CITY OF SANTA BARBARA
POTABLE REUSE FEASIBILITY STUDY
FINAL
March 2017
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EXECUTIVE SUMMARY

INTRODUCTION

This report presents the background and findings associated with a potable reuse feasibility study completed by the City of Santa Barbara, California (City). The City’s current Long Term Water Supply Plan (LTWSP) was adopted in 2011 and identifies seawater desalination as a water supply to be used during and immediately following periods of extended drought. The desalination plant is permitted to produce 10,000 acre-feet per year (AFY) of finished water. This potable reuse feasibility study evaluates the maximum water yield that is technically feasible from various potable reuse alternatives (i.e., indirect and direct potable reuse) to determine if the City’s desalinated water supply can be replaced by potable reuse. Determination of the technically feasible maximum capacity includes an evaluation of the infrastructure required to convey and use the water (e.g., injection wells, spreading basins, pipelines, etc.). The infrastructure concepts presented are not intended to be an exhaustive list of alternatives, but are simply shown to demonstrate the water can be used.

BACKGROUND AND GOALS

On September 23, 2014 City Council directed “staff… [to evaluate the] feasibility, cost, and timeline associated with both converting the offshore [screened open ocean intake] facility to a subsurface intake (SSI) and look at the options about potable reuse”.¹ This motion was further adopted by the Central Coast Regional Water Quality Control Board (RWQCB), who on January 30, 2015 amended the City’s NPDES Permit by adding a provision to require the City to “Analyze the feasibility of a range of alternatives, including SSI and potable reuse options.” The subject of this study is the maximum yield that is technically feasible for potable reuse alternatives. SSI feasibility findings are presented in a separate report.

In addition to meeting requirements set forth by City Council and the RWQCB, results of this study may inform future studies, including updates to the City’s LTWSP. Lake Cachuma (Cachuma) is the City’s primary water source, providing over 50 percent of the annual water supply; however, availability of water from Cachuma may be reduced because of pending federal environmental decisions, reduced operational yield due to siltation, and reduced yield as a result of the current historic drought.

Because the volume of the reduction in the City’s water supply from Cachuma is currently unknown, the goal of this study was to understand the maximum yield that is technically feasible from potable reuse options. The City can use the findings of this report to inform future water supply studies, including an update to the City’s LTWSP.

¹ Mayor Schneider, as documented in the September 23, 2014 City Council Meeting video recording (available on the City’s website): http://media-07.granicus.com:443/OnDemand/santabarbara/santabarbara_d2343df5-*a20-499d-b1fb-5dda1f9e0414.mp4 at 2 hours and 33 minutes.
PROJECT ALTERNATIVES

The basis for establishing and evaluating project alternatives is presented in the Work Plan (Appendix A) and subsequently in Section 3 of this report.

Capacity

The target yield for each potable reuse alternative is based on the replacing the City’s desalination plant’s production capacity, which is 10,000 acre-feet per year (AFY). It should be noted that the City’s current Long Term Water Supply Plan is based on 1,400 AFY of non-potable recycled (NPR) water and a potable reuse alternative cannot reduce the City’s planned recycled supply. Therefore, the combined potable and non-potable reuse alternative production capacity must be capable of up to 11,400 AFY to be considered as a replacement for the City’s desalination plant.

Potable Reuse Applications

Potable reuse applications considered in this study included either indirect potable reuse (IPR) or direct potable reuse (DPR) and may be defined as:

1. **Indirect potable reuse (IPR):** The introduction of advanced treated water into an environmental buffer such as a groundwater aquifer or surface water body before being withdrawn for potable purposes. Indirect potable reuse can also be conducted using tertiary effluent when applied by spreading in percolation basins. Two types of IPR were considered:
   a. **Groundwater replenishment by surface application:** The application of recharge water to a natural area or constructed facility with sufficient permeability allowing the recharge water to infiltrate into an underlying and unconfined aquifer (e.g., spreading basin, surface spreading, percolation ponds, permeable creek/river beds, etc.).
   b. **Groundwater replenishment by subsurface application:** The application of recharge water to a groundwater basin(s) by a means other than surface application, usually by direct injection into the aquifer using wells (e.g., injection wells, groundwater recharge wells, etc.).

2. **Direct potable reuse (DPR):** There are two forms of direct potable reuse. In the first form, advanced treated water is introduced in close proximity to a drinking water treatment facility intake without an environmental buffer (i.e., raw water supply augmentation). In the second form, finished water from an advanced water treatment facility that is permitted as a drinking water treatment facility is introduced directly into a potable water distribution system.
Project Sites

Possible treatment facility locations included:

- 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006), and
- Repurposing a portion of the the Charles Meyer Desalination Plant site located at 525 E. Yanonali Street

Possible groundwater replenishment (a.k.a., recharge) locations for IPR included groundwater replenishment by surface and subsurface application in the Foothill Basin and Storage Unit 1.

Possible DPR location alternatives included raw water supply augmentation at the Lauro Reservoir for the Cater Water Treatment Plant (WTP) or the Charles E Meyer Desalination Plant (i.e., dilution of seawater intake water); or raw water supply for a new water treatment plant (WTP) to be co-located at the Charles Meyer Desalination Plant.

Water Quality and Treatment Requirements

Water quality and treatment requirements for IPR alternatives are dictated by the California Code of Regulations, Title 22. All IPR alternatives considered were developed to comply with the regulations set forth in Title 22 by providing adequate treatment and environmental buffer retention time requirements stated therein.

The state of California does not currently have regulations for DPR, however, the State Water Resources Control Board, Division of Drinking Water (DDW) has stated they would review DPR projects on a case by case basis. For the purpose of this study, the basis of design for treatment and finished water quality goals for DPR was based upon the most recent regulatory activity and comparable precedent activity in California, requiring 14/12/12 log reduction of virus/Giardia/ Cryptosporidium with multiple treatment barriers and 3 hours of engineered storage before distribution.

INITIAL SCREENING PROCESS

An initial screening analysis was conducted to identify the potable reuse alternatives that were potentially technically feasible. For this study, initial screening criteria were defined and based on the following factors:

1. Geotechnical Hazards
2. Hydrogeologic Factors (i.e., for IPR alternatives only)
3. Oceanographic Factors
4. Presence of Sensitive Habitats
5. Design and Construction Constraints

Following initial screening, alternatives were classified as "not feasible", "potentially feasible but does not meet current study goals", or "potentially feasible". In accordance with the
Work Plan (Appendix A), only “potentially feasible” alternatives are to be considered further in this study, for an evaluation of their social, environmental and economic feasibility. However, alternatives that were identified as “potentially feasible but does not meet current study goals” can be considered as part of future studies.

REGULATORY AND PERMITTING REQUIREMENTS

Implementing a potable reuse project in the City will include environmental, regulatory, and permitting requirements. A complete overview of the specific regulatory and permitting requirements, including descriptions of specific IPR and DPR regulations and estimated schedule and cost impacts, is presented in Section 2; in total, 12 requirements/permits were identified within 8 regulatory bodies. Some of the notable regulatory and permitting requirements are highlighted below:

- Two central permitting documents (i.e., relevant for IPR projects):
  - Engineering Report
  - Report of Waste Discharge (ROWD)
- California Environmental Quality Act (CEQA) requirements
- Update to City Urban Water Management Plan, which includes information from an update to the City Long Term Water Supply Plan (LTWSP)
- Update to City Programmatic Environmental Impact Report (EIR)
- California Coastal Commission (CCC)
  - Coastal Development Permit (CDP)
- State Water Resources Control Board (SWRCB)
  - Division of Drinking Water (DDW)
    - Public Water System (PWS) Permit
  - Regional Water Quality Control Board (RWQCB)
    - National Pollution Discharge Elimination System (NPDES)
- Santa Barbara County Public Health Department
  - Water Well Permit
- United States Environmental Protection Agency (U.S. EPA)
  - Underground Injection Control (UIC) Program
- City of Santa Barbara
  - Local Coast Development Permit
  - Industrial Pretreatment Permit
  - Building Permits
Further information on these and additional permitting requirements that are prompted by the construction of project alternatives are presented in Section 2.

**BASIS OF DESIGN**

A basis of design (BOD) was used to establish the conceptual design for each potable reuse alternative evaluated. The following BOD criteria were established; refer to Section 3.2 for additional information.

1. Potable Reuse Application (presented in Section 3.2.1)
2. Water Quality and Treatment Requirements (presented in Section 3.2.2)
3. Production Capacity (presented in Section 3.2.3)
   a. It is worth noting that the annual average daily flow from the City’s El Estero Wastewater Treatment Plant is 7.73 mgd (8,660 AFY). Based upon water loss during advanced treatment (i.e., brine from an RO plant) and other non-potable reuse demands (when applicable), the annual average daily flow available from potable reuse ranges from 5,808 AFY to 6,928 AFY.
4. Subsurface Properties and Other Hydrogeologic Considerations (presented in Section 3.2.4)
5. Project Site Alternatives (presented in Section 3.2.5)
6. Project Life (presented in Section 3.2.6)
7. Reliability Features (presented in Section 3.2.7)

**HYDROGEOLOGIC ANALYSIS OF GROUNDWATER REPLENISHMENT (IPR) ALTERNATIVES**

Based upon the hydrogeologic and effluent production capacity BOD criteria, groundwater recharge IPR applications were further evaluated to determine information necessary to generate conceptual design criteria. Hydrogeologic analyses were performed to aid in this study and summarized below; refer to Section 3.3 for additional information.

1. Hydrogeologic Evaluation Approach (presented in Section 3.3.1)
2. Rate of Groundwater Replenishment, Storage, Yield Increases (presented in Section 3.3.2)
3. Impacts to Local Groundwater Supplies and Existing Water Users (presented in Section 3.3.3)
4. Impacts to Sensitive Habitats (presented in Section 3.3.4)
5. Potential Capture or Mobilization of Known Groundwater Contamination (presented in Section 3.3.5)
6. Geologic Hazards including Liquefaction, Slope Failure, High Groundwater (presented in Section 3.3.6)
SUMMARY OF POTABLE REUSE ALTERNATIVES

Using the basis of design requirements, conceptual designs were developed for multiple alternatives. However, the following alternatives were discounted from further consideration based upon information presented below; refer to Section 3 of this report for additional information.

1. **IPR by Surface Water Augmentation to Cachuma Reservoir:**
   Cachuma Reservoir is the nearest surface water body large enough for surface augmentation and is approximately 23 miles away. Thus, it would require significant pumping conveyance and is not practical compared to other options.

2. **Use of advanced water treatment facility (AWTF) product water for diluting intake water at the Charles E Meyer Desalination Plant:**
   Dilution was determined to be inadequate to significantly affect the desalination process or change the recovery rate. Too much AWTF product water would be lost (i.e., wasted) to the desalination process brine.

3. **IPR Alternative No. 2 to provide a seawater intrusion barrier:**
   Groundwater modeling indicated that the capacity of the Storage Unit 1 producing zones to accept, store, and transmit recycled water is limited in the coastal portion of the basin. Even with injection of water from 24 wells, the barrier is not effective against seawater intrusion.

4. **IPR by surface application:**
   Groundwater modeling and literature review identified potential risks associated with liquefaction, slope failure, high groundwater, mobilization/capture of existing contamination, and impacts to sensitive habitats. The benefits of surface recharge (annual average storage of 740 AFY) are too low to warrant additional consideration.

Alternatives that would be carried forward for additional analysis included combinations of NPR (currently practiced by the City), IPR (Refer to Figure ES.1), DPR (Refer to Figure ES.2), and a new WTP (Refer to Figure ES.3). A schematic presenting the final potable reuse alternatives considered in this study is located in Figure ES.4.
Figure ES.1 - Indirect Potable Reuse Train PFD

Notes:
1. Provides 4 hours of response retention time.
Notes:
1. Provides 4 hours of response retention time.
Figure ES.3 - New Water Treatment Train PFD
NOTES:
1. RO recovery is assumed to be 80% for treatment process involving RO membranes (i.e., IPR and DPR).

**ALTERNATIVE NUMBER** | **FLOW DIAGRAM** | **DESCRIPTION NOTES**
---|---|---
1A | El Estero WWTP | Maximize NPR treatment & use Lauro Reservoir
- Only tertiary treated flow going east.
- DPR treat all flows going west.
- DPR treated flow sent to Lauro Reservoir.
- Alternative maximizes NPR treated flow.

1B | El Estero WWTP | Maximize DPR by minimizing NPR & use Lauro Reservoir
- Title 22 system is removed, and all flow is DPR treated and sent to Lauro Reservoir.

2A | El Estero WWTP | Maximize NPR treatment & use new WTP
- NPR system remains in place as is.
- Remaining flow is sent to DPR facility, and retreated at new WTP co-located with Desalination Facility.

2B | El Estero WWTP | Maximize DPR by minimizing NPR & use new WTP
- NPR system is removed, and all flow is DPR treated and retreated at new WTP co-located with Desalination Facility.

3A | El Estero WWTP | Maximize NPR treatment & use remaining flow for IPR
- NPR system remains in place.
- The remaining water is used for IPR and is injected/spread.

3B | El Estero WWTP | Maximize IPR by minimizing NPR
- NPR system is removed, and all flow is IPR treated and sent to injection wells/spreading basins.

Figure ES.4
Final Summary of Potable Reuse Alternatives
CONCEPTUAL DESIGN

Conceptual designs were developed for each of the six potable reuse alternatives and subsequently used in the initial screening analysis to evaluate technical feasibility. For each potable reuse alternative, conceptual designs included the following:

- Design criteria summary table (e.g., process flow rates for unit processes, etc.)
- Conceptual site plans and piping alignments
- List of significant considerations for each alternative
- Appendix C - containing design criteria for all key project components

A summary of potential maximum yields for each of the six alternatives considered in this study is presented in Table ES.1. Figure ES.5 presents a conceptual site plan of the AWTF. Refer to Section 3.4 and corresponding Appendix C and D for detailed results of the conceptual design process for each alternative.

<table>
<thead>
<tr>
<th>Alternative Number</th>
<th>Potential Maximum Yields (AFY)</th>
<th>NPR Yield</th>
<th>IPR Yield</th>
<th>DPR Yield</th>
<th>Desalination Yield</th>
<th>Total Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1A</td>
<td></td>
<td>716</td>
<td>0</td>
<td>6,355</td>
<td>10,000</td>
<td>17,071</td>
</tr>
<tr>
<td>Alternative 1B</td>
<td></td>
<td>0</td>
<td>0</td>
<td>6,928</td>
<td>10,000</td>
<td>16,928</td>
</tr>
<tr>
<td>Alternative 2A</td>
<td></td>
<td>1,400</td>
<td>0</td>
<td>5,808</td>
<td>5,000(1)</td>
<td>12,208</td>
</tr>
<tr>
<td>Alternative 2B</td>
<td></td>
<td>0</td>
<td>0</td>
<td>6,928</td>
<td>5,000(1)</td>
<td>11,928</td>
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<tr>
<td>Alternative 3A</td>
<td></td>
<td>1,400</td>
<td>5,808</td>
<td>0</td>
<td>10,000</td>
<td>17,208</td>
</tr>
<tr>
<td>Alternative 3B</td>
<td></td>
<td>0</td>
<td>6,928</td>
<td>0</td>
<td>10,000</td>
<td>16,928</td>
</tr>
</tbody>
</table>

Note:

a. As presented in Section 3.5.1, desalination yield is reduced because half of the site is used for new WTP that treats AWTF product water before distribution to the City's potable water system.
Figure ES.5
AWTF Site Plan 2

Engineered Storage Tanks
- Diameter: 75 ft
- Height: 40 ft
- Residence Time: 4 hrs

Equalization Tanks
- Diameter: 82 ft
- Height: 40 ft

Control Room
- 20 ft x 40 ft

MF Feed Pumps and Strainers

Pre RO UV System

Electrical Room/Mechnical Room
- 23 ft x 103 ft

UV/AOP System

MF Racks

Process Area
- 103 ft x 140 ft

CIP Systems

RO Trains and Feed Pumps

Chemical Storage and Feed Area

NOTE: Site address is 401 E. Yaronal Street.
INITIAL SCREENING RESULTS

Results of the initial screening analysis are presented in Table ES.2, which indicates that none of the potable reuse alternatives considered in this study were determined to be "potentially feasible" based upon the study objectives. Where a potable reuse alternative was determined to be "not feasible" or "potentially feasible, doesn't meet the study goals" based upon this study's initial screening criteria, this failure to pass initial screening was explained further in Section 3.6.2 of the report.

CONCLUSIONS AND RECOMMENDATIONS

Potable reuse alternatives were evaluated through an initial screening process to identify the maximum potential yield that may be technically feasible. The objective of the overall Study was to determine if alternatives existed that could replace the City’s desalination plant permitted capacity of 10,000 AFY, or provide 11,400 AFY of supply for those alternatives that affect the City's planned 1,400 AFY of non-potable reuse. Alternatives 1A/1B, and 2A/2B considered direct potable reuse, and Alternatives 3A/3B considered indirect potable reuse.

To perform the initial screening analysis, conceptual designs were developed to estimate the maximum potential water yield for each alternative. As defined in the Work Plan, only those alternatives that pass initial screening are those that are determined to have potential for technically feasibility and meet Study objectives.

All of potable reuse alternatives evaluated in Table ES.2 were found to be potentially feasible, but did not meet study objectives. Therefore, they did not pass the initial screening for further analysis of social, environmental, and economic factors at this time. Regardless, the Study provides valuable technical information that will inform future planning studies conducted by the City, such as an update to the Long-Term Water Supply Plan.

The State has standard regulations for indirect potable reuse; however, there are not currently standard regulations for direct potable reuse. This is an industry topic that continues to evolve. Recently, in accordance with California Water Code 13560-13569, the State released a December 2016 report entitled, “Investigation of the Feasibility of Developing Uniform Water Recycling Criteria”. The general findings in the report were that standard regulations for direct potable reuse are attainable, but knowledge gaps exist and additional research is necessary to assure adequate public health protection prior to adoption of standard regulations. It is recommended that the City track the State’s progress in developing uniform regulations for direct potable reuse, as it may be a potentially feasible option for the City in the future.
## Table ES.2 Potable Reuse Alternatives Initial Screening Results

<table>
<thead>
<tr>
<th>Initial Screening Criteria</th>
<th>Potable Reuse Alternative</th>
<th>Alternative 1A</th>
<th>Alternative 1B</th>
<th>Alternative 2A</th>
<th>Alternative 2B</th>
<th>Alternative 3A</th>
<th>Alternative 3B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical Hazards</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Seismic Hazard</td>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
<td>PF</td>
<td>PF</td>
<td>PF</td>
<td>PF</td>
<td>PF</td>
<td>PF</td>
</tr>
<tr>
<td><strong>Hydrogeologic Factors</strong></td>
<td></td>
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</tr>
<tr>
<td>2 Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts existing fresh water aquifers, local water supplies or existing water users.</td>
<td>a. Insufficient travel time (e.g., &lt; 2 months) between groundwater replenishment point and other groundwater users.</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
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<tr>
<td></td>
<td>a. Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water).</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(5)</td>
<td>PF(5)</td>
</tr>
<tr>
<td>3 Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.</td>
<td>a. Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water).</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(5)</td>
<td>PF(5)</td>
</tr>
<tr>
<td></td>
<td>a. Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF*</td>
<td>PF*</td>
</tr>
<tr>
<td></td>
<td>b. Groundwater replenishment of IPR water causes loss of ability to adequately manage the groundwater basin (e.g., artesian or flooding conditions, loss of stored water, etc.)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
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<tr>
<td></td>
<td>c. Groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (or 11,400 AFY).</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
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<td><strong>Oceanographic Factors</strong></td>
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<tr>
<td>5 Sea level rise or tsunami hazard</td>
<td>a. Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept</td>
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<td><strong>Presence of Sensitive Habitats</strong></td>
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<td>6 Habitat creation</td>
<td>a. Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR or DPR facility) or adversely affects local ecosystem</td>
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<td>Alternative 1A</td>
<td>Alternative 1B</td>
<td>Alternative 2A</td>
<td>Alternative 2B</td>
<td>Alternative 3A</td>
<td>Alternative 3B</td>
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<td><strong>Design and Construction Issues</strong></td>
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<td><strong>7 Adequate capacity</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>a. Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out</td>
<td>PF*</td>
<td>PF*</td>
<td>PF*</td>
<td>PF*</td>
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<tr>
<td>b. IPR or DPR production capacity and/or aquifer losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out</td>
<td>PF*</td>
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<td>PF*</td>
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<tr>
<td><strong>8 Lack of adequate land required for IPR or DPR treatment facilities or groundwater replenishment facilities</strong></td>
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<tr>
<td>a. Surface area needed for footprint of IPR or DPR treatment facilities or groundwater replenishment facilities is greater than what is available.</td>
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<td>PF(4)</td>
<td>PF(4)</td>
<td>PF(4)</td>
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<tr>
<td>b. Requires condemnation of property for new injection well facilities.</td>
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<td>N</td>
<td>N</td>
<td>N</td>
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<td><strong>Passes Initial Screening? Yes (Y) or No (N)</strong></td>
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<td>n(7)</td>
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<td>Y</td>
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<td><strong>Regulations Exist in CA? Yes (Y) or No (N)</strong></td>
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<td>n(7)</td>
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<tr>
<td>a. NF = Not Feasible</td>
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<tr>
<td>b. PF = Potentially Feasible</td>
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<tr>
<td>c. PF* = Potentially Feasible, but does not meet current study goals</td>
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<tr>
<td>d. Potentially feasible because alternative does not include an IPR component. Thus, this initial screening criteria is not applicable.</td>
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<tr>
<td>e. Additional study will be required to locate groundwater replenishment wells at locations that will not adversely affect sensitive areas or other users.</td>
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<tr>
<td>f. Do standard regulations exist in the state of California currently to implement the alternative?</td>
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<tr>
<td>g. Although regulations do not exist in California, DDW has stated that they will review DPR projects on a &quot;case by case&quot; basis. Refer to Section 3.2.2 for additional discussion.</td>
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</table>
List of Footnotes

1 Mayor Schneider, as documented in the September 23, 2014 City Council Meeting video recording (available on the City’s website): http://media-07.granicus.com:443/OnDemand/santabarbara/santabarbara_d2343df5-*a20-499d-b1fb-5dda1f9e0414.mp4 at 2 hours and 33 minutes.
1.0 INTRODUCTION

This report presents the background and findings associated with a potable reuse feasibility study completed by the City of Santa Barbara, California. This section of the report presents the background, study scope and goals, study methods, and a summary of alternatives considered.

1.1 Background

On September 23, 2014 the City of Santa Barbara City Council directed Public Works Department staff to report back on a plan to evaluate the feasibility of subsurface desalination intakes (subsurface intake) and potable reuse, including indirect and direct potable reuse options. The direction given by City Council was to report back with a plan for this evaluation following award of the desalination plant contract in April 2015. Furthermore, on January 30, 2015, the Central Coast Regional Water Quality Control Board (RWQCB) adopted an amendment to the City’s El Estero Wastewater Treatment Plant (WWTP) Waste Discharge Requirements (WDR) that included a condition that the City should report back to the RWQCB by August of 2015 with a Work Plan that will result in completed feasibility studies by June 2017.

The City subsequently retained the services of Carollo Engineers, Inc. (Carollo) to complete these studies. Carollo will deliver the work for these feasibility studies under three work authorizations:

- **Work Authorization 1**: The Work Plans for both the subsurface desalination intake and potable reuse studies.
- **Work Authorization 2**: Subsurface desalination intake initial screening analysis and potable reuse feasibility study.
- **Work Authorization 3**: Subsurface desalination intake feasibility study.

This document presents only the work associated with the potable reuse feasibility study. A programmatic workflow diagram for this study (i.e., Work Authorizations 1 and 2) is presented in Figure 1.1.

1.2 Scope

The City Council meeting minutes from September 23, 2014, Agenda Item 16: **Authorize Actions and Adopt a Resolution for Reactivating the Charles E. Meyer Desalination Facility**, state that there was an additional motion “to direct staff to return to the City Council after the [Desalination Plant Reactivation] contract decision is made in April [2015] to begin...
exploring a range of alternatives, including subsurface intake and potable reuse options." To determine City Council’s intent as to the scope of this study, the verbal transcript of the meeting was examined. In review of this transcript, Council’s intent can be more clearly discerned from their discussion which included the comment to “direct staff…[to evaluate the] feasibility, cost, and timeline associated with both converting the offshore facility to a subsurface intake and look at the options about potable reuse”.¹

This motion was further adopted by the Central Coast RWQCB, who on January 30, 2015 amended the City’s NPDES Permit (AMENDED ORDER NO. R3-2010-0011, NPDES NO. CA0048143) and in Section VI Paragraph C.6.c.iii (Special Provisions, Desalination Facility) adopted a provision to require the City to “Analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options.”

Therefore, the direction given by both the City Council and RWQCB, relative to the scope of this study was to evaluate the feasibility of:

1. A replacement of the City’s open ocean intake using a subsurface intake.
2. Potable reuse alternatives, also in the context of a replacement of desalination plant’s open ocean intake use.

1.3 Study Methods

The City was required to submit a Work Plan for evaluating potable reuse alternatives to the RWQCB by August 2015. On August 31, 2015, the City submitted the Work Plan, which is presented in Appendix A. The objective of the Work Plan is to present the methodology and procedures that were used to perform the potable reuse feasibility study. Objectives of the Work Plan include:

1. Establish the project schedule.
2. Establish the methods to determine the design basis. Design basis includes production capacity and site alternative evaluation.
3. Establish the types of potable reuse alternatives to be studied.
4. Establish procedure to identify sites for treatment, storage, and distribution facilities to evaluate when considering both direct potable reuse (DPR) and indirect potable reuse (IPR) alternatives.
5. Establish the scope of cost estimates and cost estimating procedures.
6. Establish and define feasibility screening criteria.

¹ Mayor Schneider, as documented on September 23, 2014 City Council Meeting video recording (available on the City’s website): http://media-07.granicus.com:443/OnDemand/santabarbara/santabarbara_d2343df5-8a20-499d-b1fb-5dda1f9e0414.mp4 at 2 hours and 33 minutes.
7. Establish and define initial screening criteria that may limit further consideration of project sites and potable reuse alternatives.

