Subtotal:				**$ 18,455,710**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 1,845,571*	
	Subtotal:				**$ 20,301,281**	
	Escalation at 3.5% annually	*9%*			*$ 1,823,262*	
	Subtotal:				**$ 22,124,543**	
	Contractor Overhead	*10%*			*$ 2,212,454.34*	
	Subtotal:				**$ 24,336,998**	
	Contractor Profit	*10%*			*$ 2,433,699.78*	
	Subtotal:				**$ 26,770,698**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 26,770,698**	
	Bond and Insurance	*3%*			*$ 803,120.93*	
	Subtotal:				**$ 27,573,818**	
	Design Contingency	*35%*			*$ 9,650,836.46*	
	Subtotal:				**$ 37,224,655**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 37,225,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 3 – CSD FLOWS TO VSD, DELIVER TO RECYCLED WATER CUSTOMERS, AND SURFACE SPREADING AT VSD WRF

Estimator:	*S. Valdez*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	*2 acres*
	On-site Facilities					
	Spreading Basins	*968,000*	*CY*	*$ 5*	*$ 4,840,000*	
	36" Outfall and Overflow Piping	*4,622*	*LF*	*$ 505*	*$ 2,334,110*	
	Recycled Water Distribution					
	RW Distribution System	*1*	*LS*	*$ 23,052,879*	*$ 23,052,879*	*Phase 2*
	Subtotal:				**$ 41,508,589**	
	Other Indirect Factors:					
	Equipment Installation Cost	0%			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	0%			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	0%			$ -	As percent of total cost. Including site preparation and improvements
	Structural	0%			$ -	As percent of total cost
	HVAC/Plumbing	0%			$ -	As percent of total cost
	Electrical	0%			$ -	As percent of total cost
	Instrumentation and Controls	0%			$ -	As percent of total cost
	General Conditions (Div01)	10%			*$ 4,150,859*	
	Subtotal:				**$ 45,659,447**	
	Escalation at 3.5% annually	9%			*$ 4,100,685*	
	Subtotal:				**$ 49,760,132**	
	Contractor Overhead	10%			*$ 4,976,013.23*	
	Subtotal:				**$ 54,736,145**	
	Contractor Profit	10%			*$ 5,473,614.55*	
	Subtotal:				**$ 60,209,760**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 60,209,760**	
	Bond and Insurance	3%			*$ 1,806,292.80*	
	Subtotal:				**$ 62,016,053**	
	Design Contingency	35%			*$ 21,705,618.50*	
	Subtotal:				**$ 83,721,671**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 83,722,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 4 – CSD FLOWS TO VSD, GROUNDWATER INJECTION AT VSD WRF

Estimator:	*S. Valdez*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	
	On-site Facilities					
	Low-head Injection Pump Station	*9*	*MGD*	*$ 100,000*	*$ 900,000*	*Total of 9.0 MGD injection*
	1.5 MGD Injection Well	*6*	*EA*	*$ 1,500,000*	*$ 9,000,000*	*Total of 9.0 MGD injection*
	20" Injection Piping	*5642*	*LF*	*$ 265*	*$ 1,495,130*	
	36" Overflow Piping	*3347*	*LF*	*$ 345*	*$ 1,154,715*	
	Backflush Pump	*6*	*EA*	*$ 100,000*	*$ 600,000*	
	12" Backflush Piping	*4927*	*LF*	*$ 205*	*$ 1,010,035*	
	Monitoring Well	*2*	*EA*	*$ 250,000*	*$ 500,000*	
	Subtotal:				**$ 25,941,480**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 2,594,148*	
	Subtotal:				**$ 28,535,628**	
	Escalation at 3.5% annually	*9%*			*$ 2,562,791*	
	Subtotal:				**$ 31,098,419**	
	Contractor Overhead	*10%*			*$ 3,109,841.89*	
	Subtotal:				**$ 34,208,261**	
	Contractor Profit	*10%*			*$ 3,420,826.08*	
	Subtotal:				**$ 37,629,087**	
	Contract Allowances/Unit Price Items				*$ -*	
	Subtotal:				**$ 37,629,087**	
	Bond and Insurance	*3%*			*$ 1,128,872.61*	
	Subtotal:				**$ 38,757,959**	
	Design Contingency	*35%*			*$ 13,565,285.82*	
	Subtotal:				**$ 52,323,245**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 52,324,000**	