8. Establish technical advisory panel role, procedures, and objectives.

9. Establish the role of outside agencies (e.g., RWQCB, California Coastal Commission, etc.) and City residents.

The potable reuse feasibility study Work Plan, presented in Appendix A, is organized into the following sections:

- Introduction
- Basis of Design
- Feasibility and Initial Screening Criteria
- Implementation Schedule Development
- Cost Estimating Methodology
- Feasibility Analysis
- Technical Advisory Process

The City's subsurface desalination intake feasibility study is addressed as separate Work Plan.

The programmatic workflow diagram presented in Figure 1.1 shows the chronology that project work product was developed and reviewed for each of the potable reuse feasibility study’s work authorizations. As noted in Figure 1.1, only potentially feasible alternatives are evaluated in as part of subsequent tasks. Initial screening was performed and if enough data was available to determine that the alternative does not pass initial screening, no further feasibility analysis was performed for that potable reuse alternative.

A complete project schedule including the anticipated dates of all project milestones and deliverables is presented in Figure 1.2.
Figure 1.1 - Potable Reuse Feasibility Study
Programmatic Work Plan
<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
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<th>2015</th>
<th>2016</th>
<th>2017</th>
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<td>1/3/15</td>
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<td>1/3/15</td>
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<td>Notice to Proceed (Work Authorization) 3</td>
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<td>1/3/15</td>
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<td>TASK 1 - SUBSURFACE DECONSTRUCTION INTAKE FEASIBILITY STUDY</td>
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<td>1.3 Basis of Design &amp; Initial Screening Analysis</td>
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<td>1.3.2 Basis of Design and Initial Screening</td>
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<td>11/3/16</td>
<td>11/13/16</td>
<td></td>
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<tr>
<td>36</td>
<td>City Review</td>
<td>5 days</td>
<td>11/14/16</td>
<td>11/19/16</td>
<td></td>
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<tr>
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<td>Submit Draft Work Plans to RWQCB</td>
<td>1 day</td>
<td>11/20/16</td>
<td>11/20/16</td>
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<tr>
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<td>RWQCB Approval/Comments</td>
<td>1 day</td>
<td>11/21/16</td>
<td>11/21/16</td>
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<td></td>
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<td>39</td>
<td>Final Work Plan</td>
<td>10 days</td>
<td>11/22/16</td>
<td>12/2/16</td>
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<tr>
<td>40</td>
<td>TMS (Revision-0) Intris, Background &amp; Project Alternatives</td>
<td>10 days</td>
<td>12/3/16</td>
<td>12/13/16</td>
<td></td>
<td></td>
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<td>41</td>
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<td>12/14/16</td>
<td>12/14/16</td>
<td></td>
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<tr>
<td>42</td>
<td>TMS (Revision-1) Intris, Background &amp; Project Alternatives</td>
<td>5 days</td>
<td>12/15/16</td>
<td>12/19/16</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>43</td>
<td>3.2 Literature Review</td>
<td>106 days</td>
<td>1/31/16</td>
<td>4/28/16</td>
<td></td>
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<td>44</td>
<td>Collect Literature</td>
<td>99 days</td>
<td>1/31/16</td>
<td>4/28/16</td>
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<tr>
<td>45</td>
<td>Data Collection List Updates</td>
<td>105 days</td>
<td>2/1/16</td>
<td>5/2/16</td>
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<td></td>
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<td></td>
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<tr>
<td>46</td>
<td>Weekly Data Collection Updates</td>
<td>11 days</td>
<td>2/1/16</td>
<td>2/15/16</td>
<td></td>
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<tr>
<td>47</td>
<td>Monthly Data Collection Updates</td>
<td>66 days</td>
<td>3/1/16</td>
<td>6/30/16</td>
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<td></td>
<td></td>
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<tr>
<td>48</td>
<td>3.3 Regulatory and Permit Requirements</td>
<td>30 days</td>
<td>6/27/16</td>
<td>7/27/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>49</td>
<td>3.4 Conceptual Design</td>
<td>45 days</td>
<td>7/28/16</td>
<td>8/31/16</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>50</td>
<td>3.5 Estimated Schedule and Cost</td>
<td>25 days</td>
<td>8/30/16</td>
<td>9/24/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>51</td>
<td>3.6 Feasibility Analysis</td>
<td>70 days</td>
<td>9/25/16</td>
<td>11/5/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>52</td>
<td>3.7 Potable Reuse Feasibility Report</td>
<td>7 days</td>
<td>11/6/16</td>
<td>11/12/16</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>53</td>
<td>TASK 3 - TECHNICAL ADVISORY PROCESS</td>
<td>763 days</td>
<td>8/3/15</td>
<td>5/25/27</td>
<td></td>
<td></td>
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<tr>
<td>54</td>
<td>Workshop 2: Initial Screening</td>
<td>1 day</td>
<td>8/3/15</td>
<td>8/3/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>55</td>
<td>Workshop 2: Initial Screening</td>
<td>1 day</td>
<td>8/3/15</td>
<td>8/3/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Workshop 3: Feasibility Analysis (Potable Reuse Study)</td>
<td>1 day</td>
<td>11/3/15</td>
<td>11/3/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>57</td>
<td>Workshop 4: Feasibility Analysis (Subsurface Study)</td>
<td>1 day</td>
<td>11/4/15</td>
<td>11/4/15</td>
<td></td>
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<td></td>
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<tr>
<td>58</td>
<td>RWQCB FINAL REPORT DEADLINE</td>
<td>1 day</td>
<td>11/4/15</td>
<td>11/5/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.2 - Project Schedule
1.4 Goal of Study

The goal of this study is to meet the requirements set forth by City Council and the RWQCB that were described in Section 1.2. However, this study may also inform future studies including future updates to the City’s Long Term Water Supply Plan. The City’s primary water source is Cachuma Reservoir, which provides over 50 percent of the City’s water supply during a normal (non-drought) year. The City’s water supply allocation from Cachuma could be reduced in the future due to pending federal environmental decisions on a revised Biological Opinion for the Cachuma Project, reduced operational yield due to siltation in the reservoir, and reduced drought yield as a result of the current historic drought. The City’s supply planning will need to be updated to address shortages caused by such reductions to the City's existing Cachuma supply. Options for replacing a reduced Cachuma supply may include desalination and potable reuse.

Because the amount of the reduction from the City’s Cachuma supply is unknown at this time, it is premature for the City to evaluate exact desalination and potable reuse capacity options that may or may not meet the City’s needs. The timing for this analysis would be more appropriate following the final federal environmental decisions and operational yield analyses that determine the future Cachuma allocations. Therefore, the direction given by City Council and the RWQCB (as presented in Section 1.3) is appropriate at this time because it determines the maximum capacity that is technically feasible from subsurface intakes and potable reuse without requiring the City to invest in developing many project concepts that may or may not meet the City’s future needs pending forthcoming environmental and operational yield decisions.

Thus, the goal of this study is to understand the maximum yield that is technically feasible for potable reuse alternatives and subsurface intake alternatives (i.e., the subject of a separate feasibility study report). The maximum yield will provide information on whether the alternatives could replace the open ocean intake independently, and potentially combined. How the City will use these technically feasible maximum yields needs to be informed by the City's need, which will follow at a later date. Therefore, the information developed in this study will inform future studies, such as an update to the City’s Long Term Water Supply Plan.

Feasibility and initial screening criteria are presented in Section 3 of the Work Plan. Alternatives are first subjected to initial screening criteria, which are based on technical feasibility criteria and capacities defined under current project objectives. It is anticipated that alternatives may end up in the following three general categories:

1. **Infeasible** – The alternative does not pass the initial screening criteria and is fatally flawed due to technical criteria.

   **Action:** The alternative shall not be considered further in this study and is not recommended for inclusion in future studies.
2. **Potentially feasible, does not meet Study goals** – The alternative meets technical screening criteria and is potentially feasible. However, the alternative’s capacity does not meet the current Study goals.

   **Action:** The alternative shall not be considered further in this study but is potentially feasible and may be considered in future studies. Information collected during the screening process is useful to inform future studies.

3. **Potentially feasible** – The alternative passes through the initial screening stage and is considered potentially feasible.

   **Action:** The alternative shall be considered further in this study under current objectives and is subject to the work sequence laid out in the Work Plan.

### 1.5 Technical Advisory Process

The technical advisory process described in the Work Plan (Appendix A) provides an independent, third party review of the project work product at key intervals throughout the project duration, as the work product is developed. The technical advisory process shall achieve the following objectives:

1. Provide timely review of project work product by experts in the required subject matter to advise and guide the City's feasibility study.
2. Facilitate input from project stakeholders that can be used to inform the City's comparison of potentially feasible alternatives.
3. Create a record of the review and stakeholder process to be included as an appendix to the feasibility study report.

To assist the Central Coast Regional Water Quality Control Board administer the technical advisory process, the City retained the services of the National Water Research Institute (NWRI). NWRI is a California non-profit organization whose activities include ensuring safe, reliable sources of water now and for future generations through a variety of research, education, and public out-reach activities. NWRI has facilitated similar technical advisory programs on subsurface intake and potable reuse feasibility projects in California, including programs for both municipal and state regulatory agencies. NWRI retained the services of the experts that reviewed the work, facilitated the project meetings (i.e., that included an opportunity for stakeholder comments) and completed the documentation of the technical review and stakeholder process. Refer to the Work Plan (Appendix A) for additional information regarding the technical advisory process.
1.6  **Potable Reuse Project Alternatives**

The purpose of this section is to present the project alternatives considered for this study. The basis for establishing and evaluating project alternatives is presented in the Work Plan (Appendix A) and subsequently in Section 3 of this report.

1.6.1  **Capacity**

As stated in the Work Plan (Appendix A), to meet the study’s scope requirements stated in Section 1.2, project alternatives must be able to produce between 10,000 and 11,400 AFY to be considered a replacement for the City's open ocean intake. However, consistent with the project goals stated in Section 1.3, maximum yield was determined through initial screening and this information can be used to inform future studies.

1.6.2  **Potable Reuse Treatment Criteria**

This study considers the following treatment for potable reuse alternatives:

- Indirect potable reuse (IPR), as defined by:
  - Title 22, Article 5.1 - Groundwater Replenishment - Surface Application: requires advanced treatment (as defined by Title 22, $§60301.320$ and $§60301.230$).
  - Title 22, Article 5.2 - Groundwater Replenishment - Subsurface Application: requires Full Advanced Treatment (FAT), as presented in Figure 1.3.

![Figure 1.3  Typical Full Advanced Treatment (FAT) Schematic](image)

- Direct potable reuse (DPR)
  - The state of California does not have regulations for DPR. However, this does not mean that DPR cannot be implemented in California. In September 2010, the Governor of the State of California signed into law Senate Bill 918 which mandated the State Water Resources Control Board, Division of Drinking Water
(DDW) to investigate the feasibility of developing regulatory criteria for DPR and to provide a final report on that investigation to the legislature by the end of 2016. DDW has held a series of workshops on this topic, and has also worked with a number of agencies, including the City of San Diego to review DPR projects on a case by case basis. DDW has indicated through these meetings and project reviews that in addition to the IPR requirements stated in Title 22, Article 5.1 and 5.2 (as amended in June 2014), DPR projects will likely be required to incorporate the following features:

- Treatment for pathogenic microorganisms may likely be required in excess of the treatment required by Title 22 Article 5.1 and 5.2 (i.e., 12 log enteric virus reduction, 10 log Giardia reduction and 10 log Cryptosporidium reduction (12/10/10) using at least 3 treatment processes, each being credited with no less than 1.0-log reduction may likely be required). Recent statements made by the DDW staff charged with implementing DPR regulations, have indicated 14/12/12-log reduction of virus/Giardia/Cryptosporidium may be required.

- Engineered storage – so that advanced treated wastewater can be held (i.e., not distributed) until the results of various water quality parameters can be tested to establish the water is safe.

For the purpose of this study, the basis of design for treatment and finished water quality goals for DPR will be based upon the most recent regulatory activity and comparable precedent activity in California.

1.6.3 Potable Reuse Project Site Alternatives

Possible potable reuse treatment facility location options may include:

- 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006).
- Repurposing the Charles Meyer Desalination Plant located at 525 E. Yanonali Street.

Possible groundwater replenishment (a.k.a., recharge) locations for IPR may include:

- Injection wells (i.e., subsurface application) in the Foothill basin (near Route 154 and Highway 101)
- Injection wells (i.e., subsurface application) in groundwater basin referred to as “Storage Unit 1” (north of Highway 101).
- Surface application of water (i.e., a spreading basin) in Mission Creek from just above Rocky Nook Park to Oak Park, to recharge Storage Unit 1.
- Surface application of water (i.e., a spreading basin) in or near the Foothill basin.

Project site alternatives are generated based on existing city infrastructure, proximity to existing City wells, and proximity to City owned or patrolled land. It is possible that
additional production wells may be required to fully recover the water stored. Therefore, identification of any new groundwater production well sites follows a similar process as for locating groundwater replenishment wells.

Possible direct potable reuse options may include (but may not be limited to):

- Discharge of advanced treated wastewater into Lauro Canyon Reservoir (a.k.a., raw water production).
- Dilution and off-setting the intake volume of seawater flowing to the Charles Meyer Desalination Plant.

Figure 1.4 presents the locations of the City’s existing wells, groundwater basins, and water treatment facilities.
Figure 1.4 - Potential Areas for Potable Reuse Project Alternatives

Figure will be updated with USGS data showing potential IPR surface and recharge locations.
List of Footnotes

1. Mayor Schneider, as documented on September 23, 2014 City Council Meeting video recording (available on the City’s website): http://media-07.granicus.com:443/OnDemand/santabarbara/santabarbara_d2343df5-8a20-499d-b1fb-5dda1f9e0414.mp4 at 2 hours and 33 minutes.
2.0 REGULATORY AND PERMITTING REQUIREMENTS

2.1 Introduction

This section provides a summary of the relevant environmental, regulatory, and permitting requirements related to developing a potable reuse project in the City of Santa Barbara. The material in this section includes a summary of:

- Definition of the types of potable reuse;
- Regulatory requirements for indirect potable reuse;
- Regulatory status of direct potable reuse; and
- General regulatory or permitting process requirements.

The following regulatory requirements and permits are required to implement a potable reuse project in the City of Santa Barbara:

- Environmental Review
  - California Environmental Quality Act (CEQA)
- California Coastal Commission (CCC)
  - Coastal Development Permits
- State Water Resources Control Board (SWRCB)
  - Division of Drinking Water (DDW)
    - Public Water System (PWS) Permit
  - Regional Water Quality Control Board (RWQCB)
    - National Pollutant Discharge Elimination System (NPDES)
- Santa Barbara County Public Health Department
  - Water Well Permit
- United States Environmental Protection Agency (U.S. EPA)
  - Underground Injection Control (UIC) Program
- City of Santa Barbara
  - Local Coastal Development Permit
  - Industrial Pretreatment Permit
  - Building permits
2.2 Types of Potable Reuse

As described in the Work Plan (Appendix A), potable reuse applications include either indirect potable reuse (IPR) or direct potable reuse (DPR) (Independent Advisory Panel, 2015) and may be defined as:

- **Indirect potable reuse (IPR):** The introduction of *advanced treated water* into an environmental buffer such as a groundwater aquifer or surface water body (e.g., spreading basin or reservoir) before being withdrawn for potable purposes. Indirect potable reuse can also be accomplished with *tertiary effluent* when applied by spreading (i.e., groundwater recharge - "surface application") to take advantage of a natural process known as “soil aquifer treatment”, however, more stringent requirements for the environmental buffer apply (e.g., increased residence time and mixing with other sources).

- **Direct potable reuse (DPR):** There are two forms of direct potable reuse. In the first form, *advanced treated water* is introduced into the raw water supply upstream of a drinking water treatment facility with limited storage time before use (i.e., raw water supply augmentation). In the second form, finished drinking water from an advanced water treatment facility (i.e., permitted as a drinking water treatment facility) is introduced directly into a potable water supply distribution system.

California Code of Regulations, Title 22, Article 5.1 and 5.2 classifies two types of IPR, both referred to as “Groundwater Replenishment” and defined below (California Department of Public Health, 2014).

- **Groundwater replenishment by surface application:** The application of recharge water to a spreading area (e.g., spreading basin, surface spreading, etc.).

- **Groundwater replenishment by subsurface application:** The application of recharge water to a groundwater basin(s) by a means other than surface application (e.g., injection wells, groundwater recharge, etc.).

No regulations currently exist for DPR, though surface water augmentation regulations are under development.

The following potable reuse applications will be considered as part of this study:

- **IPR for groundwater recharge - both groundwater replenishment by surface and subsurface application in the Foothill Basin and Storage Unit 1.**

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1 “Recharge water” means recycled municipal wastewater, or the combination of recycled municipal wastewater and credited diluent water, which is utilized by a (Groundwater Replenishment Reuse Project (GRRP) for groundwater replenishment.
2.3 Regulatory Requirements for Indirect Potable Reuse

Water quality and treatment requirements for IPR alternatives are specified in the California Code of Regulations, Title 22. Article 5.1 presents IPR regulations for groundwater replenishment by surface application (e.g., spreading basins). Article 5.2 presents IPR regulations for groundwater replenishment by subsurface application (e.g., injection wells). All IPR alternatives evaluated by the City as part of this study are required to comply with the regulations set forth in Title 22 by providing adequate treatment and producing water conforming to requirements:

- **Title 22, Article 5.1 - Groundwater Replenishment - Surface Application (i.e., for spreading):** requires, at minimum, disinfected tertiary treatment (as defined by Title 22, §60301.320 and §60301.230).²

- **Title 22, Article 5.2 - Groundwater Replenishment - Subsurface Application:** requires full advanced treatment (FAT), as presented in Figure 2.1.

![Figure 2.1 Full Advanced Treatment Process Flow Schematic](image)

Key requirements for potable reuse, as found in Title 22, Articles 5.1 and 5.2, are listed below.

**Travel Time Requirements:**

An environmental buffer is required, between the location where treated effluent is recharged and the point where it is withdrawn for potable use, to provide adequate time to evaluate the quality of IPR water. As presented in table 2.1, the required travel time varies based upon the treatment provided by an engineered process or by the environment (e.g.,

² Although not required, Title 22 does allow surface application to be performed using FAT water. This reduces travel time and response retention time requirements.
soil aquifer treatment). Minimum travel time requirements are based upon the "Response Retention Time" (RRT), as defined by Title 22 (a.k.a., "Failure Response Time" (FRT), as defined by other industry publications) and represents the minimum time required for analytical procedures to be completed so that the quality and health effects of IPR water can be determined.

**Table 2.1 Minimum Travel Time Requirements for Groundwater Replenishment**

<table>
<thead>
<tr>
<th>Application</th>
<th>Travel Time Demonstrated by Added Tracer</th>
<th>Travel Time Demonstrated by Intrinsic Tracer</th>
<th>Travel Time Calculated by Darcy's Law</th>
<th>Travel Time Calculated by Complex Numerical Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Application - Disinfected Tertiary Water&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>6 Months</td>
<td>9 Months</td>
<td>24 Months</td>
<td>12 Months</td>
</tr>
<tr>
<td>Surface Application - Advanced Treated Water&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>2 Months</td>
<td>3 Months</td>
<td>8 Months</td>
<td>4 Months</td>
</tr>
<tr>
<td>Subsurface Application - Advanced Treated Water&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>2 Months</td>
<td>3 Months</td>
<td>8 Months</td>
<td>4 Months</td>
</tr>
</tbody>
</table>

**Notes:**
Title 22, Article 5.1.
Title 22, Article 5.2.

**Diluent Water Requirements – referred as Recycled Municipal Wastewater Contribution (RWC)<sup>3</sup> Requirements [§60320.116 and §60320.216]**

Where advanced treatment is not provided, Title 22 requires wastewater total organic carbon (TOC) at the point of potable use to be reduced by dilution using other acceptable water sources. This requirement limits public consumption of wastewater derived TOC to a maximum value of 0.5 mg/L, which is intended to protect public health and safety by limiting exposure to trace level pollutants. Wastewater effluent TOC concentrations can range from approximately 5 mg/L to >10 mg/L. Performance data from Southern California spreading basins suggest that TOC removal through spreading may range from <50% to 75%. Thus, for an effluent TOC of 10 mg/L, the TOC could be reduced to 2.5 mg/L after spreading and soil aquifer treatment. Therefore, a minimum dilution requirement of 4:1 dilution (20% recycled water, 80% diluent water) would bring the wastewater TOC concentration to the goal of 0.5 mg/L. The following requirements for dilution water are stated in Title 22 [§60320.116, §60320.118, §60320.216, and §60320.218].

---

3. As defined in Title 22, a Recycled Municipal Wastewater Contribution or RWC means the faction equal to the quantity of recycled municipal wastewater applied at the Groundwater Replenishment Reuse Project (GRRP) divided by the sum of the quantity of recycled municipal wastewater and credited diluent water.
1. Spreading disinfected tertiary wastewater (Groundwater Replenishment – Surface Application): 4:1 blending with another water supply. The requirement constitutes an **RWC of 0.2** [§60320.116].
   a. This is the initial RWC maximum, or an alternative approved by DDW. DDW approval can be sought for up to 1.0 after the project is operational if various requirements set forth in Title 22 are met [§60320.116 (c)].

2. Spreading a full advanced treated (FAT) water (Groundwater Replenishment – Surface Application): There is no dilution requirement (i.e., dilution is not necessary). The **RWC can be up to 1.0** [§60320.216].

3. Groundwater Injection of a full advanced treated (FAT) water (Groundwater Replenishment – Subsurface Application): There is no dilution requirement (i.e., dilution is not necessary). The **RWC can be up to 1.0** [§60320.216].

Diluent water requirements are specified in Title 22 §60320.114 and §60320.214 for surface and subsurface application, respectively.

**Treatment Requirements**

The control of pathogenic microorganisms and trace pollutants for indirect potable reuse projects is described in Title 22 of the California Code of Regulations. This includes final regulations for groundwater replenishment. Key water quality criteria are shown in Table 2.2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Criteria</th>
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</thead>
<tbody>
<tr>
<td><strong>Pathogen Microorganism Control</strong></td>
<td></td>
</tr>
<tr>
<td>Enteric Virus</td>
<td>12 - log(^a) reduction</td>
</tr>
<tr>
<td>Giardia cyst</td>
<td>10 - log(^a) reduction</td>
</tr>
<tr>
<td>Cryptosporidium oocysts</td>
<td>10 - log(^a) reduction</td>
</tr>
<tr>
<td><strong>Total Organic Carbon (TOC)</strong></td>
<td>Maximum 0.25 mg/L in 95% of samples within first 20 weeks / Maximum 0.5 mg/L 20-week running average</td>
</tr>
<tr>
<td><strong>1,4-dioxane(^b)</strong></td>
<td>0.5 - log reduction by an advanced oxidation process</td>
</tr>
<tr>
<td><strong>NDMA</strong></td>
<td>10 ng/L Notification Level (NL)</td>
</tr>
<tr>
<td><strong>Total Nitrogen (TN)</strong></td>
<td>10 mg/L</td>
</tr>
</tbody>
</table>

**Notes:**
- 1-log is 90% reduction, 2-log is 99% reduction, etc.
- Indicator compounds can be substituted for 1,4-dioxane with approval from DDW.
2.3.1 Regulatory Process for IPR

IPR is currently regulated by the SWRCB and the Regional Water Quality Control Board (RWQCB) through the issuance of National Pollutant Discharge Elimination System (NPDES) permits and Waste Discharge Requirements (WDR). For a groundwater recharge and surface water augmentation projects, there are two central permitting documents for potable water reuse:

- The Engineering Report, which is focused on public health protection, and
- The Report of Waste Discharge (ROWD), which is focused on the protection of groundwater quality or surface water quality.

Content and development of these two reports have substantial overlap. Components of these two reports include:

- Developing an industrial pretreatment and pollutant source control program that is focused on protecting water quality for advanced treatment and potable water reuse.
- Demonstration of water quality (raw wastewater, secondary effluent, and tertiary effluent that has undergone advanced treatment) in accordance with regulated values.
- Developing a SWRCB-approved plan that provides an alternative source of domestic water supply or a SWRCB-approved treatment mechanism in the event that the reuse project causes the drinking water source to become unusable.
- Conducting a public hearing for reuse projects, with specific requirements for public notification via various methods.
- Develop of an operations plan for the advanced treatment system.
- Development of a monitoring plan for the advanced treatment system, the groundwater basin, and the surface water reservoir.
- Groundwater and/or surface water quality monitoring and documentation of background water quality.
- Groundwater anti-degradation analysis.
- Hydraulic modeling of groundwater basin and/or surface water reservoir to document travel time (and thus residence time).

Based upon prior IPR permitting experience in California, the regulatory process described above is estimated to require a minimum of 12 months, potentially longer depending upon groundwater modeling efforts and the industrial source control efforts. The permitting above is in addition to standard environmental permitting done as part of the CEQA process, the
California Coastal Commission process, and other permitting efforts detailed further on in this document.

### 2.3.2 Future IPR Regulations

The State Water Resources Control Board (SWRCB), Department of Drinking Water (DDW) (Carollo and DDW staff, 2015) is developing rules for surface water augmentation in a manner that can classify the reuse application as IPR with the following additional requirements:

- The reservoir must have an average retention time of 6 months, which is calculated as the volume of the reservoir divided by the monthly reservoir discharge;
- The volume of water withdrawn in 24 hours contains 1% or less by volume the purified water delivered to the reservoir during the same 24 hour period; or
- The volume of water withdrawn in 24 hours contains 10% or less by volume the purified water delivered to the reservoir during the same 24 hour period; and an extra 1-log (90%) pathogen reduction is provided via an independent treatment process.

For the purposes of this study, because Lauro Canyon Reservoir has low residence time, application of reuse water to this reservoir cannot be considered IPR by these anticipated future criteria.4

#### Future Water Quality Requirements

Potable water reuse projects are held to stringent water quality standards that exceed the rigor of conventional water projects. The proposed water quality monitoring program for the City of Oxnard's forthcoming potable reuse project is included as Appendix B. This monitoring program includes contaminants of emerging concern (CECs), which includes chemicals such as 1,2,3-trichloropropane (1,2,3-TCP), and N-Nitrosodimethylamine (NDMA), pharmaceuticals, endocrine-disrupting compounds such as hormones, and other environmentally persistent chemicals that enter the wastewater system through human use.

### 2.4 Regulatory Status Direct Potable Reuse

As stated previously, the State of California has not adopted regulations for DPR at this time. However, DPR guidelines are now complete and can be used as a starting point, and the State is moving ahead with a rigorous evaluation of DPR as a water supply alternative which will likely be informed by these newly published guidelines (Independent Advisory Panel, 2015). California Senate Bill 918 (SB 918), signed into law on September 30, 2010 by the Governor, provided funding and deadlines to complete regulations for indirect potable reuse projects and to evaluate direct potable reuse. The law required the California

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4 The Lauro Canyon Reservoir has a storage capacity of approximately 640 AF (208 MG) and supplies water to the 37 MGD Cater Water Treatment Plant.
Department of Public Health (CDPH) Drinking Water Program (now the SWRCB Division of Drinking Water [DDW]) to adopt uniform water recycling criteria for potable water reuse for groundwater replenishment by December 31, 2013. These draft regulations were completed and adopted on June 18, 2014, as 22 CCR Division 4, Chapter 3, Articles 5.1 and 5.2, “Indirect Potable Reuse: Groundwater Replenishment – Surface Application / Subsurface Application” (refer to Section 2.3). The law also requires DDW to develop and adopt uniform water recycling criteria for surface water augmentation by December 31, 2016 (herein otherwise referred to as one of two types of direct potable reuse), if an expert panel convened pursuant to the bill finds that the criteria would adequately protect public health. The SWRCB is required to provide a final report on that investigation to the legislature by the December 31, 2016 deadline. This deadline has been moved "up." and the final report is anticipated by Fall of 2016.

Since the bill has been adopted, DDW has held a series of workshops on this topic and has clearly stated that they are open to review DPR projects on a case by case basis. DDW has indicated that in addition to the IPR requirements stated in Title 22, Article 5.1 and 5.2 (as amended in June 2014), DPR projects will likely be required to incorporate the following features:

- Treatment for pathogenic microorganisms may likely be required in excess of the treatment required by Title 22 Article 5.1 and 5.2 (i.e., 12-log enteric virus reduction, 10-log Giardia reduction and 10-log Cryptosporidium reduction (12/10/10) using at least 3 treatment processes, each being credited with no less than 1-log reduction may likely be required). It is Carollo’s expectation that the pathogen reduction requirements will be increased from 12/10/10 to 14/12/12, and the additional pathogen treatment must be completed by a fourth treatment process.

- DDW may opt to require an additional treatment barrier for trace pollutants, which could be in many forms (GAC, ozone/BAC, etc.).

- Engineered storage – The engineered storage buffer (ESB) would hold the water sufficiently long to allow each key process to be monitored and quality verified prior to distribution. The hold time would be determined through a detailed process by process evaluation of the “Failure and Response Time,” or FRT.

For the purpose of this study, the regulatory requirements for DPR were based upon the most recent regulatory activity and comparable precedent activity in California. With respect to augmentation of water supply reservoirs using water that has undergone advanced treatment, it is stated in the California Health and Safety Code (Section 116551) that DDW shall not issue a permit to a public water system or amend a valid existing permit for the use of a reservoir as a source of supply that is directly augmented with recycled water unless DDW performs an engineering evaluation of the proposed recycled water treatment process and finds that the proposed treatment process produces recycled water that meets all applicable primary and secondary drinking water standards, and poses no significant threat to public health. Therefore, source water augmentation at the Lauro Canyon
Reservoir should use a purified recycled water meeting the groundwater injection standards.

2.5 Regulatory Requirements and Permitting

2.5.1 Environmental Review

California Environmental Quality Act (CEQA) Requirements

Implementation of an indirect potable reuse or direct potable reuse project will require certain discretionary actions by the City of Santa Barbara and other agencies. Those actions need to be examined in the context of California Code of Regulations, Title 14 ("State CEQA Guidelines"). California Public Resources Code, Sections 21000–21177 comprise the California Environmental Quality Act (CEQA) statute in California, which requires review and consideration of environmental effects when a California public agency, such as a City or County, carries out or approves a project. As defined in the CEQA Statute (Section 21065), “Project” means an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following:

1. An activity directly undertaken by any public agency.
2. An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.
3. An activity that involves the issuance to a person of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies.

Depending on the potential for significant impacts and feasibility of anticipated mitigation, the appropriate CEQA documentation would either be a Mitigated Negative Declaration (MND) or an Environmental Impact Report (EIR). Generally an MND is easier to prepare and process, requiring a 30-day review period, a scope of work that does not require consideration of alternatives, and a smaller cost required for preparation. However, an MND has a lower standard for legal review and is subject to the “fair argument test” for determining the adequacy of the environmental analysis. For an EIR the scope of analysis similar to an MND, but more thorough and requires a 45 day public review period. An EIR has a higher standard of legal review whereby in the event of a challenge, there is a higher probability that a court will uphold the adequacy of the environmental analysis in an EIR. However, an EIR typically requires review of alternatives, longer preparation, and processing time, and higher associated costs.

Given the scope and effect of an indirect or direct potable reuse project on the City’s water supply, the City of Santa Barbara would likely prepare a programmatic EIR based upon an update to their Long Term Water Supply Plan (LTWSP). This is also based upon the fact that the City has prepared two prior EIRs supporting their previous LTWSPs and any new
alternatives as significantly different as a potable reuse project would require a new EIR analysis. The process to prepare this LTWSP update and EIR would require approximately 12 to 18 months and cost approximately $3 to $4 Million, including all costs for engineering concept development and environmental, public, and legal review.

2.5.2 California Coastal Commission

The following subsections summarize regulations, permits, and agreements that may be involved as part of the potable reuse project(s). The requirements stated herein are based on the current status of regulations at the time of publication.

Coastal Development Permits

The California Coastal Commission (CCC) administers the Federal Coastal Zone Management Act. The most significant provisions of the Coastal Zone Management Act give the CCC primacy over all federal activities and federally licensed, permitted, or assisted activities if the activity affects coastal resources. The CCC retains permanent coastal permit jurisdiction over development proposed on tidelands, submerged lands, and public trust lands. They also act on appeals from certain local government coastal permit decisions, where local governments have been delegated authority to administer a Local Coastal Program. The City of Santa Barbara has a certified Local Coastal Program and administers permits for on-shore areas within the Coastal Zone. Figure 2.2 presents State and local areas of jurisdiction within the City.

The California Coastal Act includes several policies intended to protect water quality. Requirements include controlling runoff and waste discharges to protect water quality and preventing substantial interference with surface water flows in order to sustain biological productivity of coastal waters, and minimizing alteration of riparian habitats and streams.

Facilities associated with indirect potable reuse and direct potable reuse projects may include pipelines, treatment facilities, spreading basins, production wells, and injection wells that would fall into the City’s areas of jurisdiction identified in Figure 2.2. Facilities within State or local areas of jurisdiction are required to obtain a Coastal Development Permit (CDP). No beach or offshore facilities that are under the permanent jurisdiction of the CCC are anticipated.
Section 30601.3 of the Coastal Act authorizes the CCC to process a consolidated CDP application, which requires fewer approvals from the local government, when requested by the local government and approved by the Executive Director of the CCC, for projects that straddle jurisdictions of the CCC and a local government. When a project is located in the Coastal Zone solely within a local government’s certified Local Coastal Program jurisdiction, such as the City of Santa Barbara’s Local Coastal Program, the local jurisdiction has CDP permit issuance authority, but the State may still appeal for jurisdictional authority due to the nature of the project (i.e., major public works project).

Development of an indirect potable reuse or potable reuse project would likely fall solely within the City of Santa Barbara’s Local Coastal Program jurisdiction. As such, potable reuse projects would need a CDP issued from the City that would require a CDP application, a letter detailing CDP application submittal requirements and compliance of the project submittal, a memorandum summarizing the environmental information and technical studies included in the submittal, a Coastal Act/Local Coastal Program policy consistency analysis, and other information required to demonstrate compliance. However, a potable reuse project would be appealable to the CCC, because the approval or denial of a major public works project is appealable to the CCC regardless of location.

The coastal permitting process is estimated to require 2 to 6 months once the CEQA process has been completed. This permitting effort may cost between $100,000 and $400,000, including legal and other reviews.

2.5.3 State Water Resources Control Board (SWRCB)

Division of Drinking Water (DDW)

Public Water System Permits

Public Water System (PWS) permits are issued to each producer or purveyor of drinking water serving a specified minimum number of connections as required by the California Health and Safety Code. The permit covers each source of water used by the system. These permits and their accompanying engineering reports identify the source site, construction, and contaminant threats, and establish the treatment, operational, and monitoring requirements for each source. Almost all permits include special provisions established specifically for the individual water system, setting forth operating requirements that, if not met, could result in a formal enforcement action. Permits do not have expiration dates, but whenever a water system adds a new water source, adds or changes treatment, or has a change in ownership, an amendment to the water permit is required.

In the case of potable reuse, the use of recycled water as a source must be identified in the PWS permit. There are several regulations, draft regulations, and policies that SWRCB uses in its current operations that must be considered in the development of any project involving potable reuse.
A Consumer Confidence Report is required annually for each PWS (22 CCR 64481). Each report must contain information on the source of the water delivered, including:

- The type of water delivered by the water system (e.g., surface water, groundwater, and the commonly used name [if any] and location of the body of water).
- If a source water assessment has been completed, notification that the assessment is available, how to obtain it, the date it was completed or last updated, and a brief summary of the system's vulnerability to potential sources of contamination.

The report is intended to clearly communicate to the public the source of their water, threats to the source, and any water quality problems.

*Long Term 2 Enhanced Surface Water Treatment Rule*

The Surface Water Treatment Rule and its subsequent amendments were enacted to protect public health and safety by addressing the occurrence of various microbial pathogens and viruses. The Long Term 2 Enhanced Surface Water Treatment Rule (LT2EWSTR) requires a PWS to monitor source water quality for the occurrence of chlorine resistant pathogens and implement watershed protection and treatment accordingly.

The addition of reuse water will require an update to the City's source water assessments and sanitary surveys for production wells affected by IPR water and for the desalination plant or the Cater WTP, depending upon the DPR application point. For well head assessments, the required data is largely already known and monitored through other regulatory requirements and this information need only be conveyed to DDW as part of the potable well's periodic sanitary survey. For DPR alternatives where the reuse water is used for source water augmentation, additional source water assessments will be required. 36 months of source water sampling at each source will be necessary to comply with this requirement and analytical and reporting costs will be approximately $300,000 per source.

*2.5.4 Regional Water Quality Control Board (RWQCB)*

*Domestic Water Supply Permit*

The SWRCB provides direction to the RWQCBs, proponents of recycled water projects, and the public regarding the appropriate criteria to be used by the SWRCB and RWQCBs in issuing permits for recycled water projects. The SWRCB developed regulations for Groundwater Replenishment Using Recycled Water that became effective June 18, 2014. Article 5.2, Indirect Potable Ruse: Groundwater Replenishment – Subsurface Application establishes regulations for advanced treatment criteria (e.g., reverse osmosis and oxidation effectiveness), dilution amounts, retention times (minimum two months), acceptable pollutant and pathogenic microorganism concentration levels (e.g., giardia, nitrogen, and physical characteristics), as well as monitoring and reporting requirements. Indirect potable reuse projects used for groundwater replenishment would be required to comply with the
design, testing, and monitoring regulations established by the SWRCB to obtain a Domestic Water Supply Permit.

The SWRCB is in the process of establishing Surface Water Augmentation Using Recycled Water regulations, which are required to be effective December 31, 2016, pursuant to SB 918. Additionally, under SB 918 and SB 322 (Chapter 637, Statutes of 2013), the SWRCB is required to investigate and report on the feasibility of developing uniform water recycling criteria for direct potable reuse by December 31, 2016.

**Domestic Water Supply Permit Amendment**

The DDW is responsible for the issuance of permits for potable water systems and their sources and treatment, inspection of water systems, tracking of monitoring requirements of water systems to determine compliance, and enforcement actions governing these water systems. Domestic Water Supply Permits are issued by the SWRCB on a one-time basis, do not expire, and typically contain specific operating requirements. Indirect potable water recycling projects operate under permits are also issued by the SWRCB and RWQCBs, which consult with DDW to establish conditions necessary to protect drinking water supplies. As described above for SWRCB requirements, regulations for recycled water projects for groundwater replenishment were adopted and became effective on June 18, 2014. Additionally, the SWRCB is developing regulations for the use of recycled water to supplement surface water supplies.

Amendments to Domestic Water Supply Permits are required if changes in the water system occur. None of the following change can occur unless a permit amendment has been issued:

- Change in ownership of the water system.
- The addition of new water sources.
- Any changes in the method of treatment.
- The addition of any storage reservoirs.
- A major expansion of the service area.
- Any change in the distribution system that does not comply with the waterworks standards.

Indirect potable reuse and direct potable reuse projects would trigger an amendment to the Domestic Water Supply Permit. These projects would be required to comply with the existing regulations governing indirect potable reuse established by the SWRCB. This could include additional advanced treatment methodologies as well as modified operations to meet retention times, and altered designs or operating conditions to meet pollutant and pathogenic levels.
National Pollution Discharge Elimination System (NPDES)

The 1972 amendments to the Clean Water Act (CWA) provide the statutory basis for the National Pollution Discharge Elimination System (NPDES) permit program and the basic structure for regulating the discharge of pollutants from point sources to waters of the United States. Section 402 requires the U.S. EPA to develop and implement the NPDES program. The CWA gives the U.S. EPA authority to set effluent limits on an industry-wide basis and on a water quality basis, which ensures protection of receiving waters. Brine wastes (i.e., from advanced water purification systems) and other side-stream disposal from water treatment plants are regulated as a point source of pollution through the NPDES Permit Program. The CWA allows the U.S. EPA to delegate authority to state governments, enabling states to perform many of the permitting, administrative, and enforcement aspects of the NPDES Program. In states that have been authorized to implement CWA programs, U.S. EPA still retains oversight responsibilities.

In California, the NPDES program is administered by the RWQCB. NPDES permits are also referred to as Waste Discharge Requirements (WDR) permits that regulate discharges into waters of the United States. For a potable reuse project developed by the City, this would include:

- Brine waste discharges resulting from advanced water purification processes used for potable reuse that are discharged to the City's outfall; Industrial pretreatment standards for discharges to the City's wastewater treatment plants (i.e., discussed further in the City administered Industrial Pretreatment Program); and

- NPDES permit and associated Waste Discharge Requirements for Discharges of Groundwater from Potable Water Supply Wells to Surface Water as a part of well construction and testing activities.

As specified in 40 CFR Section 124, a NPDES permit typically includes technology-based effluent limits, water quality-based effluent limits, monitoring requirements for each pollutant, and conditions on discharge operations. Discharge pollutant levels would likely be required to be amended in the NPDES permit to allow for potable reuse projects in consultation with the RWQCB. Regulations limiting discharge of pharmaceutically active compounds, endocrine disrupting compounds (EDCs), and other contaminants of concern (CECs) may be developed in the future to protect the marine environment. However, current regulations do not require removal of these contaminants from brine water produced by advanced water purification processes.

Additionally, a WDR permit is required for the overall indirect potable reuse program (water code section 60320.200 through 60320.230). This permit is jointly issued by the DDW and also includes the regulatory approvals and requirements of DDW. Application for this permit requires a pre-application meeting, preparation of a comprehensive Engineering Report,
compliance with State Board Resolution 68-16 (Anti-Degradation policy) and environmental review under CEQA.

Development of revised effluent limits that reflect the wastes generated by a potable reuse project in consultation with the RWQCB is anticipated to cost $100,000 and require approximately 6 to 12 months of effort.

2.5.5 Santa Barbara County Public Health Department

Water Well Permit

For each injection or production well required as part of a potable reuse alternative, a Well Drilling permit is required from Santa Barbara County, Public Health Department, Environmental Health Services (EHS). The permit is available on the County’s website and is for the construction, modification, inactivation, and destruction of water wells as defined and regulated by the County Well Standards Ordinance. The procedures for completing a Water Well Permit application are as follows:

1. Application – Submit a completed application.
2. Plot Plan – Submit a plot plan as part of the permit application. All setback distances from proposed well sites must be accurately depicted.
3. Site Evaluation – Following submittal of application, an EHS representative will conduct a site inspection of the proposed water well site.
4. Permit Issuance – Once determined to be satisfactory, the application may be approved. When approved and signed on the reverse side by the EHS representative, the application shall be considered a permit to perform the proposed work.

2.5.6 United States Environmental Protection Agency (U.S. EPA)

Underground Injection Control (UIC) Program

The use of wells for injection of water is regulated by U.S. EPA’s Underground Injection Control (UIC) program as part of the Safe Drinking Water Act. The UIC program regulations prohibit any underground injection except as authorized by rule or permit. Injection wells as contemplated for this project would be considered as “Class V” wells under the UIC program and are currently “authorized by rule”, which exempts these types of wells from permitting procedures, although the U.S. EPA may require a permit on a case-by-case basis if they determine it poses a threat to the aquifer’s usability as a source of potable water. All owners of injection wells in this category must submit inventory information (such as name/location of facility, owner information, nature of injection well(s) and operational information of the injection well(s) to the U.S. EPA. Compliance with the UIC program is essentially procedural and can be quickly completed.
2.5.7 City of Santa Barbara

Local Coastal Development Permit

As discussed previously, the City of Santa Barbara will likely administer their Certified Local Coastal Program to review and issue a Local Coastal Development Permit for the facilities associated with this project that are located with the Coastal Zone. The City will consult with the State early during the project to determine if the State would like to appeal for jurisdiction over the process as is their option in accordance with the type of project being considered (i.e., major public works project). If the State declines jurisdiction, the Public Works Department would serve as the applicant and the Planning Division will review the application and administer the City's Local Coastal Program.

Industrial Pretreatment Permit

As presented in Section 2.8.3, to implement a potable reuse project, the City must implement an Industrial Pretreatment Program that requires the City to regulate the quality of wastewater discharged to the City's collection system by industrial dischargers, such as the potable reuse facility. The purpose of the Industrial Pretreatment Program is to allow the City to set standards for industrial dischargers to ensure the quality of these discharges will not adversely affect the treatment operations at the City's El Estero WWTP and/or adversely affect the City's ability to meet their NPDES discharge water quality standards, which include standards for non-potable reuse (i.e., currently) and potable reuse (i.e., following a implementation of a potable reuse project).

The City currently has an industrial pretreatment program. This program will require additional review based upon the requirements set forth in Title 22 for potable reuse.

Building Permit Requirements

Construction of indirect potable reuse and direct potable reuse facilities would be required to comply with the applicable building codes and regulations of the City. Pertinent codes that have been adopted are summarized in the City's 2010 Adopting Ordinance:

- California Building Code 2010 as published by the International Code Council (also known as Part 2 of Title 24 of the California Code of Regulations), including Appendix Chapters B, G, I and J

- California Electrical Code 2010 as based on the 2008 National Electrical Code (also known as Part 3 of Title 24 of the California Code of Regulations)

- California Mechanical Code 2010 as based on the 2009 Uniform Mechanical Code, as published by the International Association of Plumbing and Mechanical Officials (also known as Part 4 of Title 24 of the California Code of Regulations)
- **California Plumbing Code 2010 as based on the 2009 Uniform Plumbing Code**, as published by the International Association of Plumbing and Mechanical Officials (also known as Part 5 of Title 24 of the California Code of Regulations), including the Installation Standards and Appendix Chapters G and K

- **California Energy Code 2010 as published by the International Code Council** (also known as Part 6 of Title 24 of the California Code of Regulations)

- **California Historical Building Code 2010 as published by the International Code Council** (also known as Part 8 of Title 24 of the California Code of Regulations)

- **California Existing Building Code 2010 as published by the International Code Council** (also known as Part 10 of Title 24 of the California Code of Regulations)

- **California Green Building Code 2010 as published by the International Code Council** (also known as Part 11 of Title 24 of the California Code of Regulations)

All modifications to the facilities will require a plan check from the City’s Building Department prior to issuing a building permit. During construction, it is anticipated that the Building Department would provide occasional inspection of the facilities. The contractor will provide a certified Qualified Stormwater Practitioner (QSP) to prepare a construction phase Stormwater Pollution Prevention Plan (SWPPP) to be reviewed and approved by the City. The QSP shall be responsible for all duties (i.e. monitoring, inspection, sampling, etc.) required by the approved SWPPP and the latest version of the State of California General Construction Activity Stormwater Permit. The contractor will submit all required documents to the City for approval.

The costs and schedule associated with the local permitting process are generally included in the design and construction phase activities.
List of Footnotes

1. “Recharge water” means recycled municipal wastewater, or the combination of recycled municipal wastewater and credited diluent water, which is utilized by a (Groundwater Replenishment Reuse Project (GRRP) for groundwater replenishment.

2. Although not required, Title 22 does allow surface application to be performed using FAT water. This reduces travel time and response retention time requirements.

3. As defined in Title 22, a Recycled Municipal Wastewater Contribution or RWC means the faction equal to the quantity of recycled municipal wastewater applied at the Groundwater Replenishment Reuse Project (GRRP) divided by the sum of the quantity of recycled municipal wastewater and credited diluent water.

4. The Lauro Canyon Reservoir has a storage capacity of approximately 640 AF (208 MG) and supplies water to the 37 MGD Cater Water Treatment Plant.
References


Carollo and DDW staff. 2015. Correspondence between Carollo Engineers, Inc. and DDW staff.

Section 3

BASIS OF DESIGN AND INITIAL SCREENING

3.0 BASIS OF DESIGN AND INITIAL SCREENING ANALYSIS

3.1 Introduction

This section provides a basis of design (BOD), conceptual design, and the initial screening analysis that evaluates the technical feasibility of each of the potable reuse (PR) alternatives considered in this study. Establishing the BOD and conceptual design for the various PR alternatives will help to identify the PR alternatives that are determined technically feasible through initial screening using the criteria that were defined in the Work Plan (attached as Appendix A).

3.2 Basis of Design

A BOD is necessary to identify potable reuse project alternatives and develop conceptual designs. The BOD is determined by the following technical factors:

- Potable reuse application (i.e., direct or indirect potable reuse)
- Water quality and treatment needs
- Treated water production capacity
- Subsurface properties and other hydrogeologic considerations
- Available project sites
- Project life
- Reliability features

The Work Plan presented in Appendix A provides a summary of the methodology used to establish the BOD presented in this section.

Figure 3.1 presents a flow diagram that demonstrates how the basis of design information is used to develop and evaluate project alternatives. Once identified, project descriptions were developed for each direct or indirect potable reuse alternative and include:

- Project sites
- Physical description of the system and required infrastructure/facilities
- Potential yield and water quality produced
- Relevant experience in California, U.S. and global
Using these project descriptions, each alternative is subsequently evaluated against the initial screening criteria to determine its technical feasibility. As presented in Figure 3.1, alternatives passing initial screening analysis will be further evaluated to determine the estimated implementation schedule and cost, social, and environmental feasibility, and comparison to current drought plan.

3.2.1 Potable Reuse Application

To develop basis of design criteria for a potable reuse alternative, it is first important to define the types of potable reuse applications that may occur since each application has specific requirements that will further determine design requirements. Potable reuse applications include either indirect potable reuse (IPR) or direct potable reuse (DPR) (Independent Advisory Panel, 2015) and may be defined as:

- **Indirect potable reuse (IPR):** The introduction of **advanced treated water** into an environmental buffer such as a groundwater aquifer (groundwater replenishment) or surface water body (surface water augmentation) before being withdrawn for potable purposes (also termed “de facto potable reuse” in the recently published *Framework for Direct Potable Reuse*). Indirect potable reuse can also be conducted using **tertiary effluent** when applied by spreading in percolation basins (i.e., groundwater recharge - "surface application") to take advantage of natural processes that occur in shallow unsaturated sediments that typically exist between the ground surface and the water table, known as "soil aquifer treatment".

- **Direct potable reuse (DPR):** There are two forms of direct potable reuse. In the first form, **advanced treated water** is introduced in close proximity to a drinking water treatment facility intake without an environmental buffer (i.e., raw water supply augmentation). In the second form, finished drinking water from an advanced water treatment facility permitted as a drinking water treatment facility is introduced directly into a potable water distribution system.
Figure 3.1 - Work Flow Diagram: Potable Reuse Alternative Development

Notes:
1. It is envisioned that the technical advisory process includes a public meeting where stakeholders will be given a chance to state their interests in the City's study effort and comment upon the direction of the City's work product.
Furthermore, the California Code of Regulations, Title 22, Article 5.1 and 5.2 classifies two types of IPR, both referred to as “Groundwater Replenishment” (California Department of Public Health, 2014) and defined below:1, 2

- **Groundwater replenishment by surface application:** The application of recharge water to a natural area or constructed facility with sufficient permeability allowing the recharge water to infiltrate into an underlying and unconfined aquifer (e.g., spreading basin, surface spreading, percolation ponds, permeable creek/river beds, etc.). 3

- **Groundwater replenishment by subsurface application:** The application of recharge water to a groundwater basin(s) by a means other than surface application, usually by direct injection into the aquifer using wells (e.g., injection wells, groundwater recharge wells, aquifer storage and recovery (ASR) wells, etc.). 5

As stated in the Work Plan, the following potable reuse applications will be considered as part of this study:

- IPR - both groundwater replenishment by surface and subsurface application (as defined by Title 22) in the Foothill Basin and Storage Unit 1.

- DPR - raw water supply augmentation at the Lauro Reservoir for the Cater Water Treatment Plant (WTP) or the Charles E Meyer Desalination Plant (i.e., dilution of seawater intake water); or raw water supply for a new water treatment plant (WTP) to be co-located at the Charles E Meyer Desalination Plant. 4

### 3.2.2 Water Quality and Treatment Requirements

Water quality and treatment requirements vary based upon the potable reuse application (i.e., IPR and DPR) and these requirements help to define the basis of design for the various potable reuse alternatives. As presented below, these water quality and treatment requirements are considered DPR in this study.

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1 Note that Title 22 does not yet recognize IPR by surface augmentation, but it has been proposed by draft guidelines currently under development. However, no such surface water bodies meeting the proposed guidelines for IPR exist within the City. Such guidelines require relatively large reservoirs that provide 100:1 or 10:1 dilution of recycled water and provide 2 to 6 months of residence time (based on reservoir effluent flow). While residence times as low as 2 months may be accepted, additional treatment, monitoring, or other requirements may apply. Surface water bodies not meeting these requirements are considered DPR in this study.

2 Given the nearest surface water body large enough for surface augmentation (e.g. Cachuma) is 23 miles away and would require significant pumping conveyance, this option is not practical compared with other options. Because, groundwater storage is within 1 to 5 miles, IPR has been evaluated for its application in groundwater recharge scenarios only.