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RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 5A – CSD FLOWS TO VSD, DELIVER TO RECYCLED WATER CUSTOMERS, THEN SURFACE SPREADING AT POSSE PARK

Estimator:	*S. Valdez*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	*2 acres*
	Off-site Facilities					
	36" Tertiary Treated RWTM	*16,975*	*LF*	*$ 505*	*$ 8,572,375*	
	Spreading Basins	*968,000*	*CY*	*$ 5*	*$ 4,840,000*	
	Recycled Water Distribution					
	RW Distribution System	*1*	*LS*	*$ 23,052,879*	*$ 23,052,879*	*Phase 2*
		Subtotal:			**$ 47,746,854**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 4,774,685*	
		Subtotal:			**$ 52,521,539**	
	Escalation at 3.5% annually	*9%*			*$ 4,716,971*	
		Subtotal:			**$ 57,238,510**	
	Contractor Overhead	*10%*			*$ 5,723,850.97*	
		Subtotal:			**$ 62,962,361**	
	Contractor Profit	*10%*			*$ 6,296,236.07*	
		Subtotal:			**$ 69,258,597**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 69,258,597**	
	Bond and Insurance	*3%*			*$ 2,077,757.90*	
		Subtotal:			**$ 71,336,355**	
	Design Contingency	*35%*			*$ 24,967,724.12*	
		Subtotal:			**$ 96,304,079**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 96,305,000**	

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RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 5B – CSD FLOWS TO VSD, DELIVER TO RECYCLED WATER CUSTOMERS, THEN GROUNDWATER INJECTION AT POSSE PARK

Estimator:	*S. Valdez*	*Date:*	*3/23/2018*
Reviewer:	*C. Portner*	*Date:*	*3/23/2018*

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	
	Off-site Facilities					
	36" Tertiary Treated RWTM	*16,447*	*LF*	*$ 505*	*$ 8,305,735*	
	Low-head Injection Pump Station	*4.5*	*MGD*	*$ 100,000*	*$ 450,000*	*Total of 4.5 MGD injection*
	1.5 MGD Injection Well	*3*	*EA*	*$ 1,500,000*	*$ 4,500,000*	*Total of 4.5 MGD injection*
	20" Injection Piping	*4067*	*LF*	*$ 265*	*$ 1,077,755*	
	Backflush Pump	*3*	*EA*	*$ 100,000*	*$ 300,000*	
	12" Backflush Piping	*3647*	*LF*	*$ 205*	*$ 747,635*	
	Monitoring Well	*2*	*EA*	*$ 250,000*	*$ 500,000*	
	Recycled Water Distribution					
	RW Distribution System	*1*	*LS*	*$16,809,132*	*$ 16,809,132*	*Phase 1*
		Subtotal:			**$ 43,971,857**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 4,397,186*	
		Subtotal:			**$ 48,369,043**	
	Escalation at 3.5% annually	*9%*			*$ 4,344,034*	
		Subtotal:			**$ 52,713,077**	
	Contractor Overhead	*10%*			*$ 5,271,307.68*	
		Subtotal:			**$ 57,984,384**	
	Contractor Profit	*10%*			*$ 5,798,438.44*	
		Subtotal:			**$ 63,782,823**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 63,782,823**	
	Bond and Insurance	*3%*			*$ 1,913,484.69*	
		Subtotal:			**$ 65,696,308**	
	Design Contingency	*35%*			*$ 22,993,707.65*	
		Subtotal:			**$ 88,690,015**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 88,691,000**	