3 “Recharge water” means recycled municipal wastewater, or the combination of recycled municipal wastewater and credited diluent water, which is utilized by a (Groundwater Replenishment Reuse Project (GRRP)) for groundwater replenishment.

4 Lauro Reservoir has a capacity of up to approximately 550 acre-feet (AF) and is used to equalize flows before treatment at the Cater Water Treatment Plant. The actual storage capacity varies, and because the reservoir has an uncertain storage time and based on its small size, it cannot be considered IPR by surface augmentation.
requirements are defined by existing or emerging regulations that were summarized previously in Section 2 of this report.

**Indirect Potable Reuse**

Water quality and treatment requirements for IPR alternatives are dictated by California Code of Regulations, Title 22. All IPR alternatives shall comply with the regulations set forth in Title 22 by providing adequate treatment and producing water meeting the following requirements:

- **Title 22, Article 5.1 - Groundwater Replenishment - Surface Application:** requires disinfected tertiary treatment (as defined by Title 22, §60301.320 and §60301.230 and presented in Figure 3.2).\(^5\)
- **Title 22, Article 5.2 - Groundwater Replenishment - Subsurface Application:** requires full advanced treatment (FAT), as presented in Figure 3.2.

![Figure 3.2 Typical Tertiary Treatment and FAT Process Flow Schematic](image)

**Direct Potable Reuse**

As presented in Section 2 of this report, the state of California does not have regulations for DPR. However, this does not mean that DPR cannot be implemented in California. In September 2010, the Governor of the State of California signed into law Senate Bill 918 which mandated the State Water Resources Control Board, Division of Drinking Water.

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\(^5\) Although not required, Title 22 does allow surface application to be performed using FAT water. This reduces travel time and response retention time requirements.
(DDW) to investigate the feasibility of developing regulatory criteria for DPR and to provide a final report on that investigation to the legislature by the end of 2016. DDW has held a series of workshops on this topic, and has also worked with a number of agencies, including the City of San Diego to review DPR projects on a case by case basis. DDW has indicated through these meetings, and project reviews, that in addition to the IPR requirements stated in Title 22, Article 5.1 and 5.2 (as amended in June 2014), DPR projects will likely be required to incorporate the following features:

- Treatment for pathogenic microorganisms may likely be required in excess of the treatment required by Title 22 Article 5.1 and 5.2. That is, treatment in excess of 12 log enteric virus reduction, 10 log Giardia reduction and 10 log Cryptosporidium reduction (12/10/10) using at least 3 treatment processes, each being credited with no less than 1.0-log reduction may likely be required. Recent statements made by the DDW staff charged with developing DPR regulations, have indicated 14/12/12-log reduction of virus/Giardia/Cryptosporidium, with limits on the maximum log reduction given for any one process to ensure multiple treatment barriers, may be required.

- Engineered storage – so that advanced treated wastewater can be held (i.e., not distributed) for a minimum of 3 to 4 hours, or until the results of various water quality parameters can be tested to establish the water is safe.

- Advanced monitoring of water quality to verify performance of the treatment process in a timely manner.

For the purpose of this study, the basis of design for treatment and finished water quality goals for DPR was based upon the most recent regulatory activity and comparable precedent activity in California, requiring 14/12/12 log reduction of virus/Giardia/Cryptosporidium with multiple treatment barriers and 3 hours of engineered storage before distribution of the treated water.

### 3.2.3 Production Capacity

As described in the Work Plan (Appendix A), the target yield for each potable reuse alternative is based on the replacing the City’s desalination plant’s production capacity, which is 10,000 acre-feet per year (AFY). It should be noted that the City’s current Long Term Water Supply Plan is based on 1,400 AFY of non-potable recycled (NPR) water and a potable reuse alternative cannot reduce the City’s planned recycled supplies. Therefore, the combined potable and non-potable reuse alternative production capacity must be capable of up to 11,400 AFY to be considered as a replacement for the City’s desalination plant. During the evaluation of a range of alternatives for consideration (Section 3.4), alternatives were considered where NPR was maximized and minimized.

The capacity of wastewater available from the City’s El Estero WWTP was characterized based upon historical data, taking into account drought conditions and diurnal flows so that the basis of design can be determined. The following flows were characterized for the design basis:

- Average, minimum and maximum annual flow
• Average, minimum and maximum day flow
• Minimum and maximum hour flows

No additional wastewater flows (i.e., regional flows from other agencies) were included in the capacity determination. It is also important to note the potential requirements for blending desalination process brine from the City's desalination plant with WWTP effluent. Dispersion modeling results have demonstrated that the desalination plant brine does not require blending with WWTP effluent to meet permit requirements (i.e., there is no minimum amount of effluent needed to be reserved for blending with brine prior to discharge). Therefore, all wastewater effluent is available for potable reuse.

As specified in the Work Plan, the production capacity of each reuse supply alternative (i.e., potable and non-potable treatment plant capacity) was based upon the following:

1. Average day flows with storage used to buffer the changes in diurnal flow rates (i.e., minimum and maximum hour flows). Sizing the plant on an average day flow condition makes certain that the facility's equipment is well utilized and not oversized.

2. Where full advanced treatment is required, a reverse osmosis (RO) recovery rate of 80 percent was used.6

3. Recycle of backwash water from microfiltration and other non-potable reuse treatment filter systems (to the head of the City's El Estero WWTP) to optimize recovery and reuse of these flow streams.

Figures 3.3 and 3.4 present a summary of the historic daily effluent flow data from the El Estero WWTP. These figures include all secondary effluent daily flows, including those flows that are fed to the City's tertiary treatment plant, which produces non-potable recycled water. As presented in Figure 3.3, daily flows range from a minimum of 4.25 million gallons per day (mgd) to a maximum of 26.5 mgd, however, these daily flow rates are actually much less variable. Figure 3.4 presents a statistical summary of the daily flows and indicates the daily average flow is 7.73 mgd (8,660 AFY) and 90 percent of the time, the daily flow ranges from 6.17 to 8.93 mgd (i.e., representing 5 to 95 percent flow not exceeded). Therefore, building a potable reuse treatment plant to treat the average daily flow would result in a relatively consistent utilization of the plant's production capacity.

Figure 3.5 presents a summary of secondary effluent flow rate and compares this flow rate to the amount of rain received each year. As expected, wet years result in effluent flows that exceed the average, while drought years result in effluent flows below the average. This is important to consider for drought planning purposes so that the drought year production rate is not over estimated; therefore, it has been factored into the estimated production capacity.

6 In practice, RO recovery rates for reuse facilities may range from 70 to 85 percent and is dependent upon the source water quality. For the purposes of this study, an 80 percent recovery will be assumed, since this recovery rate is common amongst other recycled water RO systems in California.
Figure 3.3 - El Estero WWTP Daily Secondary Effluent Flows

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily Flow</th>
<th>ADF</th>
<th>Max DF</th>
<th>Min DF</th>
<th>95th Percentile DF</th>
<th>5th Percentile DF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-02</td>
<td>26.5 MGD</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Jan-03</td>
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<td>Jan-04</td>
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<tr>
<td>Jan-17</td>
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</tr>
</tbody>
</table>

Total Effluent Flow (MGD)
Figure 3.4 - El Estero WWTP Daily Secondary Effluent Flow - Percent Not Exceeded

Total Effluent Flow (MGD)

Percent Not Exceeded

- ADF = 7.73 MGD
- 95th Percentile = 8.93 MGD
Figure 3.5 - El Estero WWTP Annual Flow and Annual Precipitation
Table 3.1 presents a summary of the possible production capacity available for various potable reuse supply options (note: specific alternatives are identified in Section 3.4). However, these capacities need to be taken in the context of how much water the City can actually use, which, for IPR alternatives will be influenced by the hydrologic properties of the City's groundwater basin. Still, the purpose of this section is to determine what production capacity is possible based on the historic effluent flow from the El Estero WWTP.

The average daily flow of 7.73 mgd (8,660 AFY) is the flow available for non-potable, indirect, and direct potable reuse and when sized to treat this flow rate, the City's reuse treatment facilities would be well utilized. However, as presented in Figure 3.6, the El Estero WWTP does not produce a uniform flow of secondary effluent throughout the day. On an average day, secondary effluent flow rates vary on a diurnal basis and range from 1,667 to approximately 8,500 gallons per minute (gpm). Storage is required to equalize the supply of secondary effluent to the reuse treatment facilities so that the facility does not have to be sized to treat the maximum instantaneous flow rate. Based upon this data, approximately 1.5 million gallons (MG) of storage is required to equalize the flows and provide a consistent supply of 5,369 gpm (7.73 mgd) to the reuse treatment facilities.

3.2.4 Subsurface Properties and Other Hydrogeologic Considerations

California Code of Regulations Title 22, Articles 5.1 and 5.2 present requirements for groundwater replenishment by surface and subsurface application that specify not only the water quality and process treatment requirements (discussed previously in Section 3.2.2), but also the environmental buffer requirements (i.e., travel time), which are largely dependent upon the hydrogeologic properties of an aquifer and the methods used to determine travel time between application of the reuse water and its subsequent use as a drinking water supply. Table 3.2 summarizes these requirements.

Therefore, as presented in Table 3.2, for potable reuse alternatives involving surface or subsurface application of recycled water, it is important to understand the hydrogeologic properties to develop estimate the environmental buffer (i.e., travel time). Section 3.3 of this report presents the results of numeric modeling described in the Work Plan (Appendix A) that demonstrates the location of possible subsurface injection wells based upon these requirements. As stated in Section 2 of this report, if the City were to pursue full-scale implementation, an "added tracer" study is required before a final permit will be given by DDW.
Table 3.1 Production Capacity of Potable Reuse Supply Alternatives Based upon Available Secondary Effluent Flow

<table>
<thead>
<tr>
<th>Supply Alternative</th>
<th>Secondary Effluent Supply (AFY)</th>
<th>Non-Potable Reuse Production (AFY)</th>
<th>Potable Reuse Production (AFY)</th>
<th>Total Reuse Production (AFY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Drought (1)</td>
<td>Average</td>
<td>Drought</td>
</tr>
<tr>
<td>IPR Surface Application</td>
<td>8,660</td>
<td>6,912</td>
<td>1,400</td>
<td>7,260</td>
</tr>
<tr>
<td>IPR Subsurface Application</td>
<td>8,660</td>
<td>6,912</td>
<td>1,400</td>
<td>5,808</td>
</tr>
<tr>
<td>DPR</td>
<td>8,660</td>
<td>6,912</td>
<td>1,400</td>
<td>5,808</td>
</tr>
</tbody>
</table>

Notes:
5th percentile of annual flow data based upon historic flows presented in Figure 3.5.
City’s existing tertiary treatment process using microfiltration (MF).
IPR subsurface application and DPR require RO treatment at 80% recovery.
Figure 3.6 - Diurnal Variation of Secondary Effluent Flow from the El Estero WWTP
Table 3.2 Hydrogeologic Requirements for Groundwater Replenishment

<table>
<thead>
<tr>
<th>Application</th>
<th>Travel Time Demonstrated by Added Tracer</th>
<th>Travel Time Demonstrated by Intrinsic Tracer</th>
<th>Travel Time Calculated by Darcy's Law</th>
<th>Travel Time Calculated by Complex Numerical Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Application - Disinfected Tertiary Watera</td>
<td>6 months</td>
<td>9 months</td>
<td>24 months</td>
<td>12 months</td>
</tr>
<tr>
<td>Surface Application - Advanced Treated Watera</td>
<td>2 months</td>
<td>3 months</td>
<td>8 months</td>
<td>4 months</td>
</tr>
<tr>
<td>Subsurface Application - Advanced Treated Waterb</td>
<td>2 months</td>
<td>3 months</td>
<td>8 months</td>
<td>4 months</td>
</tr>
</tbody>
</table>

Notes:
- a. Title 22, Article 5.1.
- b. Title 22, Article 5.2.
- c. All travel times are calculated between the application point (e.g., a spreading basin or injection well) and the point of use (e.g., a drinking water supply well).

In addition, the following is a complete list of basis of design information that is dependent upon hydrogeologic properties:

- Travel time between surface and subsurface application points and potable water wells.
- Capacity of reuse water the City’s groundwater basin can accept.
- Surface recharge capacity.
- Number and approximate location of recharge wells.
- Recharge well injection pressure.

The hydrogeologic properties required to estimate this information, which constitutes the hydrogeologic design basis, include aquifer and aquitard properties, well production rates, injection rates for subsurface application, and percolation rates for surface application. Table 3.3 presents these key analysis inputs required for the quantitative evaluations of IPR alternatives and the corresponding data source used for the technical feasibility evaluation.
## Table 3.3 Analysis Inputs and Primary Data Sources for Technical Feasibility Evaluation of IPR Alternatives

<table>
<thead>
<tr>
<th>Analysis Input</th>
<th>Primary Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer and Aquitard Hydraulic Properties</td>
<td>USGS Groundwater Model c</td>
</tr>
<tr>
<td>Groundwater Recharge and Discharge (non-IPR)</td>
<td>USGS Groundwater Model c</td>
</tr>
<tr>
<td>Well Production Rates</td>
<td></td>
</tr>
<tr>
<td>City Production Wells</td>
<td>City of Santa Barbara production well capacity spreadsheet</td>
</tr>
<tr>
<td>Private Wells</td>
<td>USGS Groundwater Model c,d</td>
</tr>
<tr>
<td>IPR Recovery Wells</td>
<td>Pueblo Water Resources (2013) and USGS Groundwater Model c,d</td>
</tr>
<tr>
<td>Injection Rates for Subsurface Application</td>
<td></td>
</tr>
<tr>
<td>IPR Replenishment (Injection) Wells</td>
<td>Pueblo Water Resources (2013), City of Santa Barbara production well capacity spreadsheet, and USGS Groundwater Model c</td>
</tr>
<tr>
<td>Percolation Rates for Surface Application</td>
<td></td>
</tr>
<tr>
<td>Mission Creek Infiltration Rate</td>
<td>Martin (1984)</td>
</tr>
<tr>
<td>Infiltration Rates for San Roque Creek, Arroyo Burro,</td>
<td>Freckleton (1989)</td>
</tr>
<tr>
<td>Cieneguitas Creek, and Atascadero Creek</td>
<td></td>
</tr>
<tr>
<td>Number of Days Per Month Without Storm Runoff a</td>
<td>USGS Gage Data for USGS 11119750 MISSION C NR MISSION</td>
</tr>
<tr>
<td></td>
<td>ST NR SANTA BARBARA CA</td>
</tr>
<tr>
<td></td>
<td>[<a href="http://waterdata.usgs.gov/ca/nwis/uv?site_no=11119750">http://waterdata.usgs.gov/ca/nwis/uv?site_no=11119750</a>]</td>
</tr>
</tbody>
</table>

**Notes:**

a. Surface application of IPR water in creek beds is not effective during periods of storm runoff.
b. See Appendix C for further explanation of analysis inputs and data sources.
c. USGS model is described in detail in Section 3.3.1.
d. Historical production rates are already built into the groundwater model.
Literature Review

A literature review was conducted to identify available data sources concerning the hydrogeology in the study area, and to specifically assess the subsurface properties in the vicinity of the target surface and subsurface groundwater replenishment locations, and in general to assess potential recharge rates and basin wide responses to recharge. A list of references was provided in the Work Plan. The knowledge of the basins has been greatly enhanced by the multiple USGS studies conducted for the City and is comprehensively represented in the various groundwater models and reports developed by USGS for the basins that have been developed and refined over the last three decades. The latest groundwater model of the basins is currently being finalized by USGS and was used in this study for the quantitative evaluations of IPR alternatives. For a comprehensive review of Storage Unit I and Foothill basin hydrogeology, refer to the hydrogeological analysis located in Appendix C (GSI Water Solutions, Inc. (GSI), 2016).

As noted in Table 3.3 and described in the sections below, several of the analysis inputs were taken directly from or derived from the draft Santa Barbara Groundwater Flow and Solute Transport Model currently under development by USGS (the model). This is appropriate because the model has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basin. Further description of the model is provided in Section 3.3.1.

Evaluation of Analysis Inputs

The following subsections describe the review of the data sources listed in Table 3.3 to arrive at the key analysis inputs for or the quantitative evaluations of the IPR alternatives described in this technical feasibility evaluation.

Aquifer and Aquitard Properties

Aquifer and aquitard properties were taken from the model. This is appropriate because the model has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basins.

Groundwater Recharge and Discharge

Groundwater recharge and discharge from the basins are calculated by the model during the simulation runs conducted to evaluate the IPR alternatives. This is an appropriate use of the model because it has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basin.
Well Production Rates

Three different types of well production rates were needed for this technical feasibility evaluation:

1. **Historical pumping rates for City and private wells during the simulation period:**
   Historical pumping rates were identified by USGS and are incorporated into the groundwater model. Additional evaluation of historical pumping rates was not necessary.

2. **Maximum pumping rates for City wells:** Maximum pumping rates were taken from the City’s production well capacity spreadsheet. The maximum annual pumping capacities for the City’s wells were calculated assuming the wells are operated 90 percent of the time during each year (~7,900 hours per year) at their respective instantaneous pumping rates. The 90 percent factor is used to account for typical production well maintenance and downtime and is consistent with the City’s operations planning, as documented in its production well capacity spreadsheet.

3. **Pumping rates for IPR recovery wells:** If IPR water is added to Storage Unit 1 or the Foothill Basin, this additional water must be removed to maintain hydraulic balance, thereby preventing artesian conditions in existing wells, liquefaction, slope collapse, over-saturation of sensitive vegetation (e.g., oak trees), or other undesirable conditions. New groundwater production wells, (i.e., IPR recovery wells) will be required and pumping rates for these new wells were established by developing a relationship between pumping specific capacity and calibrated model transmissivity at each IPR recovery well location in the model. Pumping specific capacity was based on the City’s newest production well (Corporation Yard #2) (Pueblo Water Resources, 2013). The ratio of Corporation Yard #2 specific capacity and the calibrated model transmissivity in the model cell associated with the location of Corporation Yard #2 well was calculated. This ratio was then multiplied by the calibrated model transmissivity at each particular IPR recovery well location to estimate the pumping specific capacity for each IPR recovery well. The estimated specific capacity of each IPR recovery well was then multiplied by the maximum available drawdown during the simulation period to estimate the maximum pumping rate for each well. The results were used to provide an upper limit on IPR recovery well pumping rates for the IPR Alternative No. 1 model simulations. No factor of safety was used to reduce the anticipated production capacity; therefore, the production volumes used for the modeling analysis are likely the maximum potential amounts.

---

7 Maximum available drawdown was based on the range of model calibrated groundwater water levels during the simulation period at each well location provided by USGS.
**Injection Rates for Subsurface Application**

Injection rates for the replenishment (injection) wells were calculated using the same methodology described above for the IPR recovery wells, except that, based on experience with many injection well projects, the injection specific capacity was assumed to be 50 percent of the pumping specific capacity. Maximum draw-up (i.e., the build-up or "mounding" of water in an injection well resulting from injection) was established on the basis of drought water levels plus a maximum of 25 pounds per square inch (psi) of pipeline injection pressure.

**Percolation Volumes for Surface Application**

Percolation volumes for surface application of recycled water were calculated using the following information:

- The infiltration rate of Mission Creek between Rocky Nook Park and Oak Park (the surface application site for Mission Creek) was measured directly during an 8-day controlled release in 1979 (Martin P., 1984). The reported infiltration rate is 1.75 acre-feet per day (AF/day).
- The infiltration rates for the surface application sites along San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek were calculated using reported data and the measured length of each surface application site. An average unit infiltration rate of 0.8 foot/day was calculated for the creeks. The measured length of each surface application site then was multiplied by the unit percolation rate and stream widths reported by Freckleton J., 1989. The resulting infiltration rates are 0.71, 0.15, 0.31, and 0.55 AF/day for the San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek surface application sites, respectively.

The above-described infiltration rates were then multiplied by the number of days per month without storm runoff to determine monthly percolation volumes for each surface application site. The resulting monthly recycled water percolation volumes were used to provide an upper limit on surface recharge for model simulations. A summary of the annualized upper limits on recycled water percolation rates is provided in Table 3.4

These percolation rates have not been adjusted or reduced for operational considerations (clogging or other percolation rate reducing conditions), geologic hazard considerations (liquefaction, slope failure, high groundwater), or habitat-related considerations. As described in Sections 3.3.4 through 3.3.6, if the range of potential negative conditions associated with surface recharge outweighs the potential benefits, the technique is considered not technically feasible.

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8 Streamflow data from the USGS gauge on Mission Creek near Mission Street (USGS Gauge No. 11119750) were used to calculate the number of non-storm flow days per month. Flow criterion used was zero cubic feet per second (no flow).
Table 3.4  Upper Limits of Recycled Water Percolation Rates

<table>
<thead>
<tr>
<th>Subsurface Application Site</th>
<th>Recycled Water Percolation Rate Upper Limits (AFY)(^a)</th>
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</thead>
<tbody>
<tr>
<td>Mission Creek</td>
<td>96 – 616</td>
</tr>
<tr>
<td>San Roque Creek</td>
<td>39 – 250</td>
</tr>
<tr>
<td>Arroyo Burro</td>
<td>8 – 54</td>
</tr>
<tr>
<td>Cieneguitas Creek</td>
<td>17 - 107</td>
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<tr>
<td>Atascadero Creek</td>
<td>30 -195</td>
</tr>
</tbody>
</table>

Notes:
\(a\) Upper limits calculated for simulation period March 1986 through January 2004. Lower values occur in wet years and higher values occur in dry years.
\(b\) AFY = acre-feet per year

3.2.5  Project Site Alternatives

During this study, the following site alternatives were considered for further analysis against the screening criteria in the Work Plan (Appendix A):

**New Treatment Facility Alternatives**

For the purposes of this study, new treatment facilities providing advanced treatment for IPR or DPR quality water are referred to as advanced water treatment facilities (AWTF). Possible locations for a new AWTF included:

- 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006), and
- Using a portion of the Charles Meyer Desalination Plant site located at 525 E. Yanonali Street.

It should be noted that the Charles Meyer Desalination Plant, undergoing a reactivation project at the time of this technical memorandum, is not compatible with conversion to advanced treatment for potable reuse due to fundamental differences in the treatment processes (e.g., different membranes, operating conditions, pumping requirements, etc.). While some components could be salvaged, there would be limited cost savings since most components would need replacement. Therefore, the options evaluated consist of new facilities for the potable reuse advanced water treatment process.

**Groundwater Replenishment Location Alternatives**

New groundwater production wells (i.e., recovery wells) are required to maintain hydraulic balance within the Foothill Basin and Storage Unit 1, thereby preventing undesired conditions such as artesian flow from existing wells, liquefaction, slope collapse, over-saturation of sensitive vegetation (e.g., oak trees), etc.. Identification of new recovery well sites followed a similar process as locating groundwater replenishment wells. Groundwater replenishment and recovery locations analyzed for technical feasibility included inland
locations (Approach No. 1) as well as coastal locations (Approach No. 2). The coastal locations under Approach No. 2 are intended to act as a seawater intrusion barrier.

**IPR Implementation Approach No. 1**

IPR Implementation Approach No. 1 included both surface and subsurface application of recycled water in the up-gradient portions of the Foothill Basin and Storage Unit I to increase the yield of the basins, as depicted in Figure 3.7.

Surface application sites included portions of the following streams:

- San Roque Creek (Foothill Basin)
- Arroyo Burro (Foothill Basin)
- Cieneguitas Creek (Foothill Basin)
- Atascadero Creek (Foothill Basin)
- Mission Creek (recharges both basins$^9$)

For San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek, surface application sites are the upper reaches of each creek along the northern boundary of the Foothill Basin. This is an area where the confining layer within the Santa Barbara Formation is thin, creating opportunities for direct recharge to the principal aquifer zone within the Santa Barbara Formation (hydrogeology of the Foothill Basin is described in detail in Appendix C (GSI Water Solutions, Inc., 2016)). For Mission Creek, the surface application site is between Rocky Nook Park and Oak Park, which is the reach of Mission Creek having the highest reported infiltration rates (Martin P., 1984).

Subsurface application sites (replenishment or injection wells) for both basins were located in the up-gradient portions of both basins. Proposed IPR recovery wells were located towards the middle of each basin, downgradient from the injection wells and surface recharge sites. The final simulated injection well and recovery well locations are presented in Figure 3.7, and were iteratively selected to conform to travel time requirements associated with IPR regulations. Actual property sites to be used for IPR replenishment or recovery wells were not identified for the purposes of this study and all locations presented in Figure 3.7 are approximate. The City would need to further refine the locations based upon available properties should IPR be considered beyond this study's feasibility level screening.

To maximize the amount of recycled water recharged to the aquifer, new IPR recovery wells were located using the methodology described above in Section 3.2.4. Two new IPR recovery wells are located in the Foothill basin (FH_2 and FH_3) and four new IPR recovery wells in Storage Unit I (SU1_1, SU1_2, SU1_3, and SU1_4). The approximate locations of these proposed new IPR recovery wells are presented in Figure 3.7.

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$^9$ Pursuant to the U.S. Geological Survey (USGS) model.
**IPR Implementation Approach No. 2**

IPR Implementation Approach No. 2 includes subsurface application of recycled water near the coast to provide an effective hydraulic barrier to seawater intrusion into the primary water-producing zones of Storage Unit I. This concept is intended to not only reduce the potential for salt water intrusion during periods of increased pumping in the basin, but it also provides additional water to the basin because a significant fraction of the injected water would flow landward toward City production wells. Historical groundwater data indicate that some salt water intrusion occurred during the last drought, and USGS studies indicate some level of seawater intrusion may occur depending on the amount of water pumped from the basin (Martin, P., 1984).

The assumed seawater barrier location is along E. Cabrillo Blvd. The simulated seawater barrier injection (i.e., replenishment) well locations are presented in Figure 3.8. As with Implementation Alternative No. 1, these locations are approximate and actual locations would be further evaluated if a future study is conducted. These injection well locations were determined by conducting a series of model runs to determine the well spacing and flow rates necessary to create the hydraulic barrier, as described in Section 3.3.1 without causing negative effects such as liquefaction or artesian flow conditions.

**Direct Potable Reuse Location Alternatives**

Possible direct potable reuse options included:

- Discharge of advanced treated water into Lauro Reservoir, which is then re-treated at the Cater Water Treatment Plant (a.k.a., raw water augmentation).
- Production of advanced treated water, which be used to dilute intake water at the Charles E Meyer Desalination Plant.
- Production of advanced treated water, which is then retreated at a new water treatment plant co-located with the Charles E Meyer Desalination Plant and then pumped into the City's distribution system.

**3.2.6 Project Life**

As discussed in the Work Plan, a 20 year project life will be assumed for each potable reuse alternative considered in this study. A 20 year project life was selected based upon the time that is assumed to be required for repayment of any loan used to finance a potable reuse project. It is not the City's intent to finance replacement facilities before they are finished paying for the original potable reuse project.
FIGURE 3.8
IPR Implementation Approach
No.2 Recharge Locations

City of Santa Barbara
Subsurface Desalination Intake and
Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial
Screening: Potable Reuse

LEGEND
- City Production Well
- IPR Seawater Barrier Well

All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads
- Streams and Creeks

Date: June 3, 2016
Data Source: Santa Barbara County, USGS, ESRI
An image was taken on June 1, 2014 by the USA

San Antonio Creek  
Arroyo Burro  
Cieneguitas Creek  
Atascadero Creek  
Sycamore Creek  
San Roque Creek  
Mission Creek
3.2.7  Reliability Features

Based upon the potable reuse alternative (e.g., surface spreading, groundwater injection, DPR, etc.), current state of regulations, source water quality, hydrogeology, geochemistry, the use of literature data, a safety factor was substantiated and established as a basis of design requirement used to determine the redundancy required to address downtime for maintenance and repairs, as well as a possible decrease in production capacity due to plugging or a decrease in groundwater replenishment capacity (i.e., for IPR alternatives). Table 3.5 presents a summary of the reliability features for each potable reuse technology alternative.

Table 3.5  Potable Reuse Alternative Reliability Features

<table>
<thead>
<tr>
<th>Parameter</th>
<th>IPR</th>
<th>DPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redundancy&lt;sup&gt;a&lt;/sup&gt;</td>
<td>N+1</td>
<td>N+1</td>
</tr>
<tr>
<td>Screened Area Safety Factor&lt;sup&gt;b&lt;/sup&gt;</td>
<td>x 1.2</td>
<td>x 1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

a. Redundancy applies to the largest unit of the plant's operating infrastructure, including water storage tanks and clearwells, pumps and other treatment equipment, including membrane trains and UV reactors.

b. Safety factors are used to address downtime for maintenance and repairs, as well as a possible decrease in production capacity due to plugging or a decrease in groundwater replenishment capacity.

3.3 Hydrogeologic Analysis of Groundwater Replenishment (IPR) Alternatives

Based upon the hydrogeologic and effluent production capacity BOD criteria presented in Section 3.2, groundwater recharge IPR applications were evaluated to determine conceptual design criteria that include the following:

- Determining the maximum rate of groundwater replenishment using recycled water that can be established to collectively accept, store and produce up to 10,000 AFY (or 11,400 AFY) of treated recycled water.
- Determining if there is adequate storage in production zone aquifers under wet-year and drought conditions.
- Determining the increase in yield from groundwater basins and existing wells as a result of groundwater replenishment.
- Consideration of impacts to freshwater aquifers, local water supplies, other wells, and existing water users. Adequate travel time must be achievable.
• Preventing impact to sensitive vegetation and habitats such as marshlands, drainage areas, etc.
• Preventing conditions that could capture or mobilize known groundwater contamination.
• Preventing conditions that increase the risk of geologic hazards, such as liquefaction and slope collapse.
• Determining the amount of "diluent water" (i.e., water source other than recycled wastewater) required - if any - based upon recycled water quality, degree of treatment provided and application (i.e., surface or subsurface application) pursuant to the requirements of Title 22, Article 5.1 §60320.114 and Article 5.2 §60320.214.
• Determining the number of additional production wells required to meet project production goals and avoiding adverse impacts such as artesian conditions in other wells or increasing the risk of geologic hazards.

A detailed hydrogeologic analysis of these parameters is presented in Appendix C, but is summarized in the following subsections. It is noted that the numerical groundwater flow and transport model of the Storage Unit 1 and Foothills basins, as discussed in this section, was used only to inform the analysis of the IPR alternatives, and thus do not apply to DPR alternatives.

3.3.1 Hydrogeologic Evaluation Approach

The hydrogeologic evaluation approach for this study consisted of using a numerical groundwater flow and transport model of the Storage Unit 1 and Foothill basins to determine the potential increase in basin yield for each IPR alternative. The numerical model used for the evaluation is the draft Santa Barbara Groundwater Flow and Transport Model (SBFTM) prepared by USGS (the model). The model is the latest version of the numerical groundwater flow model that was originally developed for the City’s Long Term Water Supply Program, adopted in 1994. The model is based on SEAWAT-2000, a complex numerical computer model which simulates groundwater flow and seawater intrusion by coupling the MODFLOW-2000 software with MT3D. This model does not simulate flow within the sediments that overlie the upper producing zone (UPZ), including the Shallow Zone.

USGS staff working on the model determined that the model is appropriate for evaluating changes in available groundwater storage in the basin as a result of surface or subsurface application of recycled water. The model update was recently completed and the corresponding model report is undergoing technical review at the USGS and will be published in late 2016. USGS staff indicated that the model is completed and calibrated and they were willing to use the model and to generate preliminary results for this technical feasibility evaluation on an informal basis. USGS staff provided the modeling results described later in this report with the following disclaimer:
“These data are preliminary and are subject to revision. They are being provided to meet the need for timely best science. The data are provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the data.”

Thus, it should be understood that the SBFTM and any results derived therefrom are to be considered and represented as preliminary until the USGS finalizes its modeling report. That said, the preliminary model is considered the best available information for purposes of this Study, and provides for a very sophisticated evaluation approach compared with other methods. The City’s investment in the USGS model has supported the creation of this valuable tool that provides substantial benefits for the evaluations required by this Study.

The simulation period for both IPR alternatives is March 1986 through January 2004 (refer to Figure 3.9). This period spans the range of potential water levels and, therefore, the ranges of potential recycled water storage in Storage Unit I and the Foothill Basin. The period begins during the drought of the late 1980s/early 1990s and includes the subsequent wet period during which groundwater levels recovered (Storage Unit I and Foothill Basin peak groundwater levels were reached in 1999 and 2004, respectively).

![Figure 3.9 Example Hydrographs and Simulation Period](image)

**IPR Implementation Approach No. 1**

The modeling approach for IPR Implementation Approach No. 1 consisted of an iterative process where groundwater replenishment was sequentially increased simultaneously with and without IPR recovery pumping until certain constraints could no longer be met. The constraints are summarized in Table 3.6.

---

10 In Figure 3.9, solid lines represent USGS model results for selected locations and the dots represent measured water level data from selected wells.
Table 3.6  IPR Implementation Approach No. 1 - Recharge Constraints, Metrics, and Validation Methods

<table>
<thead>
<tr>
<th>No.</th>
<th>Constraint</th>
<th>Metric</th>
<th>Validation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Rejected Surface Recharge</td>
<td>Heads in recharge cells above land surface</td>
<td>Inspect model hydrographs in surface recharge areas</td>
</tr>
<tr>
<td>2</td>
<td>Avoid Excessive Injection Pressure</td>
<td>&lt;=25 psi at injection well</td>
<td>Inspect model hydrographs at injection locations</td>
</tr>
<tr>
<td>3</td>
<td>No Artesian Conditions in Injection Areas</td>
<td>Piezometric heads below predevelopment heads</td>
<td>Compare heads to calibrated model heads for 1929</td>
</tr>
<tr>
<td>4</td>
<td>Meet Minimum Recycled Water Residence Time – Surface Recharge w/ Tertiary Treated Recycled Water</td>
<td>12 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
<tr>
<td>5</td>
<td>Meet Minimum Recycled Water Residence Time – Injection w/ FAT Recycled Water</td>
<td>4 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
<tr>
<td>6</td>
<td>No Seawater Intrusion</td>
<td>Shoreward gradient or groundwater divide near coast</td>
<td>Visual inspection of coastal groundwater gradients</td>
</tr>
</tbody>
</table>

A series of simulations were performed to maximize the total recycled water recharge rates throughout the simulation period by sequentially adding surface recharge and injection.

Surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs FAT). Injection well locations (model cells), and suggested maximum injection rates were added from a list of prioritized locations.

A series of model runs were performed to maximize recycled water recharge with and without increased pumping in the basin as follows:

- **Model runs without new groundwater pumping.** Historical pumping patterns already programmed into the groundwater flow model were used as a surrogate for baseline pumping under future conditions. Recycled water recharge was added at the surface application sites until the constraints could no longer be met. The controlling constraint was Constraint No. 3 (artesian conditions). Once the recycled water recharge rates were maximized, particle tracking was performed to verify that the required residence times for both tertiary and FAT recycled water were achieved at the existing potable well locations and IPR recovery well locations (Constraint Nos. 4 and 5). Constraint No. 6 (no seawater intrusion) was also verified.
• Model runs with additional groundwater pumping. A second set of model runs were performed to maximize recycled water recharge by adding recharge locations simultaneously with IPR recovery wells. Following each run, USGS checked the injection pressures, water levels in the injection area, and travel times to ensure that Constraint Nos. 1 through 3 were met. Recycled water recharge was added until the constraints could no longer be met. The controlling constraint was Constraint No. 3 (artesian conditions). The final simulated injection well and recovery locations are depicted in Figure 3.7, presented earlier. Once the recycled water recharge rates were maximized, particle tracking was performed to verify that the required residence times for both tertiary and FAT recycled water were achieved at the existing potable well locations and IPR recovery well locations (Constraint Nos. 4 and 5). Constraint No. 6 (no seawater intrusion) was also verified.

**IPR Implementation Approach No. 2**

The modeling approach for IPR Implementation Approach No. 2 was similar to IPR Implementation Approach No. 1. A series of model runs were performed to maximize recycled water recharge into the seawater intrusion barrier until certain constraints could no longer be met. The constraints are summarized in Table 3.7. The assumed seawater barrier location is along E. Cabrillo Blvd, as presented in Figure 3.8.

<table>
<thead>
<tr>
<th>No.</th>
<th>Constraint</th>
<th>Metric</th>
<th>Validation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Avoid Excessive Injection Pressure</td>
<td>&lt;=25 psi at injection well</td>
<td>Inspect model hydrographs at injection locations</td>
</tr>
<tr>
<td>2</td>
<td>No Excessive Artesian Conditions in Injection Areas</td>
<td>Piezometric heads do not exceed pre-development heads</td>
<td>Inspect model hydrographs at selected locations</td>
</tr>
<tr>
<td>3</td>
<td>Meet Minimum Recycled Water Residence Time – Injection w/ FAT Recycled Water</td>
<td>4 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
<tr>
<td>4</td>
<td>Seawater intrusion barrier effectiveness</td>
<td>No shoreward groundwater flow through the barrier during the simulation period</td>
<td>Particle tracking to confirm metric is met</td>
</tr>
</tbody>
</table>

Similar to IPR Implementation Approach No. 1, a series of model runs were performed to maximize recycled water recharge with and without increased pumping:

• Model runs without new pumping. Historical pumping patterns already programmed into the groundwater flow model were used as a surrogate for baseline pumping
under future conditions. Injection rates were increased until the constraints could no longer be met.

- **Model runs with additional groundwater pumping.** A second set of model runs were performed to maximize injection into the seawater intrusion barrier simultaneously with increased pumping via City wells inland of the barrier. The modeling consisted of an iterative process whereby coastal injection rates were progressively increased simultaneously with increased up-gradient pumping rates until the Table 3.7 constraints could no longer be met. The final simulated injection wells are depicted in Figure 3.8, presented above.

The groundwater modeling used to evaluate IPR Implementation Approach No. 1 and 2, summarized here, is discussed in detail in Appendix C (GSI Water Solutions, Inc, 2016).

### 3.3.2 Rate of Groundwater Replenishment, Storage, Yield Increases

The groundwater modeling performed for the technical feasibility evaluation indicates that there is very limited storage space in the aquifer system to accept, store, and transmit recycled water unless basin pumping is also simultaneously increased. This makes sense because there is a limited areal extent of unconfined groundwater conditions in both Storage Unit I and the Foothill Basin.

The modeling results indicate that the basins are only capable of accepting approximately 250 AFY of recycled water recharge on average without increasing pumping above historical rates (refer to Table 3.8). The simulated recharge rates (absent increased pumping) range from 150 to 310 AFY, with the higher recharge rates typically occurring during drought periods. The majority of the recycled water recharge (87 percent) occurred in the Foothill Basin. All of the recycled water recharge was achieved via surface application using tertiary treated recycled water.11

When recharging with tertiary treated recycled water, the City would need to demonstrate that total organic carbon (TOC) concentrations do not exceed 0.5 milligram per liter (mg/L) in the source water or that sufficient TOC removal is achieved via soil-aquifer treatment. If these conditions are not met, blending with another water supply (dilution) would likely be required by the State Water Resources Control Board Division of Drinking Water (DDW).12

It is possible that the dilution requirement could be met by demonstrating mixing with native groundwater and/or wet weather stream percolation. However, if dilution is required and cannot be demonstrated by mixing with groundwater or surface water, the City would be

11 As discussed in Section 3.3.1, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).
12 As specified in Article 5.1 of California’s Title 22, there are diluent water requirements based on a water’s TOC concentration. A minimum dilution requirement of 4:1 (20 percent recycled water, 80 percent diluent water) is applicable when TOC concentrations exceed 0.5 mg/L. This requirement formally constitutes a recycled water contribution (RWC) of 0.2.
required to blend with potable water or FAT water, thereby reducing the effective yield of surface recharge with tertiary treated recycled water by up to 80 percent. Alternatively, the City could choose to utilize FAT water, which would not require any diluent water to meet requirements set forth in Title 22. However, compared to using tertiary treated water, FAT water is more costly to produce due to more stringent treatment requirements, and total available water for surface application would be decreased by 20 percent (i.e., the volume lost to reverse osmosis treatment process brine).

Table 3.8 IPR Evaluation Approach 1 - Recharge Volumes without Increased Pumping

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
</tr>
<tr>
<td>1987</td>
<td>37</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>1988</td>
<td>38</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>1989</td>
<td>41</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>1990</td>
<td>41</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>1991</td>
<td>35</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>1992</td>
<td>32</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>1993</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>1994</td>
<td>34</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>1995</td>
<td>21</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>1996</td>
<td>31</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>1997</td>
<td>32</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>1998</td>
<td>22</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>1999</td>
<td>40</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>2000</td>
<td>34</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>2001</td>
<td>28</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>2002</td>
<td>40</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>2003</td>
<td>38</td>
<td>0</td>
<td>38</td>
</tr>
</tbody>
</table>

All values reported in acre-feet

Min 153
Ave 251
Max 310

If pumping is increased simultaneously with recycled water recharge, the modeling results indicate that approximately 7,600 to 9,100 AFY of recharge can be accepted by the basins (refer to Table 3.9). The average simulated recharge rate (with increased pumping) was 8,500 AFY. The corresponding increase in well yield and basin yield is approximately 6,700 to 9,000 AFY, with an average of 8,500 AFY (refer to Table 3.10). The results do not vary significantly between drought and non-drought periods because the recycled water recharge and recovery pumping would dominate the water balance of the basins.
Approximately 9 percent of the simulated recharge (with increased pumping) was via surface application with tertiary treated recycled water and 91 percent via subsurface application with FAT recycled water\textsuperscript{13}. As discussed above, if TOC thresholds for surface recharge with tertiary treated recycled water are not met and dilution cannot be demonstrated via mixing with groundwater or surface water, the City would be required to blend the tertiary treated recycled with potable water or FAT water, thereby reducing the effective yield of surface recharge with tertiary treated recycled water by up to 80 percent. If this were the case, the yield of the overall alternative would be reduced to approximately 7,900 AFY. As discussed above, if elevated TOC concentrations were an issue, the City could use FAT water for surface application, but would be faced with higher treatment costs and less available water (i.e., the volume lost to reverse osmosis concentrate).

### Table 3.9 IPR Alternative 1 Recharge Volumes with Increased Pumping (Not Adjusted for Potential Negative Effects)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
</tr>
<tr>
<td>1987</td>
<td>322</td>
<td>4,490</td>
<td>4,812</td>
</tr>
<tr>
<td>1988</td>
<td>331</td>
<td>4,490</td>
<td>4,821</td>
</tr>
<tr>
<td>1989</td>
<td>356</td>
<td>4,490</td>
<td>4,845</td>
</tr>
<tr>
<td>1990</td>
<td>354</td>
<td>4,490</td>
<td>4,843</td>
</tr>
<tr>
<td>1991</td>
<td>301</td>
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<td>4,790</td>
</tr>
<tr>
<td>1992</td>
<td>279</td>
<td>4,650</td>
<td>4,928</td>
</tr>
<tr>
<td>1993</td>
<td>176</td>
<td>4,490</td>
<td>4,665</td>
</tr>
<tr>
<td>1994</td>
<td>297</td>
<td>4,785</td>
<td>5,082</td>
</tr>
<tr>
<td>1995</td>
<td>186</td>
<td>5,437</td>
<td>5,623</td>
</tr>
<tr>
<td>1996</td>
<td>271</td>
<td>5,585</td>
<td>5,855</td>
</tr>
<tr>
<td>1997</td>
<td>282</td>
<td>5,585</td>
<td>5,866</td>
</tr>
<tr>
<td>1998</td>
<td>188</td>
<td>5,585</td>
<td>5,772</td>
</tr>
<tr>
<td>1999</td>
<td>345</td>
<td>5,585</td>
<td>5,930</td>
</tr>
<tr>
<td>2000</td>
<td>294</td>
<td>5,585</td>
<td>5,878</td>
</tr>
<tr>
<td>2001</td>
<td>243</td>
<td>5,585</td>
<td>5,828</td>
</tr>
<tr>
<td>2002</td>
<td>347</td>
<td>5,585</td>
<td>5,932</td>
</tr>
<tr>
<td>2003</td>
<td>334</td>
<td>5,585</td>
<td>5,919</td>
</tr>
</tbody>
</table>

All values reported in acre-feet

<table>
<thead>
<tr>
<th>Total RW Recharge Both Basins</th>
<th>Min</th>
<th>Ave</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7,569</td>
<td>8,456</td>
<td>9,104</td>
</tr>
</tbody>
</table>

\textsuperscript{13} As discussed above, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).
Table 3.10  IPR Alternative 1 Pumping/Basin Yield Increase (Not Adjusted for Potential Negative Effects)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I Pumping Increase</th>
<th>Foothill Pumping Increase</th>
<th>Total Pumping Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing City Wells</td>
<td>New Recovery Wells</td>
<td>Total</td>
</tr>
<tr>
<td>1987</td>
<td>3,314</td>
<td>2,111</td>
<td>5,425</td>
</tr>
<tr>
<td>1988</td>
<td>3,411</td>
<td>2,111</td>
<td>5,522</td>
</tr>
<tr>
<td>1989</td>
<td>2,279</td>
<td>2,111</td>
<td>4,390</td>
</tr>
<tr>
<td>1990</td>
<td>1,889</td>
<td>2,111</td>
<td>4,000</td>
</tr>
<tr>
<td>1991</td>
<td>3,680</td>
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<td>5,791</td>
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<td>1992</td>
<td>3,683</td>
<td>2,111</td>
<td>5,794</td>
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<td>1993</td>
<td>3,509</td>
<td>2,111</td>
<td>5,620</td>
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<tr>
<td>1994</td>
<td>3,680</td>
<td>2,111</td>
<td>5,791</td>
</tr>
<tr>
<td>1995</td>
<td>3,696</td>
<td>2,111</td>
<td>5,807</td>
</tr>
<tr>
<td>1996</td>
<td>3,703</td>
<td>2,111</td>
<td>5,814</td>
</tr>
<tr>
<td>1997</td>
<td>3,703</td>
<td>2,111</td>
<td>5,814</td>
</tr>
<tr>
<td>1998</td>
<td>3,679</td>
<td>2,111</td>
<td>5,790</td>
</tr>
<tr>
<td>1999</td>
<td>3,570</td>
<td>2,111</td>
<td>5,681</td>
</tr>
<tr>
<td>2000</td>
<td>3,612</td>
<td>2,111</td>
<td>5,723</td>
</tr>
<tr>
<td>2001</td>
<td>3,703</td>
<td>2,111</td>
<td>5,814</td>
</tr>
<tr>
<td>2002</td>
<td>3,440</td>
<td>2,111</td>
<td>5,551</td>
</tr>
<tr>
<td>2003</td>
<td>3,458</td>
<td>2,111</td>
<td>5,669</td>
</tr>
</tbody>
</table>

All values reported in acre-feet

<table>
<thead>
<tr>
<th>Min</th>
<th>Ave</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,749</td>
<td>8,514</td>
<td>8,953</td>
</tr>
</tbody>
</table>

Based upon consideration of potential negative effects associated with surface recharge activities (details provided below in Sections 3.3.4 to 3.3.6), the following table (Table 3.11) identifies the more likely maximum yield of an IPR operation, employing subsurface recharge methods (i.e., injection and recovery wells only) in Santa Barbara.
<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
</tr>
<tr>
<td>1987</td>
<td>0</td>
<td>4,490</td>
<td>4,490</td>
</tr>
<tr>
<td>1988</td>
<td>0</td>
<td>4,490</td>
<td>4,490</td>
</tr>
<tr>
<td>1989</td>
<td>0</td>
<td>4,490</td>
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</tr>
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</tr>
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<td>1991</td>
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<td>1992</td>
<td>0</td>
<td>4,785</td>
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</tr>
<tr>
<td>1993</td>
<td>0</td>
<td>5,437</td>
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</tr>
<tr>
<td>1994</td>
<td>0</td>
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</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>5,585</td>
<td>5,585</td>
</tr>
</tbody>
</table>

Notes:
All values reported in acre-feet
RW = recycled water

For IPR Implementation Approach No. 2, the groundwater modeling results indicate that the capacity of the Storage Unit I producing zones to accept, store, and transmit recycled water, is very limited in the coastal portion of the basin. The modeling results indicate that even with increased pumping inland of the barrier, only approximately 740 AFY year of recycled water can be injected to form a partial seawater intrusion barrier before excessive head buildup occurs at the injection sites. Additionally, the model results indicate that the barrier would not completely prevent seawater intrusion even with twenty-four simulated barrier wells. Although it may be possible to create an effective seawater intrusion barrier with even more wells, the IPR yield would not increase materially. The modeling results indicate that the IPR Alternative No. 2 is not technically feasible and this implementation approach will not be carried forward to initial screening analysis.
3.3.3 **Impacts to Local Groundwater Supplies and Existing Water Users**

Title 22 of the California Code of regulations requires that there be adequate residence time of the IPR source water in an aquifer prior to any IPR water reaching the nearest groundwater well. The allowable residence time must be no less than 2 months for FAT water, but may range from 2 to 24 months depending on the advanced treatment technology being used, the actual water quality benefits of aquifer storage determined during pilot testing, and the accuracy of the method used to estimate residence time. Similarly, the allowable residence time is no less than 6 months for tertiary-treated recycled water recharged at the surface (surface spreading).

For the purposes of this study, since a numeric model was used for evaluation, based upon the criteria presented in Table 3.2, the travel times required as a result of the USGS modeling were:

- 12 months for surface application
- 4 months for subsurface application

Because residence time requirements were built into the IPR Implementation Approach No. 1 modeling constraints, they were met in all cases, except one. The exception was that a few of the travel times calculated for surface application of tertiary treated recycled water were slightly less than the required 12-month residence time. However, as noted in Section 3.3.1, the model does not simulate the sediments overlying the UPZ. As such, surface recharge was introduced directly into the UPZ within the model and, therefore, the vertical travel time through the vadose zone and sediments above the UPZ is not reflected in the particle tracking calculations. If this additional travel time was included, the 12-month residence time would very likely be met.

3.3.4 **Impacts to Sensitive Habitats**

Potential impacts to sensitive habitats resulting from IPR activities could occur at surface application locations. Impacts to sensitive habitats resulting from injection into deeper confined aquifers would be less likely to occur, however, additional work, as described in Sections 3.3.5 and 3.3.6 would be required to evaluate the degree of potential impacts. Potential impacts to sensitive habitats from IPR surface application activities could include:

- Increased groundwater levels near the recharge site where there is vegetation that is sensitive to saturated conditions (e.g., oak trees).
- Increased surface water flow and increased groundwater levels contributing to establishment of riparian or wetland vegetation that may require preservation as habitat and/or generation of nuisance plant species.
- Changes in water quality (including increased temperature) in existing stream and riparian areas.
The County of Santa Barbara has classified riparian areas within the study area along Atascadero Creek, Cieneguitas Creek, Arroyo Burro, and Mission Creek as sensitive habitat (Figures 3.10A & 3.10B) (County of Santa Barbara, 2015). The zones classified as sensitive habitat on each of these creeks are at least partially coincident with proposed surface recharge reaches. The length of proposed surface recharge reach coincident with sensitive habitat along each creek is summarized in Table 3.12. The proposed surface recharge activities would create perennial wetted conditions along the creek reaches where recharge is applied, and would raise the alluvial aquifer water table both adjacent to the recharge reach and downgradient. Following storms, the wetted length of the creeks would likely take longer than normal to retreat due to the high water table conditions maintained by proposed surface recharge activities. The higher water table conditions could create habitat for phreatophytic vegetation in the areas adjacent to proposed recharge reaches and downstream. The newly created habitat would then potentially need to be preserved. Conversely, the higher water table conditions may adversely affect existing vegetation that is sensitive to saturated conditions, such as oak trees. Additional work is needed to quantify the alluvial aquifer water table response to the proposed surface recharge activities and to evaluate potential changes in water quality (including temperature) in existing riparian areas.