RECYCLED WATER PROGRAM DEVELOPMENT FEASIBILITY STUDY

REGIONAL REPORT

20050-002

ALTERNATIVE 6 – DELIVER TO RECYCLED WATER CUSTOMERS AND EXCESS TO CVSC

Estimator:	S. Valdez	Date:	3/23/2018
Reviewer:	C. Portner	Date:	3/23/2018

#	Description	QTY	UNIT	UNIT COST	TOTAL COST	NOTES
	Regional Facilities					
	20" Regional RW Pipeline	*41,440*	*LF*	*$ 265*	*$ 10,981,600*	
	Pump Station	*3*	*MGD*	*$ 100,000*	*$ 300,000*	*2 acres*
	Recycled Water Distribution					
	RW Distribution System	*1*	*LS*	*$ 23,052,879*	*$ 23,052,879*	*Phase 2*
		Subtotal:			**$ 34,334,479**	
	Other Indirect Factors:					
	Equipment Installation Cost	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Process Mechanical (Piping, Valves, Appurtenances, etc)	*0%*			$ -	As percent of total cost. If not included in the unit cost above
	Site Civil	*0%*			$ -	As percent of total cost. Including site preparation and improvements
	Structural	*0%*			$ -	As percent of total cost
	HVAC/Plumbing	*0%*			$ -	As percent of total cost
	Electrical	*0%*			$ -	As percent of total cost
	Instrumentation and Controls	*0%*			$ -	As percent of total cost
	General Conditions (Div01)	*10%*			*$ 3,433,448*	
		Subtotal:			**$ 37,767,926**	
	Escalation at 3.5% annually	*9%*			*$ 3,391,946*	
		Subtotal:			**$ 41,159,872**	
	Contractor Overhead	*10%*			*$ 4,115,987.21*	
		Subtotal:			**$ 45,275,859**	
	Contractor Profit	*10%*			*$ 4,527,585.93*	
		Subtotal:			**$ 49,803,445**	
	Contract Allowances/Unit Price Items				*$ -*	
		Subtotal:			**$ 49,803,445**	
	Bond and Insurance	*3%*			*$ 1,494,103.36*	
		Subtotal:			**$ 51,297,549**	
	Design Contingency	*35%*			*$ 17,954,141.99*	
		Subtotal:			**$ 69,251,691**	
	TOTAL PROBABLE CONSTRUCTION COST:				**$ 69,252,000**	

O&M Categories	**Factor**
Pump Station / Treatment Plant O&M	2%
Non-plant infrastructure O&M	0.5%

Alternative 2 – CSD flows to VSD for Surface Spreading at VSD WRF	
Tertiary Treatment Capital Cost ($)	50,723,000
Treatment Plant O&M	*1,014,460*
Remaining Non-plant Capital Cost ($)	37,225,000
Non-plant infrastructure O&M	*186,125*
Power	
Tertiary Process Pump HP	75
Tertiary Process Pump Runtime per day (hrs)	24
Number of Chemical Pumps	2
Chemical Feed Pump HP	0.8
Chemical Feed Pump Runtime per day (hrs)	24
Chemical Feed Pump kWh/yr	9,798
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
Total Pump kWh/yr	1,480,226
Electricity Cost ($/kWh)	0.1141
Total Electricity Cost ($/yr)	168,894
Chemical	
NaOCl (gal/yr)	281,501
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	547,938
PACl Cost ($/lb)	0.33
Polymer (gal/yr)	
Polymer Cost ($/gal)	
Total Chemical Cost ($/yr)	817,012
Labor	
No. of FTE	3
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	314,400
Consumables	
Filtration Media - Sand (ton./yr)	5.00
Sand Cost ($/ton)	300
Total Consumable Cost ($/yr)	1,499
TOTAL	**2,502,390**