Table 3.12 Proposed Recharge Reaches Coincident with Existing Sensitive Habitat

<table>
<thead>
<tr>
<th>Creek Name</th>
<th>Length of Proposed Recharge Reach Coincident with Sensitive Habitat(1) (feet)</th>
<th>Percent of Proposed Recharge Reach Coincident with Sensitive Habitat(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atascadero Creek</td>
<td>1,400</td>
<td>74%</td>
</tr>
<tr>
<td>Cieneguitas Creek</td>
<td>1,150</td>
<td>100%</td>
</tr>
<tr>
<td>Arroyo Burro</td>
<td>1,000</td>
<td>100%</td>
</tr>
<tr>
<td>San Roque Creek</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mission Creek</td>
<td>300</td>
<td>6%</td>
</tr>
</tbody>
</table>

Note: Sensitive habitat zones defined by the County of Santa Barbara

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14 Phreatophytes are plants that depend upon groundwater that lies within reach of their roots for their water supply.
3.3.5 Potential Capture or Mobilization of Known Groundwater Contamination

The Shallow Zone that underlies the City in Storage Unit I is about 100 to 200 feet thick in the downtown area and extends toward and beneath the shoreline. The Shallow Zone thins to the northwest in Storage Unit I, toward the Mission Ridge Fault. In the Foothill Basin, the shallow alluvium varies in thickness from 100 to 400 feet, with the area of greatest thickness occurring just north of the Mission Ridge Fault and generally thinning toward the northern edge of the Foothill Basin. Groundwater quality in this Storage Unit I Shallow Zone and Foothill Basin alluvium has been impacted by a number of sources of contamination, which are regulated by the Regional Water Quality Control Board and other regulatory agencies. It is possible that surface or subsurface application activities could mobilize or affect the movement of contaminants in the subsurface. This potential was evaluated by:

1. Preparing a contaminant source inventory for the area within 1 mile of each potential groundwater replenishment site and IPR recovery well.\(^{15}\)

2. Identifying known and documented sources of groundwater contamination that have the potential, due to proximity and mobility characteristics, to be affected by recycled water recharge and recovery activities (Shallow Zone or deeper producing zones).

3. Using the results from the numerical modeling assessment to assess whether changes in groundwater gradients due IPR related groundwater replenishment and recovery operations may cause mobilization of contaminants in the unsaturated zone, movement of known sources of contamination, or impacts to existing City production wells.

4. In relative terms, describing the relative risk (high, medium, or low) of capturing or mobilizing known sources of contamination.

5. Identifying the need for a geochemical mixing analysis that can determine whether dissolution of naturally-occurring minerals in the aquifer sediments or precipitation of porosity-reducing constituents could occur.

A total of 355 sites were identified near the locations of the potential groundwater replenishment sites and recovery wells. Of these, 51 sites are listed as ‘Open’ and ‘Active’, while the remainder is designated as ‘Case Closed,’ ‘Eligible for Closure,’ or ‘Inactive.’ The ‘Open’ sites had status designations of ‘Site Assessment’ or ‘Verification Monitoring’ and include contamination from heavy metals, cyanide, gasoline, diesel, waste oil, solvents, polynuclear aromatic hydrocarbons (PAH), and total petroleum hydrocarbons (TPH). The 51 open sites include 13 sites that have not impacted groundwater (contamination reported in near-surface soil only), leaving 38 open sites with reported groundwater contamination in the Shallow Zone. A summary of these 38 ‘Open’ sites and their respective constituents of concern (COC) are provided in Appendix C and the locations of all contaminated sites are shown in Figure 3.11 (GSI Water Solutions, Inc., 2016).

\(^{15}\) Source: California State Water Resources Control Board (SWRCB) GeoTracker database.
Contaminated Sites Potentially Affected by Proposed Surface Recharge Sites

Only one ‘Open’ alluvial groundwater contamination site is located in the northern portion of the Foothill Basin where the proposed surface recharge reaches are located. The site is located approximately 300 feet from the proposed surface recharge reach in Atascadero Creek, near the intersection of Foothill Road and Highway 154. In Storage Unit I, there is one ‘Open’ Shallow Zone groundwater contamination site located in close proximity to the proposed surface recharge reaches in Mission Creek. The contaminated site in Storage Unit I is also located in close proximity to three proposed IPR injection wells (shown in Figure 3.11). Therefore, there is a medium to high risk of contaminant mobilization from proposed IPR surface recharge. Refer to Appendix C for a detailed discussion (GSI Water Solutions, Inc., 2016).

Contaminated Sites Potentially Affected by Proposed IPR Wells

Because the IPR injection and recovery wells would be completed in the primary water producing zones of the UPZ, MZ, and LPZ beneath the confining layer at the top of the Santa Barbara Formation, the proposed IPR operations likely will not significantly alter groundwater flow in the overlying Shallow Zone in Storage Unit I and alluvium in Foothill Basin. The confining layer, which occurs in both Storage Unit I and the Foothill Basin, is generally 20 to 100 feet thick and has an estimated vertical hydraulic conductivity of 0.03 foot/day (Freckleton J., 1989). Changes to groundwater levels or flow directions above the confining layer and potential for contaminant mobilization as a result of proposed injection would be inhibited by this confining layer. The persistent upward gradient between the UPZ and the Shallow Zone seen in monitoring wells at the Mission Industries/Ambassador Laundry site (GeoTracker ID# SL203061244) demonstrates the effectiveness of the confining layer at preventing upward migration of contaminated groundwater. The USGS groundwater model does not simulate shallow groundwater levels; therefore, it does not directly address the question of potential changes to water level and flow direction above the confining layer. Injection of water into the UPZ would act to increase the upward gradient toward the Shallow Zone, but additional work would be needed to evaluate the degree of potential changes in water level and mobilization of contaminants in the Shallow Zone. Approaches might include comparing Shallow Zone water levels at other cleanup sites with producing zone water levels to better understand the degree of connectivity, updating the groundwater model to simulate shallow groundwater levels (using Shallow Zone water levels available from GeoTracker), or performing aquifer testing to characterize vertical connectivity.

Of the 38 ‘Open’ contaminated sites affecting shallow groundwater, 12 are considered to have a higher likelihood of impact from proposed IPR activities due to their proximity to the proposed IPR wells (either injection or recovery wells). The risk of contaminant mobilization or capture from these 12 sites ranges from low to high, a detailed discussion of these 12 contamination sites is provided in Appendix C (GSI Water Solutions, Inc., 2016).
There are 13 contaminated sites in Storage Unit I with affected soils, but without direct impact to groundwater (refer to Figure 3.11). Two of these sites are located in close proximity to a proposed IPR injection well. The extent of soil contamination at these sites is less than 10 feet below ground surface (bgs) and groundwater levels in the Shallow Zone at or near these two sites is typically more than 45 feet bgs (GeoTracker, 2016). Pre-development groundwater levels at these sites are estimated to be about 30 feet bgs (USGS, in press) and modeling indicates that the proposed IPR injection would not raise UPZ water levels above pre-development levels. Therefore, these sites are considered to be at low risk for contaminant mobilization in groundwater due to rising groundwater levels in the Shallow Zone.

**Summary**

The soil and/or groundwater contamination sites identified above present potential challenges to siting surface recharge reaches and IPR injection or recovery wells. However, the bulk of these contaminated sites only impact the Shallow Zone soil and/or groundwater. Only one site, Mission Industries/Ambassador Laundry (ID# SL203061244), has documented contamination in the UPZ, potentially affecting one of the IPR well sites that was considered (URS Corporation (URS), 2010). It is unlikely that elevated water levels in the confined UPZ and LPZ aquifers would affect Shallow Zone water levels because of the significant permeability barrier constituted by the low permeability confining layer present above the UPZ. If IPR planning is carried forward into a more detailed design, permitting and planning phase, all of the proposed sites would undergo more rigorous consideration. Based upon the hydrogeologic considerations used in this preliminary injection and recovery well site selection, alternative sites could likely be identified if issues such as potential risk to existing contaminated sites are identified.

### 3.3.6 Geologic Hazards

Geologic hazards, including liquefaction, slope failure, and high groundwater have the potential to be created or exacerbated due to proposed IPR activities. The Santa Barbara General Plan provides baseline conditions for each of these three geologic hazards (City of Santa Barbara, 2011). Locations of the proposed IPR recharge facilities relative to the 2011 mapped hazard areas and descriptions of how hazard levels might be affected by proposed IPR activities is presented below.

**Liquefaction**

Liquefaction is a temporary loss of soil strength that can occur in highly saturated sediments during moderate to large earthquakes. Three conditions must be present for liquefaction to occur:

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16 The Ambassador Supply Well, historically used to supply water for laundry operations at the Mission Industries/Ambassador Laundry site, was properly abandoned at the direction of the RWQCB in 1988. Prior to abandonment, this well may have acted as a conduit for minor amounts of PCE from the SZ to reach the UPZ.
1. Affected soils must be composed of granular materials such as sand or silt;  
2. The soil must be saturated by groundwater; and  
3. The soil must be relatively loose or cohesionless.

Of these three conditions, saturation by groundwater is the condition that can change over time. A significant increase in groundwater levels in the Shallow Zone could increase the occurrence and severity of liquefaction, which could result in greater impact to buildings and other structures than would otherwise occur during an earthquake event. In general, liquefaction risk is considered to be low when groundwater levels are greater than 60 feet bgs (City of Santa Barbara, 2011). A baseline liquefaction hazard map from the Santa Barbara General Plan is shown in Figure 3.12.

Groundwater replenishment via the proposed surface recharge areas in Foothill Basin and Storage Unit I would result in rising water levels in the Shallow Zone/alluvium adjacent to those creeks. These rising water levels could increase the liquefaction hazard level, especially if water table levels rise to above 60 feet bgs.

For injection, the groundwater model indicates that head levels in the UPZ would increase as a result of IPR injection. By model year 2004, the UPZ head levels approach pre-development conditions and indicate an increase in overall area where the potentiometric surface in the UPZ is 60 feet or less bgs (Figure 3.13). \(^\text{17}\) As stated in Section 3.3.5, changes to groundwater levels in the Shallow Zone/alluvium resulting from increased head in the UPZ would be inhibited by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases in liquefaction hazard in response to injection in the underlying producing zones. Localized increases in liquefaction hazard adjacent to the surface recharge reaches should be expected. Areas where groundwater levels in the Shallow Zone/alluvium are 60 feet or less bgs are likely to increase due to IPR injection in deeper productive zones, but the magnitude of water table response in the Shallow Zone/alluvium requires further evaluation.

\(^{17}\) Pre-development conditions were determined for 1929 by USGS using the groundwater model.
FIGURE 3.12
Baseline Potential Liquefaction Hazard Zones

City of Santa Barbara
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial Screening: Potable Reuse

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells
- Liquefaction Potential (Santa Barbara General Plan, 2011)
  - High
  - Moderate
- All Other Features
  - Study Area
  - Santa Barbara City Limits
  - Highway 101
  - Major Roads
  - Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
FIGURE 3.13
Groundwater Model Predicted Areas of UPZ Heads Less Than 60 Feet Below Ground Surface

City of Santa Barbara
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial Screening: Potable Reuse

LEGEND
Stream Recharge Reach
Injection Wells
IPR Recovery Wells
Groundwater Model Predicted Areas of UPZ Heads Less Than 60 Feet Below Ground Surface
Liquefaction Potential (Santa Barbara General Plan, 2011)

High
Moderate
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
Slope Failure

Slope failures occur when the weight of the material that comprises a slope plus the weight of the objects placed on the slope (i.e., driving forces) exceed the shear strength of the slope material (i.e., resisting forces). The potential for slope movement to occur is dependent on many factors, including, but not limited to: the height and angle of the slope, the orientation of the bedding planes in the underlying geologic formation(s), and the amount of water contained in the slope material. The addition of water to a slope increases the likelihood for failure due to the added weight of the water, reduction in cohesive forces between grains, and lubrication effect on slip planes, if any, within the slope materials (City of Santa Barbara, 2011).

The City has defined hazard areas as follows:
- Hazard Area 1 – Very Low Landslide Potential
- Hazard Area 2 – Low Landslide Potential
- Hazard Area 3 – Moderate Landslide Potential
- Hazard Area 4 – High Landslide Potential

The study area falls mostly within hazard areas 1 and 2, but also contains minor portions of hazard areas 3 and 4 in the northern sections of Storage Unit I and Foothill Basin. There are four proposed IPR injection wells located within hazard areas 3 or 4 in Storage Unit I and two in Foothill Basin. In addition, the surface recharge reaches on Cieneguitas Creek, Arroyo Burro, and Mission Creek fall partially within hazard areas 3 or 4 (refer to Figure 3.14).

Localized increases to the high groundwater hazard immediately adjacent to the surface recharge reaches should be expected. Areas of high groundwater in the alluvium of the western Foothill Basin are likely to increase due to IPR activities and ponding north of the Mission Fault, but the magnitude of water table response in the alluvium requires further evaluation, which is beyond the scope of this study.

It is possible that groundwater replenishment at these locations could increase the likelihood for slope failure. Surface recharge in the creeks would result in rising water levels in the Shallow Zone, which could directly impact adjacent slope stability. As stated in Section 3.3.5, changes to groundwater levels in the Shallow Zone resulting from injection would be inhibited by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases in slope failure hazard in response to injection in the underlying producing zones, which is beyond the scope of this study.
High Groundwater

High groundwater or near-surface groundwater is a hazard that can have adverse effect on building construction, roads, storage tank installation, utilities, and other projects with structural elements that penetrate the subsurface. The major issues that can result from high groundwater are moisture intrusion and buoyancy forces that can potentially cause structural offsets. In general, groundwater within 15 feet of the ground surface can create a nuisance and can require special structure design to address buoyancy and moisture intrusion (City of Santa Barbara, 2011). The baseline high groundwater hazard map from the Santa Barbara General Plan is shown in Figure 3.15.

Groundwater replenishment via the proposed surface recharge reaches in Foothill Basin and Storage Unit I would result in rising groundwater levels in the Shallow Zone/alluvium adjacent to the creeks where surface application is performed. These rising water levels could increase the high groundwater hazard level, especially if water levels reach levels above 15 feet bgs.

For injection, the groundwater model indicates that the area in which UPZ head levels would be within 15 feet of the ground surface is approximately the same as the ‘Potentially Shallow Groundwater’ area defined in the baseline high groundwater hazard map (refer to Figure 3.15), except for in the western Foothill Basin, where an additional area of high groundwater hazard is suggested by the model (presented in Figure 3.16). As stated in Section 3.3.5, changes to groundwater levels in the alluvium resulting from increased head in the UPZ would be muted by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases to the high groundwater hazard in western Foothill Basin caused by IPR activities.

Localized increases to the high groundwater hazard immediately adjacent to the surface recharge reaches should be expected. Areas of high groundwater in the alluvium of the western Foothill Basin are likely to increase due to IPR activities and ponding north of the Mission Fault, but the magnitude of water table response in the alluvium requires further evaluation, which is beyond the scope of this study.

Summary

In consideration of the potential risks associated with surface recharge activities from liquefaction, slope failure and high groundwater (plus potential mobilization/capture of existing contamination, Section 3.3.5), the benefits of surface recharge (annual average storage of 740 AFY) are considered too low for this screening level analysis; therefore, surface recharge is removed as a method of re-using recycled water (whether tertiary-treated or FAT).
FIGURE 3.14
Slope Failure Hazard Areas Relative to Proposed IPR Facilities

City of Santa Barbara
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial Screening: Potable Reuse

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells
Relative Landslide Potential Areas
(Santa Barbara General Plan, 2011)
- High
- Moderate
- Low
- Very Low
All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads
- Streams and Creeks

Legend
Stream Recharge Reach
Injection Wells
IPR Recovery Wells
Relative Landslide Potential Areas
(Santa Barbara General Plan, 2011)
High
Moderate
Low
Very Low
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
FIGURE 3.15
Baseline High Groundwater Hazard Zones

City of Santa Barbara
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial Screening: Potable Reuse

Legend
Stream Recharge Reach
Injection Wells
IPR Recovery Wells

Groundwater Hazard Zones
(Santa Barbara General Plan, 2011)
- Potentially Shallow Groundwater
- Moderately Shallow Groundwater
- Deep Groundwater

All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, County of Santa Barbara, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
FIGURE 3.16
Groundwater Model Predicted Areas of UPZ Heads Less Than 15 Feet Below Ground Surface

City of Santa Barbara
Subsurface Desalination Intake and Potable Reuse Feasibility Studies
Technical Memorandum No. 3
Basis of Design and Initial Screening; Potable Reuse

LEGEND
Stream Recharge Reach
Injection Wells
IPR Recovery Wells
Groundwater Model Predicted Areas of UPZ Heads Less Than 15 Feet Below Ground Surface
Groundwater Hazard Zones (Santa Barbara General Plan, 2011)
Potentially Shallow Groundwater
Moderately Shallow Groundwater
Deep Groundwater
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 3, 2016
Data Source: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
3.4 Summary of Potable Reuse Alternatives

Using the design basis information presented previously in this section, Figures 3.17A and 3.17B present a summary of the initial potable reuse alternatives that were further developed as part of this study. It should be noted that the Work Plan (Appendix A), requires that this study also evaluate dilution of the intake water at the Charles E Meyer Desalination Plant (Desalination Plant), however, this alternative was discounted based upon the following:

- AWTF treatment is still required. Raw wastewater cannot be combined with seawater and sent to the desalination plant, due to source water regulations. Thus, to be used as source water for the desalination plant, the wastewater must be treated at the AWTF, and then combined with seawater.

- When combined with the maximum amount of AWTF effluent, intake water salinity was reduced from an average concentration of 34,451 mg/L to 25,754 mg/L, which will reduce the power required, but does not affect the recovery rate of the Desalination Plant (i.e., equal to 45 percent). Therefore, a 55 percent loss of AWTF product water will result, which is a substantial loss of yield from potable reuse supply.

- Better utilization of the effluent water from El Estero will result from construction of a separate water treatment facility to receive and treat the AWTF product water.

The alternatives presented in Figures 3.17A and 3.17B represent the range of alternatives considering various combinations of NPR, IPR, and DPR (both re-treatment at Cater WTP and a new WTP co-located with the desalination facility).

The combination of alternatives presented in Figures 3.17A and 3.17B were selected to provide the full range of options for the City to consider while incorporating potable reuse into their water supply portfolio. The characteristics for numbering each alternative combination are presented as a matrix in Figure 3.18. This matrix explains the priority for maximizing each type of reuse (e.g., NPR, IPR, etc.) for each alternative.

Other considerations for alternatives analyzed in this study include the following:

- Alternatives that pump AWTF product water to Lauro Reservoir will utilize the existing NPR distribution pipeline repurposed to convey DPR quality water.

- Alternative 1a will split existing NPR treatment. Demands east of the AWTF will continue to send NPR quality water via the existing NPR distribution system. The existing NPR pipeline to the west of the AWTF will be repurposed to convey AWTF water to Lauro Reservoir.
  - The motivation to abandon portions of the existing West NPR system was the significant time and financial cost associated with management of the City’s current recycled water system. Eliminating the West NPR system poses many advantages for the City’s water supply portfolio.

- Alternatives maximizing NPR treatment consider future demands identified in the City’s 2009 Water Supply Planning Study (Carollo Engineers and City of Santa Barbara, 2009).
Figure 3.17A
Initial Summary of Potable Reuse Alternatives

### ALTERNATIVE NUMBER

#### 1A
- **Flow Diagram:**
  - 8,660 AFY
  - 716 AFY
  - To East NPR Distribution System (including future)

- **Description Notes:**
  - Maximize NPR treatment & use Lauro Canyon Reservoir
  - Only tertiary treated flow going east.
  - DPR treat all flows going west.
  - DPR treated flow sent to Lauro Canyon Reservoir.
  - Alternative maximizes NPR treated flow.

#### 1B
- **Flow Diagram:**
  - 8,660 AFY
  - To NPR Distribution System & Lauro Canyon Reservoir
  - 6,355 AFY

- **Description Notes:**
  - Maximize DPR by minimizing NPR & use Lauro Canyon Reservoir
  - Title 22 system is removed, and all flow is DPR treated.

#### 2A
- **Flow Diagram:**
  - 8,660 AFY
  - 7,944 AFY
  - 1,589 AFY

- **Description Notes:**
  - Maximize NPR treatment & use new WTP
  - NPR system remains in place as is.
  - Remaining flow is sent to DPR facility and retreated at new WTP co-located with Desalination Facility.

#### 2B
- **Flow Diagram:**
  - 8,660 AFY
  - 6,928 AFY
  - 1,732 AFY

- **Description Notes:**
  - Maximize DPR by minimizing NPR & use new WTP
  - NPR system remains is removed, and all flow is DPR treated and retreated at new WTP co-located with Desalination Facility.

### NOTES:

1. Numbers in red represent the maximum amount of IPR that can be applied via surface application. These numbers are obtained from a hydrogeological evaluation and are placeholder for the purpose of determining the initial range of alternatives.
2. Flow available to send to DPR treatment is calculated as: DPR = total El Estero Secondary Effluent - NPR - IPR. This number is based on IPR flow potential and is considered a placeholder for purposes of this figure.
3. RO recovery is assumed to be 80% for treatment process involving RO membranes (i.e., IPR and DPR).
### Initial Summary of Potable Reuse Alternatives

**Table 3.17B**

<table>
<thead>
<tr>
<th>ALTERNATIVE NUMBER</th>
<th>FLOW DIAGRAM</th>
<th>DESCRIPTION NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3A</td>
<td></td>
<td><strong>Maximize NPR/IPR &amp; use Lauro Canyon Reservoir</strong>&lt;br&gt;• Only tertiary treated flow going east.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and sent to west NPR system and Lauro Canyon Reservoir.</td>
</tr>
<tr>
<td></td>
<td>8,660 AFY</td>
<td><strong>Maximize IPR/DPR by minimizing NPR &amp; use Lauro Canyon Reservoir</strong>&lt;br&gt;• NPR system is removed.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and sent to Lauro Canyon Reservoir.</td>
</tr>
<tr>
<td>3B</td>
<td></td>
<td><strong>Maximize NPR/IPR &amp; use new WTP</strong>&lt;br&gt;• NPR system remains in place.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and retreated at new WTP co-located with Desalination Facility.</td>
</tr>
<tr>
<td></td>
<td>8,660 AFY</td>
<td><strong>Maximize IPR/DPR by minimizing NPR &amp; use new WTP</strong>&lt;br&gt;• NPR system is removed.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and retreated at new WTP co-located with Desalination Facility.</td>
</tr>
<tr>
<td>4A</td>
<td></td>
<td><strong>Maximize NPR/IPR &amp; use new WTP</strong>&lt;br&gt;• NPR system remains in place.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and retreated at new WTP co-located with Desalination Facility.</td>
</tr>
<tr>
<td></td>
<td>8,660 AFY</td>
<td><strong>Maximize IPR/DPR by minimizing NPR &amp; use new WTP</strong>&lt;br&gt;• NPR system is removed.&lt;br&gt;• The maximum amount of water that can be feasibly used for IPR is injected/spread.&lt;br&gt;• The remaining water is DPR treated and retreated at new WTP co-located with Desalination Facility.</td>
</tr>
</tbody>
</table>

**Notes:**
1. Numbers in red represent the maximum amount of IPR that can be applied via surface application. These numbers are obtained from a hydrogeological evaluation and are placeholder for the purpose of determining the initial range of alternatives.
2. Flow available to send to DPR treatment is calculated as: DPR = total El Estero Secondary Effluent - NPR - IPR. This number is based on IPR flow potential and is considered a placeholder for purposes of this figure.
3. RO recovery is assumed to be 80% for treatment process involving RO membranes (i.e., IPR and DPR).
### Figure 3.18 - Initial Alternatives Numbering Characteristics Matrix

<table>
<thead>
<tr>
<th>ALTERNATIVE NUMBER</th>
<th>TYPES OF POTABLE REUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NPR Treatment</td>
</tr>
<tr>
<td>1A</td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td></td>
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<tr>
<td>2B</td>
<td></td>
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<tr>
<td>3A</td>
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<td>3B</td>
<td></td>
</tr>
<tr>
<td>4A</td>
<td></td>
</tr>
<tr>
<td>4B</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
1) Odd alternatives provide re-treatment at use Cater WTP for DPR; even alternatives provide re-treatment at new WTP for DPR.
2) Alternatives 1 and 2 do not consider IPR; alternatives 3 and 4 consider IPR and then use DPR for any remaining flow.
3) “A” letter alternatives maximize NPR first; “B” alternatives minimize NPR.
4) There is no waste brine stream associated with NPR treatment.
5) Water re-treated at new WTP can be distributed in City’s low-pressure zone or sent to South Coast using new transmission main.

**PRIORITY LEVELS TO MAXIMIZE CAPACITY**
- 1st Priority
- 2nd Priority
- 3rd Priority
Although the methodology presented above considers eight possible potable reuse alternatives, results of the hydrogeological analysis (Section 3.3) caused refinement in the final alternatives to be considered further in the study. As demonstrated in Section 3.3, the average amount of water that can be used for IPR was approximately 8,500 AFY, with a minimum year value of 7,570 AFY. An analysis of available secondary effluent presented in Section 3.2.3 indicated that 8,660 AFY is available for all types of water reuse, which amounts to 6,928 AFY of IPR quality water, accounting for 80% RO recovery. Therefore, based on hydrogeological analysis, all of the potential water for IPR can be used, and no water would remain for DPR in alternatives considering IPR. As a result, the alternatives considered for potable reuse were simplified to those presented in Figure 3.19. The characteristics for numbering final alternatives are presented as a matrix in Figure 3.20. Each of the six alternatives presented were carried forward for conceptual design in Section 3.5. The following subsections present process development for the treatment trains associated with NPR, IPR, DPR, and the new WTP to re-treat AWTF product water in certain DPR alternatives.

### 3.4.1 Non-Potable Reuse Treatment

NPR treatment is currently practiced by the City of Santa Barbara and consists of treating secondary effluent with microfiltration (MF), followed by chlorination. For the purposes of this study, it is assumed that NPR treatment facilities will be relocated to the City's Corporation Yard (401 E. Yanonali Street) and incorporated into the new IPR or DPR advanced treatment facilities. However, NPR water does not require treatment with reverse osmosis (RO) or ultraviolet light (UV) and advanced oxidation (AOP). Relocating the NPR treatment facilities offers the potential to free up much needed land on the El Estero WWTP site for future improvements and allows treatment equipment and operations expertise for MF treatment to be consolidated into a single location. This assumption, that existing NPR treatment will be relocated to the Corporation Yard, will be further evaluated as part of the City's future planning studies.

### 3.4.2 Indirect Potable Reuse Treatment Process

As presented in Section 3.2.2, water quality and treatment requirements for IPR alternatives are dictated by California Code of Regulations, Title 22. Figure 3.21 presents the IPR treatment train selected for this study. All alternative combinations containing IPR will utilize this train. Major components of the treatment process are as follows:

1. **Equalization Tanks:** Secondary effluent is sent to equalization tanks to equalize the diurnal flow received at the El Estero WWTP. The equalization basins also may help normalize variations in water quality.

2. **Microfiltration (MF):** From equalization tanks, MF feed pumps transfer water through strainers and microfiltration membrane racks.
Figure 3.19
Final Summary of Potable Reuse Alternatives

<table>
<thead>
<tr>
<th>ALTERNATIVE NUMBER</th>
<th>FLOW DIAGRAM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td><img src="1A" alt="Diagram" /></td>
<td>El Estero WWTP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td><img src="1B" alt="Diagram" /></td>
<td>El Estero WWTP</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td><img src="2A" alt="Diagram" /></td>
<td>El Estero WWTP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B</td>
<td><img src="2B" alt="Diagram" /></td>
<td>El Estero WWTP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td><img src="3A" alt="Diagram" /></td>
<td>El Estero WWTP</td>
</tr>
<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3B</td>
<td><img src="3B" alt="Diagram" /></td>
<td>El Estero WWTP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. RO recovery is assumed to be 80% for treatment process involving RO membranes (i.e., IPR and DPR).

Maximize NPR treatment & use Lauro Canyon Reservoir
- Only tertiary treated flow going east.
- DPR treat all flows going west.
- DPR treated flow sent to Lauro Canyon Reservoir.
- Alternative maximizes NPR treated flow.

Maximize DPR by minimizing NPR & use Lauro Canyon Reservoir
- Title 22 system is removed, and all flow is DPR treated and sent to Lauro Canyon Reservoir.

Maximize NPR treatment & use new WTP
- NPR system remains in place as is.
- Remaining flow is sent to DPR facility, and retreated at new WTP co-located with Desalination Facility.

Maximize DPR by minimizing NPR & use new WTP
- NPR system is removed, and all flow is DPR treated and retreated at new WTP co-located with Desalination Facility.

Maximize NPR treatment & use remaining flow for IPR
- NPR system remains in place.
- The remaining water is used for IPR and is injected/spread.

Maximize DPR by minimizing NPR & use new WTP
- NPR system is removed, and all flow is IPR treated and sent to injection wells/spreading basins.
### Figure 3.20 - Final Alternatives Numbering Characteristics Matrix

<table>
<thead>
<tr>
<th>ALTERNATIVE NUMBER</th>
<th>NPR Treatment</th>
<th>IPR Treatment</th>
<th>DPR: Cater WTP</th>
<th>DPR: New WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1B</td>
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<td></td>
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<tr>
<td>2A</td>
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<td>3A</td>
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<tr>
<td>3B</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**NOTES:**
1) “A” letter alternatives maximize NPR first; “B” alternatives minimize NPR.
2) There is no waste brine stream associated with NPR treatment.
3) Water re-treated at new WTP can be distributed in City’s low-pressure zone or sent to South Coast using new transmission main.

**PRIORITY LEVELS TO MAXIMIZE CAPACITY**
- 1st Priority
- 2nd Priority
Figure 3.21 - Indirect Potable Reuse Train PFD

Notes:
1. Provides 4 hours of response retention time.
3. Reverse Osmosis (RO): After MF treatment, water is directed to a wet well. RO feed pumps transfer water through cartridge filters, then through a 2 stage RO treatment train.\(^{18}\)

4. Ultraviolet/Advanced Oxidation Process Disinfection (UV/AOP): Sodium hypochlorite is added to RO treated water followed by high energy UV reactors to form hydroxyl radicals, which are a powerful disinfectant.

5. Engineered Storage: Finished water is held in engineered storage tanks that provide enough response retention time (RRT) to determine if a process upset has occurred, and respond before the water leaves the facility. RRT is based on the speed at which analytical instruments are capable of determining the integrity of process components and as presented in Section 3.2.2, is assumed to be 3 hours based upon current regulatory activity.

6. Finished Water Pumps: Transfer water from IPR facility to injection wells (subsurface application) as located in Figure 3.7.\(^{19}\) The distribution pipelines will consist of repurposed NPR pipelines; however, new distribution pipelines will be required based upon the final injection well locations.

### 3.4.3 Direct Potable Reuse Treatment Process

As presented in Section 3.2.2, the State of California does not have regulations adopted for DPR. As stated in the Work Plan (Appendix A), conceptual design for DPR presented in this study is based on the most recent regulatory activity and comparable precedent activity in California. The VenturaWaterPure DPR demonstration facility represents the combined efforts of Ventura Water, the City of Ventura, Carollo Engineers, and members of the Water Research Foundation Project #4536 team. The demonstration facility was designed to have multiple barriers for both pathogens and trace pollutants in excess of the treatment required for indirect potable reuse (IPR) via groundwater injection (Carollo Engineers and Ventura Water, 2015).

The 20 gallon per minute (gpm) process train, presented in Figure 3.22 treats undisinfected filtered secondary effluent from the Ventura Water Reclamation Facility (VWRF) and provides treatment through pasteurization, ultrafiltration (UF), reverse osmosis (RO), and an ultraviolet light (UV) - advanced oxidation process (AOP). For a future DPR facility, granular activated carbon (GAC) may be added after the RO process for an additional barrier to trace pollutants. An engineered storage buffer (ESB) would be added to the treatment train after the UV/AOP to allow for appropriate system monitoring and water quality assurance.

---

\(^{18}\) Brine resulting from the IPR RO process is far less concentrated that brine from seawater desalination. Thus, introduction of this brine into the existing outfall will not affect mixing with seawater.

\(^{19}\) Spreading basins will not be used based upon the findings presented in Section 3.3.6.
While the process train proposed for the VenturaWaterPure DPR Demonstration Facility presents one possible DPR treatment system, many other alternatives have been proposed. Other alternatives include additional disinfection steps, ozone, biofiltration, and additional enhanced process monitoring. After an evaluation of many treatment process alternatives, a process was selected based on treatment robustness, footprint (ability to be constructed on available property) and the regulatory requirement that treatment meet a 14/12/12 log virus/Giardia/Cryptosporidium removal with multiple treatment barriers, engineered storage, and enhanced monitoring. Figure 3.23 presents the DPR treatment train that was selected for this study. All alternatives containing DPR will utilize this train. Major components of the treatment process are as follows:

1. **Equalization Tanks:** Secondary effluent is sent to equalization tanks to equalize the diurnal flow received from the El Estero WWTP. The equalization basins also may help normalize variations in water quality.

2. **Microfiltration (MF):** From equalization tanks, MF feed pumps transfer water through strainers and microfiltration membrane racks.

---

**Figure 3.22  Schematic of VenturaWaterPure DPR Demonstration Facility**
Figure 3.23 - Direct Potable Reuse Train PFD

El Estero WWTP

Equalization Tanks

MF Feed Pumps

Strainer

Microfiltration

UV Disinfection

RO Feed Pumps

Cartridge Filters

Reverse Osmosis (2 stage)

UV/AOP (sodium hypochlorite)

Engineered Storage

Finished Water Pumps

To Lauro Canyon Reservoir or new WTP co-located with Desalination Plant

Notes:
1. Provides 4 hours of response retention time.
3. Ultraviolet Disinfection (UV): Intermediate UV disinfection is performed using UV reactors.

4. Reverse Osmosis (RO): After UV disinfection, water is directed to a wet well. RO feed pumps transfer water through cartridge filters, then through a 2 stage RO treatment train.

5. Ultraviolet/Advanced Oxidation Process Disinfection (UV/AOP): Sodium hypochlorite is added to RO treated water followed by high energy UV reactors to form hydroxyl radicals, which are a powerful disinfectant.

6. Engineered Storage: Finished water is held in engineered storage tanks that provide enough response retention time (RRT) to determine if a process upset has occurred, and respond before the water leaves the facility. RRT is based on the speed at which analytical instruments are capable of determining the integrity of process components and as presented in Section 3.2.2, and is assumed to be 3 hours based upon current regulatory activity.

7. Finished Water Pumps: Transfers water from DPR facility to Lauro Reservoir (Alt 1) via repurposing the existing western portion of the City's NPR distribution pipeline, or transfers water from the DPR facility to a new WTP located at the City's Desalination Plant site (Alt 2).

3.4.4 Water Treatment Plant Process

As presented in the Work Plan and within this report (Section 3.2.1 and 3.4), some DPR alternatives (Alternatives 1A and 1B) will re-treat AWTF product water at the Cater WTP, while some alternatives (Alternatives 2A and 2B) will retreat AWTF product water at a new WTP co-located at the Charles E Meyer Desalination Plant site. The Cater WTP is a conventional WTP that uses pre-ozonation, flocculation/sedimentation, and dual media filtration to treat surface water from Lauro Reservoir. As described in Section 2, the addition of AWTF product water to Lauro Reservoir will require an update the City's source water assessment and sanitary survey for the Cater WTP. It is possible that this modification to the source water may change the WTP's treatment requirements in accordance with the Long Term 2 Enhanced Surface Water Treatment Rule.

The new WTP co-located at the Charles E Meyer Desalination Plant site would require, at minimum, filtration and disinfection, which can be provided by various processes. Filtration processes can include granular media filtration (i.e., similar to Cater WTP) or MF membranes; disinfection can include UV and free chlorine. Due to the size constraints associated with locating the WTP on the desalination plant site, the treatment train presented in Figure 3.24 below was selected. Major components of the treatment train include:

---

20 Brine resulting from the DPR RO process is far less concentrated that brine from seawater desalination. Thus, introduction of this brine into the existing outfall will not affect mixing with seawater.
Figure 3.24 - New Water Treatment Train PFD
• **Microfiltration (MF):** From the AWTF, water is transferred to an influent wet well located on the desalination plant site. MF feed pumps lift water from the wetwell through strainers and microfiltration membrane racks.

• **Ultraviolet Disinfection (UV):** UV disinfection is performed using UV reactors. The UV system design is already incorporated at the desalination plant currently being reactivated.

• **Holding Tank:** Water is stored in an existing hold tank.

• **Finished Water Pumps:** Convey treated drinking water from WTP facility to the City’s distribution system (i.e., into either the low pressure zone or to the South Coast Conduit using new transmission main).

Similar to the modifications of source water for the Cater WTP, this new WTP would require source water assessments and sanitary surveys according to the Long Term 2 Enhanced Surface Water Treatment Rule.

### 3.5 Conceptual Design Summary

This section presents a summary of the conceptual design for each of the potable reuse alternatives identified in Section 3.4. Conceptual designs are based upon:

- **BOD criteria (Section 3.2)**
- Results from the hydrogeological analyses (Section 3.3)
- Distribution and treatment process descriptions for new and existing facilities presented in Section 3.4, including:
  - New NPR, IPR, and DPR treatment plants
  - Drinking water treatment facilities that re-treat AWTF product water for DPR including the Cater WTP and new drinking water treatment plant located at the Charles E Meyer Desalination Plant
  - General concepts for water distribution pipelines

Each of the conceptual designs presented in this section will subsequently be evaluated for technical feasibility as part of the initial screening process (Section 3.6).

#### 3.5.1 Alternatives Conceptual Design - Project Descriptions

The following subsections provide an overview of the conceptual design for each alternative.

---

21 It is noted that conceptual designs are based on the treatment capacity required to produce a nameplate capacity equal to the annual average flow rate (7.73 mgd). Redundancy (e.g., n+1) can be incorporated into a future design to make certain that the reliable production capacity is equal to this annual average flow rate. Alternatively, the City can assume a reliable production rate less than the nameplate capacity (i.e., using and operating factor).
**Alternative 1A**

Alternative 1A consists of the following features:

- Production of NPR and DPR product water. Table 3.13 presents process flow rates for Alternative 1A.

| Table 3.13 Process Flow Rates - DPR Facility Alt 1A |
|---------------------------------|---------------------------------|---------------------------------|
| **Description**                 | **Units**                       | **Direct Potable Reuse Capacities** |
| Source and Finished Water Flows  |                                |                                  |
| City Secondary Effluent AFY     | 8,660                           |
| City Secondary Effluent gpm (mgd)| 5,369 (7.7)                     |
| Process Flows: AWTF/NPR         |                                |                                  |
| Microfiltration                 |                                |                                  |
| Recovery %                      | 94%                             |
| Permeate Flow gpm (mgd)         | 5,369 (7.7)                     |
| Feedwater Flowa gpm (mgd)       | 5,712 (8.2)                     |
| Backwash Flow gpm (mgd)         | 343 (0.5)                       |
| Pre RO UV System                |                                |                                  |
| Process Flow gpm (mgd)          | 5,369 (7.7)                     |
| Process Flows: East NPR         |                                |                                  |
| Flow to East NPR Systemb gpm (mgd)| 444 (0.6)                     |
| Process Flows: AWTF             |                                |                                  |
| Reverse Osmosis                 |                                |                                  |
| Recovery %                      | 80%                             |
| Permeate Flow gpm (mgd)         | 3,940 (5.7)                     |
| Feedwater Flow gpm (mgd)        | 4,925 (7.1)                     |
| Brine Flow gpm (mgd)            | 985 (1.4)                       |
| UV / AOP                        |                                |                                  |
| Process Flow gpm (mgd)          | 3,940 (5.7)                     |
| Total Finished Water Flows      |                                |                                  |
| Total NPR Flow gpm (mgd)        | 444 (0.6)                       |
| Total DPR Flow gpm (mgd)        | 3,940 (5.7)                     |
| Total Usable Flow gpm (mgd)     | 4,384 (6.3)                     |
| Total NPR Flow AFY              | 716                             |
| Total DPR Flow AFY              | 6,355                           |
| Total Usable Flow AFY           | 7,071                           |
| Recovery of WWTP Effluent %     | 82%                             |

Notes:

a. MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.

b. After MF and UV, flow is diverted to satisfy East NPR demand.
NPR production is maximized by splitting the East and West NPR distribution system.

- East NPR distribution system (including future flows) is separated from the existing NPR distribution network, but is unaltered and continues to receive tertiary treated water for distribution to irrigation customers.
- Portions of the West NPR distribution system may be abandoned, while the main line is repurposed to convey DPR treated water from the AWTF to Lauro Reservoir, where it will be treated again at the Cater WTP.  

New treatment and storage facilities will be located at the City’s Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils.  

- To consolidate reuse treatment facilities at one location, the existing NPR treatment system at El Estero WWTP may also be relocated to the City’s Corporation Yard.

Figure 3.25 presents the conceptual pipeline alignment for Alternative 1A. As presented in Figure 3.25:

- A new 16-inch pipeline is required to connect the DPR AWTF to the existing West NPR distribution pipeline near Quineintos Street. A new railroad crossing is also required to isolate the West portion of the existing NPR distribution system and install parallel 12-inch diameter piping to effectively convey DPR water. Additionally, pipeline construction is required in the coastal zone and may border environmentally sensitive habitat areas.
- New 12-inch pipeline is required to connect the relocated NPR treatment system to the existing East NPR distribution system.
- New 12-inch parallel pipeline is required to transmit DPR product water for sections of existing 12-inch lines installed during construction of the Phase 1 NPR distribution system. Several creek crossings in environmentally sensitive habitat areas are required.
- New 16-inch pipeline is required from Golf Course Pump Station to Lauro Reservoir. The Golf Course Pump Station will be modified and repurposed to transfer DPR product water to the Lauro Reservoir.

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22 To be evaluated in future studies.
23 The existing recycled water customers have already experienced costs to design separate irrigation systems for recycled water. If the customer is provided water from the potable system, the cost to retrofit systems on private property to use water from the potable system should be accounted for. It is noted that the City’s potable water system may require major improvements to meet former recycled water customer demands.
24 In 1925, an earthquake leveled much of Santa Barbara. Rubble was relocated to the area surrounding the Corporation Yard, Desalination Plant, and El Estero WWTP. Contaminated solids (i.e., primarily trash and hydrocarbons) are expected to be encountered.
25 Alternatively, pipe bursting techniques could be used to replace the existing 12-inch line with the required 16-inch line. Exact methodology should be evaluated in future activity.
Figure 3.25 - Alternative 1A Pipeline Alignment

NOTES:
1. Existing NPR treatment system at El Estero WWTP may be relocated to the City’s Corporation Yard (401 E. Yanonali St.) to consolidate reuse treatment facilities at one location.
2. New 12" pipeline is required to connect the relocated NPR treatment system to the existing East NPR distribution system.
– DPR treated product water augments the supply of water in the Lauro Reservoir, which is treated at the Cater WTP.

– Desalination plant build out capacity of 10,000 AFY is unaffected.

– Design criteria for treatment and conveyance facilities are presented in Appendix D.

**Alternative 1B**

Alternative 1B consists of the following features:

– Production of only DPR product water. Table 3.14 presents the overview of process flow rates for Alternative 1B.

– NPR production is eliminated. Current NPR customers may be provided water by the City's potable water system, which may require additional retrofits on private property for those affected recycled customers. DPR treatment is provided for all available secondary effluent flow. 23

– New treatment and storage facilities will be located at the City's Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils. 24

  – The existing NPR treatment system is repurposed for DPR treatment and relocated to the City's Corporation Yard.

– Portions of the West NPR distribution system may be abandoned, while the main West NPR distribution pipeline is repurposed to convey DPR treated water from the AWTF to Lauro Reservoir, where it will be treated again at the Cater WTP.

– Figure 3.26 presents the conceptual pipeline alignment for Alternative 1B. As presented in Figure 3.26:

  – Existing NPR distribution system may be abandoned, however the primary West portion of NPR pipeline is repurposed to convey DPR treated water to the existing Golf Course Pump Station.

  – New 16-inch pipeline is required to connect DPR facility to existing NPR distribution pipeline near Quinientos Street. A new railroad crossing will be required to isolate the West portion of the existing NPR distribution system and install parallel 12-inch diameter piping to effectively convey DPR water. Pipeline construction will occur in the coastal zone and may boarder environmentally sensitive habitat areas.

  – New 12-inch parallel pipeline is required to transmit DPR water for sections of existing 12-inch lines installed during construction of Phase I NPR distribution system. 25
### Table 3.14  Process Flow Rates - DPR Facility Alt 1B

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Direct Potable Reuse Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source and Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>AFY</td>
<td>8,660</td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
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<tr>
<td><strong>Process Flows: AWTF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>94%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Feedwater Flow&lt;sup&gt;a&lt;/sup&gt;</td>
<td>gpm (mgd)</td>
<td>5,712 (8.2)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>343 (0.5)</td>
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<tr>
<td><strong>Pre RO UV System</strong></td>
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</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>80%</td>
</tr>
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<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Brine Flow</td>
<td>gpm (mgd)</td>
<td>1,074 (1.5)</td>
</tr>
<tr>
<td><strong>UV / AOP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td><strong>Total Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>gpm (mgd)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>AFY</td>
<td>0</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Recovery of WWTP Effluent</td>
<td>%</td>
<td>80%</td>
</tr>
</tbody>
</table>

**Note:**
- a. MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.
Figure 3.26 - Alternative 1B Pipeline Alignment
– New 16-inch pipeline is required from Golf Course Pump Station to Lauro Reservoir. The Golf Course Pump Station will be modified and repurposed to transfer water to the Lauro Reservoir.
– DPR treated product water augments the supply of water in the Lauro Reservoir, which is treated at the Cater WTP.

• The quality of NPR irrigation water is improved by DPR treatment, however less reuse water is produced overall when compared to Alternative 1A due to losses by the DPR treatment process (i.e., brine flow from RO treatment).
• Desalination plant build out capacity of 10,000 AFY is not affected by this alternative.
• Design criteria for treatment and conveyance facilities are presented in Appendix D.

**Alternative 2A**

Alternative 2A consists of the following features:

• Production of NPR and DPR product water. Table 3.15 presents the overview of process flow rates for Alternative 2A.
• NPR production is maximized by keeping the existing NPR treatment and distribution system in place as currently installed. For the purposes of this study, future NPR flows are considered in the total NPR capacity required. The remaining secondary effluent flow is treated to DPR standards, and then a new pipeline is used to convey DPR product water from the AWTF to a new WTP co-located at the Charles E Meyer Desalination Plant site, where it will be treated again.
• New treatment and storage facilities will be located at the City's Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils. 24
– To consolidate reuse treatment facilities at one location, the existing NPR treatment system at El Estero WWTP may also be relocated to the City's Corporation Yard.
Table 3.15  Process Flow Rates - DPR Facility Alt 2A

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Direct Potable Reuse Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source and Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>AFY</td>
<td>8,660</td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td><strong>Process Flows: AWTF/NPR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microfiltration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>94%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>5,414 (7.8)</td>
</tr>
<tr>
<td>Feedwater Flow^a</td>
<td>gpm (mgd)</td>
<td>5,760 (8.3)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>346 (0.5)</td>
</tr>
<tr>
<td><strong>Pre RO UV System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>5,414 (7.8)</td>
</tr>
<tr>
<td><strong>Process Flows: NPR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow to NPR System</td>
<td>gpm (mgd)</td>
<td>868 (1.2)</td>
</tr>
<tr>
<td><strong>Reverse Osmosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>80%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>3,637 (5.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>4,547 (6.6)</td>
</tr>
<tr>
<td>Brine Flow</td>
<td>gpm (mgd)</td>
<td>909 (1.3)</td>
</tr>
<tr>
<td><strong>UV / AOP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>3,637 (5.2)</td>
</tr>
<tr>
<td><strong>Process Flows: WTP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microfiltration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>99%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td>Feedwater Flow^a</td>
<td>gpm (mgd)</td>
<td>3,637 (5.2)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>36 (0.1)</td>
</tr>
<tr>
<td><strong>Post Treatment UV System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow^b</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td><strong>Total Finished Water Flows</strong></td>
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<tr>
<td>Total NPR Flow</td>
<td>gpm (mgd)</td>
<td>868 (1.2)</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>gpm (mgd)</td>
<td>4,469 (6.4)</td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>AFY</td>
<td>1,400</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>AFY</td>
<td>5,808</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>AFY</td>
<td>7,208</td>
</tr>
<tr>
<td>Recovery of WWTP Effluent</td>
<td>%</td>
<td>83%</td>
</tr>
</tbody>
</table>

Notes:

a. MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.
b. New WTP will use UV system capacity included in desalination plant design.
Figure 3.27 presents the conceptual pipeline alignment for Alternative 2A. As presented in Figure 3.27:
- Existing NPR distribution system is not altered and conveys tertiary treated water for all existing and future NPR irrigation customers.
- New 16-inch pipeline is required to connect DPR AWTF to new WTP co-located with Charles E Meyer Desalination Plant.
- New 12-inch pipeline is required to connect the relocated NPR treatment system to the existing NPR distribution system.
- New WTP is co-located with desalination facility to re-treat product water from DPR AWTF.

Desalination plant build-out capacity is reduced to 5,000 AFY because half of the site is used for a new WTP that treats AWTF product water before distribution to the City's potable water system.

Design criteria for treatment and conveyance facilities are presented in Appendix D.

Alternative 2B

Alternative 2B consists of the following features:
- Production of only DPR product water. Table 3.16 presents the overview of process flow rates for Alternative 2B.
- NPR production is eliminated by abandoning the existing NPR treatment and distribution system. Current NPR customers may be provided water by the City's potable water system which may require additional retrofits on private property for those affected customers. DPR treatment is provided for all available secondary effluent flow. 23
- New treatment and storage facilities will be located at the City's Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils. 24
  - The existing NPR treatment system is repurposed for DPR treatment and relocated to the City's Corporation Yard.
NOTES:
1. Existing NPR treatment system at El Estero WWTP may be relocated to the City’s Corporation Yard (401 E. Yanonali St.) to consolidate reuse treatment facilities at one location.
2. New 12" pipeline is required to connect the relocated NPR treatment system to the existing NPR distribution system.
Table 3.16  Process Flow Rates - DPR Facility Alt 2B

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Direct Potable Reuse Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source and Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>AFY</td>
<td>8,660</td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>gpm (mgd)</td>
<td>5,369   (7.7)</td>
</tr>
<tr>
<td><strong>Process Flows: AWTF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microfiltration</td>
<td>%</td>
<td>94%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>5,423   (7.8)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>5,769   (8.3)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>346     (0.5)</td>
</tr>
<tr>
<td><strong>Pre RO UV System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>5,423   (7.8)</td>
</tr>
<tr>
<td><strong>Reverse Osmosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>80%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>4,338   (6.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>5,423   (7.8)</td>
</tr>
<tr>
<td>Brine Flow</td>
<td>gpm (mgd)</td>
<td>1,085   (1.6)</td>
</tr>
<tr>
<td><strong>UV / AOP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>4,338   (6.2)</td>
</tr>
<tr>
<td><strong>Process Flows: WTP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microfiltration</td>
<td>%</td>
<td>99%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>4,295   (6.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>4,338   (6.2)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>43      (0.1)</td>
</tr>
<tr>
<td>Post Treatment UV System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>4,295   (6.2)</td>
</tr>
<tr>
<td><strong>Total Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>gpm (mgd)</td>
<td>0       (0.0)</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>gpm (mgd)</td>
<td>4,295   (6.2)</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>gpm (mgd)</td>
<td>4,295   (6.2)</td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>AFY</td>
<td>0</td>
</tr>
<tr>
<td>Total DPR Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Recovery of WWTP Effluent</td>
<td>%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Notes:

a. MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.
b. New WTP will use UV system capacity included in desalination plant design.
Figure 3.28 presents the conceptual pipeline alignment for Alternative 2B. As presented in Figure 3.28:
- Existing NPR treatment and distribution system is completely abandoned to maximize DPR capacity.
- New 16-inch pipeline is required to connect DPR AWTF to the new WTP co-located with Charles E Meyer Desalination Plant.
- New WTP co-located with desalination facility to re-treat product water from DPR AWTF.

The quality of NPR irrigation water is improved by DPR treatment, however less reuse water is produced overall when compared to Alternative 2A due to losses by the DPR treatment process (i.e., brine flow from RO treatment).

Desalination plant build out capacity is reduced to 5,000 AFY because half of the site is used for new WTP that treats AWTF product water before distribution to the City's potable water system.

Design criteria for treatment and conveyance facilities are presented in Appendix D.