Alternative 3 – CSD flows to VSD, Deliver to Recycled Water Customers, and Surface Spreading at VSD WRF	
Tertiary Treatment Capital Cost ($)	50,723,000
Treatment Plant O&M	*1,014,460*
Remaining Non-plant Capital Cost ($)	83,722,000
Non-plant infrastructure O&M	*418,610*
Power	
Tertiary Process Pump HP	75
Tertiary Process Pump Runtime per day (hrs)	24
Number of Chemical Pumps	2
Chemical Feed Pump HP	0.8
Chemical Feed Pump Runtime per day (hrs)	24
Chemical Feed Pump kWh/yr	9,798
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
Distribution Pump Station Total HP	500
Distribution Pump Station Runtime per day (hrs)	8
Total Pump kWh/yr	2,568,948
Electricity Cost ($/kWh)	0.1141
Total Electricity Cost ($/yr)	293,117
Chemical	
NaOCl (gal/yr)	281,501
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	547,938
PACl Cost ($/lb)	0.33
Polymer (gal/yr)	
Polymer Cost ($/gal)	
Total Chemical Cost ($/yr)	817,012
Labor	
No. of FTE	5
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	524,000
Consumables	
Filtration Media - Sand (ton./yr)	5.00
Sand Cost ($/ton)	300
Total Consumable Cost ($/yr)	1,499
TOTAL	**3,068,698**

Alternative 4 – CSD flows to VSD, Groundwater Injection at VSD WRF	
Advanced Treatment Capital Cost ($)	76,312,000
Treatment Plant O&M	*1,526,240*
Remaining Non-plant Capital Cost ($)	52,324,000
Non-plant infrastructure O&M	*261,620*
Power	
Advanced Process MF/RO (kWh/yr)	17,983,550
UV (kWh/yr)	946,080
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
Low-head Injection Pump HP	60
Low-head Injection Pump Runtime per day (hrs)	23.95
Backflush Pump HP	100
Backflush Pump Runtime per day (hrs)	0.05
Total Energy (kWh/yr)	20,301,964
Electricity Cost ($/kWh)	0.1141
Total Electricity Cost ($/yr)	2,316,454
Chemical	
NaOCl (gal/yr)	281,501
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	547,938
PACl Cost ($/lb)	0.33
Citric Acid (gal/yr)	5,327
Citric Acid Cost ($/gal)	4.53
Anti-scalant (gal/yr)	13,706
Anti-scalant Cost ($/gal)	10
H2SO4 (lb/yr)	410,954
H2SO4 Cost ($/lb)	0.50
Hydrogen peroxide (gal/yr)	82,440
Hydrogen peroxide Cost ($/gal)	3.78
Lime (gal/yr)	562,280
Lime Cost ($/gal)	0.51
Total Chemical Cost ($/yr)	1,782,062
Labor	
No. of FTE	3
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	314,400
Consumables	
Filtration Media - Sand (ton./yr)	5.00
Sand Cost ($/ton)	300
Strainers (no./yr)	3
Strainer Cost ($/ea)	2,000
Microfilters (no./yr)	104
Microfilters Cost ($/ea)	800
RO Membranes (no./yr)	303
RO Membranes Cost ($/ea)	500
UV Lamps (no./yr)	309
UV Lamp Cost ($/ea)	352
Total Consumable Cost ($/yr)	350,568
Evaporation Ponds	
Evaporation Ponds OM ($/yr)	1,213,955
TOTAL	**7,765,299**

Alternative 5a – CSD flows to VSD, Deliver to Recycled Water Customers, then Surface Spreading at Posse Park

Tertiary Treatment Capital Cost ($)	50,723,000
Treatment Plant O&M	*1,014,460*
Remaining Non-plant Capital Cost ($)	96,305,000
Non-plant infrastructure O&M	*481,525*
Power	
Tertiary Process Pump HP	75
Tertiary Process Pump Runtime per day (hrs)	24
Number of Chemical Pumps	2
Chemical Feed Pump HP	0.8
Chemical Feed Pump Runtime per day (hrs)	24
Chemical Feed Pump kWh/yr	9,798
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
RW Dist Pump Station Total HP	500
RW Dist Pump Station Runtime per day (hrs)	8
Total Pump kWh/yr	2,568,948
Electricity Cost ($/kWh)	0.1141
Total Electricity Cost ($/yr)	293,117
Chemical	
NaOCl (gal/yr)	281,501
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	547,938
PACl Cost ($/lb)	0.33
Polymer (gal/yr)	
Polymer Cost ($/gal)	
Total Chemical Cost ($/yr)	817,012
Labor	
No. of FTE	5
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	524,000
TOTAL	**3,130,114**

Alternative 5b – CSD flows to VSD, Deliver to Recycled Water Customers, then Groundwater Injection at Posse Park	
Advanced Treatment Capital Cost ($)	94,552,734
Treatment Plant O&M	*1,891,055*
Remaining Non-plant Capital Cost ($)	88,691,000
Non-plant infrastructure O&M	*443,455*
Power	
Advanced Process MF/RO (kWh/yr)	8,991,775
UV (kWh/yr)	473,040
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
Low-head Injection Pump HP	60
Low-head Injection Pump Runtime per day (hrs)	23.95
Backflush Pump HP	100
Backflush Pump Runtime per day (hrs)	0.05
RW Dist Pump Station Total HP	300
RW Dist Pump Station Runtime per day (hrs)	8
Total Energy (kWh/yr)	9,083,480
Electricity Cost ($/kWh)	0.1141
Electricity Cost ($/yr)	1,036,425
Chemical	
NaOCl (gal/yr)	140,751
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	273,969
PACl Cost ($/lb)	0.33
Citric Acid (gal/yr)	2,664
Citric Acid Cost ($/gal)	4.53
Anti-scalant (gal/yr)	6,853
Anti-scalant Cost ($/gal)	12.00
H2SO4 (lb/yr)	205,477
H2SO4 Cost ($/lb)	0.50
Hydrogen peroxide (gal/yr)	41,220
Hydrogen peroxide Cost ($/gal)	3.78
Lime (gal/yr)	281,140
Lime Cost ($/gal)	0.51
Total Chemical Cost ($/yr)	904,736
Consumables	
Filtration Media - Sand (ton./yr)	2.50
Sand Cost ($/ton)	300
Strainers (no./yr)	1
Strainer Cost ($/ea)	2,000
Microfilters (no./yr)	52
Microfilters Cost ($/ea)	800
RO Membranes (no./yr)	151
RO Membranes Cost ($/ea)	500
UV Lamps (no./yr)	155
UV Lamp Cost ($/ea)	352
Total Consumable Cost ($/yr)	174,410
Labor	
No. of FTE	5
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	524,000
Evaporation Ponds	
Evaporation Ponds OM ($/yr)	404,652
TOTAL	**5,378,732**

Alternative 6 – CSD flows to VSD, Deliver to Recycled Water Customers and Excess to CVSC	
Tertiary Treatment Capital Cost ($)	50,723,000
Treatment Plant O&M	*1,014,460*
Remaining Non-plant Capital Cost ($)	69,252,000
Non-plant infrastructure O&M	*346,260*
Power	
Tertiary Process Pump HP	75
Tertiary Process Pump Runtime per day (hrs)	24
Number of Chemical Pumps	2
Chemical Feed Pump HP	0.8
Chemical Feed Pump Runtime per day (hrs)	24
Chemical Feed Pump kWh/yr	9,798
Regional Pump Station Total HP	150
Regional Pump Station Runtime per day (hrs)	24
RW Dist Pump Station Total HP	500
RW Dist Pump Station Runtime per day (hrs)	8
Total Pump kWh/yr	2,568,948
Electricity Cost ($/kWh)	0.1141
Electricity Cost ($/yr)	293,117
Chemical	
NaOCl (gal/yr)	281,501
NaOCl Cost ($/gal)	2.26
PACl (lb/yr)	547,938
PACl Cost ($/lb)	0.33
Polymer (gal/yr)	
Polymer Cost ($/gal)	
Total Chemical Cost ($/yr)	817,012
Labor	
No. of FTE	4
Annual Salary ($/yr/FTE)	104800
Total Labor Cost ($/yr)	419,200
Consumables	
Filtration Media - Sand (ton./yr)	5.00
Sand Cost ($/ton)	300
Total Consumable Cost ($/yr)	1,499
TOTAL	**2,891,548**

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