**Alternative 3A**

Alternative 3A consists of the following features:
- Production of NPR and IPR product water. Table 3.17 presents the overview of process flow rates for Alternative 3A.
- NPR production is maximized by keeping the existing NPR treatment and distribution system in place as currently installed. For the purposes of this study, future NPR flows are considered in the total NPR capacity required. The remaining secondary effluent flow is treated to IPR standards, and then a new pipeline is used to convey IPR treated water from the AWTF to IPR injection well locations, as described in Section 3.3.
  - As described in previous sections, the amount of water possible for IPR by subsurface application (i.e., injection wells) exceeds the available water. Per discussion in the summary paragraph at the end of Section 3.3, IPR by surface application (i.e., spreading basins) was not considered in the conceptual design as the low potential yield did not offset various potential negative effects (e.g., liquefaction, slope failure, contaminant mobilization, impacts to sensitive habitats, etc.).
- New treatment and storage facilities will be located at the City's Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils.  
  - To consolidate reuse treatment facilities at one location, the existing NPR treatment system at the El Estero WWTP may also be relocated to the City's Corporation Yard.
Existing NPR System May be Abandoned (TYP)

DPR Treatment Facility

New WTP Co-located with Desalination Facility

Water Treated at DPR Facility, then New WTP, then Sent to City Distribution System (Option to Go into Low Pressure Zone or New Transmission Main to South Coast Conduit)

Legend

City Limits

Existing NPR Pipeline which May be Abandoned

Tie-in From WTP to City Distribution System

Caltrans Right of Way

Existing NPR Water Users with Potential Additional Demand

Existing NPR Water Customers

Figure 3.28 - Alternative 2B Pipeline Alignment
### Table 3.17  Process Flow Rates - IPR Facility Alt 3A

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Direct Potable Reuse Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source and Finished Water Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>AFY</td>
<td>8,660</td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td><strong>Process Flows: AWTF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microfiltration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>94%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>5,712 (8.2)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>343 (0.5)</td>
</tr>
<tr>
<td><strong>Process Flows: NPR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow to NPR System</td>
<td>gpm (mgd)</td>
<td>868 (1.2)</td>
</tr>
<tr>
<td><strong>Reverse Osmosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>80%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>4,501 (6.5)</td>
</tr>
<tr>
<td>Brine Flow</td>
<td>gpm (mgd)</td>
<td>900 (1.3)</td>
</tr>
<tr>
<td><strong>UV / AOP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td><strong>Total Finished Water Flows</strong></td>
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<td></td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>gpm (mgd)</td>
<td>868 (1.2)</td>
</tr>
<tr>
<td>Total IPR Flow</td>
<td>gpm (mgd)</td>
<td>3,601 (5.2)</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>gpm (mgd)</td>
<td>4,469 (6.4)</td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>AFY</td>
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<td>Total IPR Flow</td>
<td>AFY</td>
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<td>Total Usable Flow</td>
<td>AFY</td>
<td>7,208</td>
</tr>
<tr>
<td>Recovery of WWTP Effluent</td>
<td>%</td>
<td>83%</td>
</tr>
</tbody>
</table>

**Note:**
a. MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.

- Figure 3.29 presents the conceptual pipeline alignment for Alternative 3A. As presented in Figure 3.29:
  - Existing NPR distribution system is not altered and conveys tertiary treated water for all existing and future NPR irrigation customers.
  - New pipelines (i.e., 24-inch and smaller) are used to transmit IPR treated water from AWTF to injection well locations within the City.
  - New 12-inch pipeline is required to connect the relocated NPR treatment system to the existing NPR distribution system.
- Desalination plant build-out capacity of 10,000 AFY is not affected by this alternative.
- Design criteria for treatment and conveyance facilities are presented in Appendix D.
NOTES:
1. Existing NPR treatment system at El Estero WWTP may be relocated to the City’s Corporation Yard (401 E. Yanonali St.) to consolidate reuse treatment facilities at one location.
2. New 12" pipeline is required to connect the relocated NPR treatment system to the existing NPR distribution system.
Alternative 3B

Alternative 3B consists of the following features:

- Production of only IPR product water. Table 3.18 presents the overview of process flow rates for Alternative 3B.

- NPR production is eliminated by abandoning the existing NPR treatment and distribution system. Current NPR customers may be provided water by the City's potable water system, which may require additional retrofits to the City Potable water distribution system and on private property for those affected recycled customers. IPR treatment is provided for all available secondary effluent flow and then a new pipeline is used to convey IPR treated water from the AWTF to IPR injection well locations, as described in Section 3.3. 23
  - As described in previous sections, the amount of water possible for IPR by subsurface application (i.e., injection wells) exceeds the available water. Per discussion in the Summary paragraph at the end of Section 3.3, IPR by surface application (i.e., spreading basins) was not considered in the conceptual design as the low potential yield did not offset various potential negative effects (e.g., liquefaction, slope failure, contaminant mobilization, impacts to sensitive habitats, etc.).

- New treatment and storage facilities will be located at the City's Corporation Yard (401 E. Yanonali Street). Construction at this location will require coastal development permitting, construction within the flood plain and tsunami run-up area, and expected discovery of contaminated soils. 24
  - The existing NPR treatment system is repurposed for DPR treatment and relocated to the City's Corporation Yard.

- Figure 3.30 presents the conceptual pipeline alignment for Alternative 3B. As presented in Figure 3.30:
  - Existing NPR distribution system is completely abandoned to maximize IPR production.
  - New 24-inch pipeline is used to transmit IPR product water from the AWTF to injection well locations within the City.

- The quality of NPR irrigation water is improved by DPR treatment, however less reuse water is produced overall when compared to Alternative 2A due to losses by the DPR treatment process (i.e., brine flow from RO treatment).

- Desalination plant build out capacity of 10,000 AFY is not affected by this alternative.

- Design criteria for treatment and conveyance facilities are presented in Appendix D.
Table 3.18  Process Flow Rates - IPR Facility Alt 3B

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Direct Potable Reuse Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source and Finished Water Flows</td>
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<td></td>
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<tr>
<td>City Secondary Effluent</td>
<td>AFY</td>
<td>8,660</td>
</tr>
<tr>
<td>City Secondary Effluent</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Process Flows: AWTF</td>
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<td></td>
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<tr>
<td>Microfiltration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>94%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Feedwater Flow(^a)</td>
<td>gpm (mgd)</td>
<td>5,712 (8.2)</td>
</tr>
<tr>
<td>Backwash Flow</td>
<td>gpm (mgd)</td>
<td>343 (0.5)</td>
</tr>
<tr>
<td>Reverse Osmosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>%</td>
<td>80%</td>
</tr>
<tr>
<td>Permeate Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Feedwater Flow</td>
<td>gpm (mgd)</td>
<td>5,369 (7.7)</td>
</tr>
<tr>
<td>Brine Flow</td>
<td>gpm (mgd)</td>
<td>1,074 (1.5)</td>
</tr>
<tr>
<td>UV / AOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Total Finished Water Flows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>gpm (mgd)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total IPR Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>gpm (mgd)</td>
<td>4,295 (6.2)</td>
</tr>
<tr>
<td>Total NPR Flow</td>
<td>AFY</td>
<td>0</td>
</tr>
<tr>
<td>Total IPR Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Total Usable Flow</td>
<td>AFY</td>
<td>6,928</td>
</tr>
<tr>
<td>Recovery of WWTP Effluent</td>
<td>%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Note:

\(^a\) MF backwash is recycled to head of WWTP. Instantaneous flow is higher than permeate flow.
Figure 3.30 - Alternative 3B Pipeline Alignment
3.5.2 Treatment Facility Conceptual Design

Each of the alternatives presented in previous subsections include an AWTF used to treat water to DPR or IPR quality standards. Several of the alternatives involve the use a new WTP to re-treat AWTF product water. To verify that new AWTF and WTP facilities can be constructed on the properties identified (i.e., Corporation Yard and Charles E Meyer Desalination Plant site), and provide a conceptual representation of the treatment facilities for future planning purposes, three dimensional (3D) modeling software was used to create scaled AWTF and WTP site plan representations. The following subsections present 3D modeling results that indicate the required AWTF and WTP facilities will fit within the properties identified.

**AWTF Site Plan**

The AWTF site plan was developed using the treatment processes and design criteria presented previously and in Appendix D. For the purposes of the AWTF layout, the AWTF with the largest capacity (alternatives abandoning NPR treatment) was used, assuming if the larger facility would fit on the site, a smaller treatment facility would also fit. As stated previously, the AWTF was modeled at the following site:

- 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006).

This site is currently occupied and used for general City operations, including storage of materials and general maintenance equipment for streets, water distribution, street lighting, waterfront, and parks. Thus, this critical facility would need to be relocated to accommodate the proposed AWTF. It is not anticipated that the site could be shared based on the AWTF footprint.

Figure 3.31 and 3.32 present several model images of the AWTF. Appendix E presents additional representations.

**WTP Design Model**

The new WTP site plan, located at the Charles E Meyer Desalination Plant used to re-treat AWTF product water before distribution to the City's potable water system was developed using the treatment processes and design criteria presented previously and in Appendix D. For the purposes of the WTP layout, the WTP with the largest capacity (alternatives abandoning NPR treatment) was used, assuming if the larger facility would fit on the site, a smaller treatment facility would also fit. As stated previously, the WTP was modeled at the following site:

- West portion of the Charles E Meyer Desalination Plant site, located at 525 E. Yanonali Street.

Figure 3.33 through 3.34 presents several model images of the WTP. Appendix E presents additional representations.

---

26 Conceptual representation also assumes full redundancy in equalization and engineered storage tanks to make certain that facilities would fit on the property available. Future studies may further evaluate tank and reliability (i.e., redundancy) requirements.
Figure 3.32
AWTF Site Plan 2

- Engineered Storage Tanks
  - Diameter: 75 ft
  - Height: 40 ft
  - Residence Time: 4 hrs

- Pre RO UV System

- Equalization Tanks
  - Diameter: 82 ft
  - Height: 40 ft

- MF Racks

- Control Room
  - 20 ft x 40 ft

- MF Feed Pumps and Strainers

- Process Area
  - 103 ft x 140 ft

- Electrical Room/Mechanical Room
  - 23 ft x 163 ft

- UV/AOP System

- CIP Systems

- RO Trains and Feed Pumps

- Chemical Storage and Feed Area
Figure 3.33
WTP Site Plan 1
Figure 3.34
WTP Site Plan 2
3.5.3 Summary of Potential Maximum Yields

Using the information presented above, a summary of potential maximum yields for each of the six alternatives considered in this study could be compiled. Table 3.19 provides the maximum yield of the following:

- NPR Yield
- IPR Yield
- Desalination Yield
- Total Yield

While the objective to this study is to evaluate potable reuse as an alternative to desalination, the maximum desalination yield is shown beside the maximum potable reuse yield (e.g., NPR yield and IPR yield) in this Table 3.19 to highlight alternatives that affect the maximum desalination plant yield. This may be useful information that can inform future studies. It is noted that Alternatives 2A and 2B reduce the total build-out capacity of the desalination facility from 10,000 AFY to 5,000 AFY because their designs occupy half of the desalination facility site.

<table>
<thead>
<tr>
<th>Alternative Number</th>
<th>Potential Maximum Yields (AFY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPR Yield</td>
<td>IPR Yield</td>
</tr>
<tr>
<td>Alternative 1A</td>
<td>716</td>
</tr>
<tr>
<td>Alternative 1B</td>
<td>0</td>
</tr>
<tr>
<td>Alternative 2A</td>
<td>1,400</td>
</tr>
<tr>
<td>Alternative 2B</td>
<td>0</td>
</tr>
<tr>
<td>Alternative 3A</td>
<td>1,400</td>
</tr>
<tr>
<td>Alternative 3B</td>
<td>0</td>
</tr>
</tbody>
</table>

Note:

a. As presented in Section 3.5.1, desalination yield is reduced because half of the site is used for new WTP that treats AWTF product water before distribution to the City's potable water system.

3.6 Initial Screening Analysis

As presented in the Work Plan (Appendix A), for this project, "feasibility" is defined by industry standard procedures for projects in California, as documented in the 2012 California Environmental Quality Act (CEQA) Statute and Guidelines. The act provides the following definition:

"Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors."
Therefore, for the purposes of this study, the factors that affect feasibility of potable reuse alternatives can be identified by the four main components of the CEQA definition of "feasible": i.e., economic, environmental, social, and technological factors.

This section presents results from the initial screening analysis performed according to the Work Plan to evaluate technical feasibility of potable reuse alternatives. These criteria were identified in the Work Plan and the design basis and conceptual designs presented in this Section were developed to support initial screening. As described in the Work Plan, any solutions that survive initial screening and are determined to be "technically feasible" are considered further for social, environmental, and economic feasibility.

3.6.1 Initial Screening Criteria

The technical factors are the starting point to determine if each Potable Reuse alternative should be further considered for evaluation - e.g., economic, environmental, and social factors are considered. Potable reuse alternatives that are judged to have technical feasibility criteria in conflict with the project objectives and were not considered further in this study. Therefore, each Potable Reuse Alternative was categorized as:

1. Not feasible (NF),
2. Potentially feasible, but does not meet study goals (PF*), or
3. Potentially feasible (PF).

Alternatives determined to be "potentially feasible, but does not meet study goals" can be considered as part of future studies that may have different threshold criteria.

For the purposes of this study, "Initial Screening Criteria" was defined as follows:

Initial Screening Criteria: Those technical factors that would not allow a full-scale system to be successfully constructed or operated, would result in a high risk of failure or unacceptable performance, or would not produce water supply required to replace the use of the desalination plant's screened open ocean intake per Study goals.

Tables 3.20 and 3.21 present initial screening criteria that were used in this study for IPR and DPR alternatives presented in Section 3.5, respectively. Initial screening criteria were analyzed concurrent to the design basis information and conceptual designs development presented in Section 3.2 through 3.5 to avoid carrying forward alternatives for further study that are not technically feasible.

3.6.2 Initial Screening Results

As indicated by the results of the initial screening criteria that are summarized in Table 3.22, none of the potable reuse alternatives considered in this study were determined to be potentially feasible based upon the study objectives. These findings are the result of
the basis of design, hydrogeological analysis, potable reuse alternative evaluation, and conceptual design information presented previously in Sections 3.2, 3.3, 3.4, and 3.5. Where a potable reuse alternative was determined to be "not feasible" or "potentially feasible, doesn't meet study goals" based upon this study's initial screening criteria, this failure to pass initial screening is explained further in Tables 3.23 through 3.28, below. Discussion is grouped by the project alternative and the initial screening criteria presented in Tables 3.20 and 3.21.

Table 3.20 Initial Screening Criteria for IPR Alternatives

<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical factors</strong></td>
<td></td>
</tr>
<tr>
<td>1. Seismic hazard</td>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
</tr>
<tr>
<td><strong>Hydrogeologic factors</strong></td>
<td></td>
</tr>
<tr>
<td>2. Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts existing fresh water aquifers, local water supplies or existing water users.</td>
<td>a. Insufficient travel time (e.g., &lt; 2 months) between groundwater replenishment point and other groundwater users.</td>
</tr>
<tr>
<td>3. Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.</td>
<td>a. Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water).</td>
</tr>
<tr>
<td>4. Insufficient storage space</td>
<td>a. Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out</td>
</tr>
<tr>
<td></td>
<td>b. Groundwater replenishment of IPR water causes loss of ability to adequately manage the groundwater basin (e.g., artesian or flooding conditions, loss of stored water, etc.)</td>
</tr>
<tr>
<td></td>
<td>c. Groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (or 11,400 AFY).</td>
</tr>
</tbody>
</table>
## Table 3.20  Initial Screening Criteria for IPR Alternatives

<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oceanographic Factors</strong></td>
<td></td>
</tr>
<tr>
<td>5. Sea level rise or tsunami hazard</td>
<td>a. Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept</td>
</tr>
<tr>
<td><strong>Presence of Sensitive Habitats</strong></td>
<td></td>
</tr>
<tr>
<td>6. Habitat creation</td>
<td>a. Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR facility) or adversely affects local ecosystem</td>
</tr>
<tr>
<td><strong>Design and Construction Issues</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 7. Adequate capacity | a. Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out  
   b. IPR production capacity and/or aquifer losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out |
| 8. Lack of adequate land required for IPR treatment or groundwater replenishment facilities | a. Surface area needed for footprint of IPR treatment or groundwater replenishment facilities is greater than what is available.  
   b. Requires condemnation of property for new injection well facilities |
<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical factors</strong></td>
<td></td>
</tr>
<tr>
<td>1. Seismic hazard</td>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
</tr>
<tr>
<td><strong>Oceanographic Factors</strong></td>
<td></td>
</tr>
<tr>
<td>5. Sea level rise or tsunami hazard</td>
<td>a. Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept</td>
</tr>
<tr>
<td><strong>Presence of Sensitive Habitats</strong></td>
<td></td>
</tr>
<tr>
<td>6. Habitat creation</td>
<td>a. Facility creates habitat that is unsustainable (i.e., requires continued discharge by DPR facility) or adversely affects local ecosystem</td>
</tr>
<tr>
<td><strong>Design and Construction Issues</strong></td>
<td></td>
</tr>
<tr>
<td>7. Adequate capacity</td>
<td>a. Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out</td>
</tr>
<tr>
<td></td>
<td>b. DPR production capacity losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out</td>
</tr>
<tr>
<td>8. Lack of adequate land required for DPR facilities</td>
<td>a. Surface area needed for footprint of DPR treatment facilities is greater than what is available</td>
</tr>
<tr>
<td>Table 3.22 Potable Reuse Alternatives Initial Screening Results</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Potable Reuse Alternative</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Initial Screening Criteria</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Geotechnical Hazards</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1 Seismic Hazard</strong></td>
<td></td>
</tr>
<tr>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
<td>PF</td>
</tr>
<tr>
<td><strong>Hydrogeologic Factors</strong></td>
<td></td>
</tr>
<tr>
<td><strong>2 Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts existing fresh water aquifers, local water supplies or existing water users.</strong></td>
<td></td>
</tr>
<tr>
<td>a. Insufficient travel time (e.g., &lt; 2 months) between groundwater replenishment point and other groundwater users.</td>
<td>PF*</td>
</tr>
<tr>
<td><strong>3 Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.</strong></td>
<td></td>
</tr>
<tr>
<td>a. Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water).</td>
<td>PF*</td>
</tr>
<tr>
<td><strong>4 Insufficient storage space</strong></td>
<td></td>
</tr>
<tr>
<td>a. Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out</td>
<td>PF*</td>
</tr>
<tr>
<td>b. Groundwater replenishment of IPR water causes loss of ability to adequately manage the groundwater basin (e.g., artesian or flooding conditions, loss of stored water, etc.)</td>
<td>PF*</td>
</tr>
<tr>
<td>c. Groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (or 11,400 AFY).</td>
<td>PF*</td>
</tr>
<tr>
<td><strong>Oceanographic Factors</strong></td>
<td></td>
</tr>
<tr>
<td><strong>5 Sea level rise or tsunami hazard</strong></td>
<td></td>
</tr>
<tr>
<td>a. Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept</td>
<td>PF</td>
</tr>
<tr>
<td><strong>Presence of Sensitive Habitats</strong></td>
<td></td>
</tr>
<tr>
<td><strong>6 Habitat creation</strong></td>
<td></td>
</tr>
<tr>
<td>a. Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR or DPR facility) or adversely affects local ecosystem</td>
<td>PF</td>
</tr>
<tr>
<td>Potable Reuse Alternative</td>
<td>Alternative 1A</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Design and Construction Issues</td>
<td></td>
</tr>
<tr>
<td>7 Adequate capacity</td>
<td></td>
</tr>
<tr>
<td>a. Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out</td>
<td>PF*</td>
</tr>
<tr>
<td>b. IPR or DPR production capacity and/or aquifer losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out</td>
<td>PF*</td>
</tr>
<tr>
<td>8 Lack of adequate land required for IPR or DPR treatment facilities or groundwater replenishment facilities</td>
<td></td>
</tr>
<tr>
<td>a. Surface area needed for footprint of IPR or DPR treatment facilities or groundwater replenishment facilities is greater than what is available.</td>
<td>PF</td>
</tr>
<tr>
<td>b. Requires condemnation of property for new injection well facilities.</td>
<td>PF*</td>
</tr>
<tr>
<td>Passes Initial Screening? Yes (Y) or No (N)</td>
<td>N</td>
</tr>
<tr>
<td>Regulations Exist in CA? Yes (Y) or No (N)a</td>
<td>N</td>
</tr>
</tbody>
</table>

Notes:
NF = Not Feasible
PF = Potentially Feasible
PF* = Potentially Feasible, but does not meet current study goals
a. Potentially feasible because alternative does not include an IPR component. Thus, this initial screening criteria is not applicable.
b. Additional study will be required to locate groundwater replenishment wells at locations that will not adversely affect sensitive areas or other users.
c. Do standard regulations exist in the state of California currently to implement the alternative?
d. Although regulations do not exist in California, DDW has stated that they will review DPR projects on a "case by case" basis. Refer to Section 3.2.2 for additional discussion.
Alternative 1A

Information supporting the determination of Alternative 1A to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.23, below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Adequate Capacity</td>
<td>• Refer to Section 3.5 and Table 3.13. This alternative is only able to produce 6,355 AFY of DPR water (compared to the initial screening criteria requirement, 10,000 AFY).&lt;br&gt;• When considering NPR, the total production capacity is only 7,071 AFY (compared to the initial screening criteria requirement, 11,400 AFY).</td>
</tr>
</tbody>
</table>

Notes:
a. Corresponds to initial screening criteria number listed in Table 3.21.<br>b. Definitions of initial screening criteria are present in Tables 3.19 and 3.20.

Alternative 1B

Information supporting the determination of Alternative 1B to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.24, below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Adequate Capacity</td>
<td>• Refer to Section 3.5 and Table 3.14. This alternative is only able to produce 6,928 AFY of DPR water (compared to the initial screening criteria requirement, 11,400 AFY).</td>
</tr>
</tbody>
</table>

Notes:
a. Corresponds to initial screening criteria number listed in Table 3.21.<br>b. Definitions of initial screening criteria are present in Table 3.19 and 3.20.
**Alternative 2A**

Information supporting the determination of Alternative 2A to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.25, below.

<table>
<thead>
<tr>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate Capacity</td>
</tr>
</tbody>
</table>

**Table 3.25 Initial Screening Supporting Information: Alternative 2A**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Adequate Capacity</td>
<td>Refer to Section 3.5 and Table 3.15. This alternative is only able to produce 5,808 AFY of DPR water (compared to the initial screening requirement, 10,000 AFY). When considering NPR, the total production capacity is only 7,208 AFY (compared to the initial screening criteria requirement, 11,400 AFY).</td>
</tr>
</tbody>
</table>

**Notes:**
- Corresponds to initial screening criteria number listed in Table 3.21.
- Definitions of initial screening criteria are present in Table 3.19 and 3.20.

**Alternative 2B**

Information supporting the determination of Alternative 2B to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.26, below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Adequate Capacity</td>
<td>Refer to Section 3.5 and Table 3.16. This alternative is only able to produce 6,928 AFY of DPR water (compared to the initial screening criteria requirement, 11,400 AFY).</td>
</tr>
</tbody>
</table>

**Notes:**
- Corresponds to initial screening criteria number listed in Table 3.21.
- Definitions of initial screening criteria are present in Table 3.19 and 3.20.
**Alternative 3A**

Information supporting the determination of Alternative 3A to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.27, below.

<table>
<thead>
<tr>
<th>Table 3.27 Initial Screening Supporting Information: Alternative 3A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No.</strong></td>
</tr>
</tbody>
</table>
| 4 | Insufficient Storage Space | - As presented in Section 3.3.2 and the full hydrogeological analysis presented in Appendix C, Storage Unit 1 and the Foothill Basin have the storage capacity to accept 8,456 AFY if additional recovery wells are installed and existing production wells are pumped at full capacity (compared to the initial screening criteria requirement, 10,000 AFY).c  
- As presented in Section 3.3.2 and Appendix C, groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (increase of 8,512 AFY).c |
| 8 | Adequate Capacity | - Refer to Section 3.5 and Table 3.17. This alternative is only able to produce 5,808 AFY of IPR water (compared to the initial screening criteria requirement, 10,000 AFY).  
- When considering NPR, the total production capacity is only 7,208 AFY (compared to the initial screening criteria requirement, 11,400 AFY). |

**Notes:**

a. Corresponds to initial screening criteria number listed in Table 3.21.  
b. Definitions of initial screening criteria are present in Table 3.19 and 3.20.  
c. Uses most optimistic values - does not adjust for potential negative effects.

**Alternative 3B**

Information supporting the determination of Alternative 3B to be “not feasible” (NF) or "potentially feasible, doesn’t meet the study goals" (PF*) during initial screening is presented in Table 3.28, below.
Table 3.28  Initial Screening Supporting Information: Alternative 3B

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Discussion</th>
</tr>
</thead>
</table>
| 4  | Insufficient Storage Space         | • As presented in Section 3.3.2 and the full hydrogeological analysis presented in Appendix C, Storage Unit 1 and the Foothill Basin have the storage capacity to accept 8,456 AFY (compared to the initial screening criteria requirement, 10,000 AFY).<sup>c</sup>  
  • As presented in Section 3.3.2 and Appendix C, groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (increase of 8,512 AFY).<sup>c</sup> |
| 8  | Adequate Capacity                  | • Refer to Section 3.5 and Table 3.18. This alternative is only able to produce 6,928 AFY of IPR water (compared to the initial screening criteria requirement, 11,400 AFY).                                                                                                                  |

Notes:

- a. Corresponds to initial screening criteria number listed in Table 3.21.
- b. Definitions of initial screening criteria are present in Table 3.19 and 3.20.
- c. Uses most optimistic values - does not adjust for potential negative effects.

3.7 Conclusions and Recommendations

This section presents the basis of design, conceptual design, and initial screening analysis for each of the potable reuse alternatives considered as part of this study. Combinations of NPR, IPR, and DPR were evaluated. As defined in the Work Plan, only those alternatives that are determined to be technically feasible through initial screening analysis shall be subjected to a further feasibility screening that also considers social, environmental, and economic factors. None of the potable reuse alternatives met the goals of this study and passed initial screening analysis.

During this study, four alternatives, each considering DPR (with and without NPR), passed all initial screening criteria except for one – adequate capacity. Because of the limited availability of effluent from El Estero WWTP, alternatives were unable to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out. In addition, alternatives considering IPR (with and without NPR) were also determined to not have sufficient storage capacity in Storage Unit 1 and the Foothill Basin. Regardless of the amount of effluent available, these groundwater basins do not have the capacity to accept 10,000 AFY, and cannot provide an overall yield of 10,000 AFY.
Several alternatives were discounted from further consideration prior to initial screening, including:

- **Use of AWTF product water for diluting intake water at the Charles E Meyer Desalination Plant.** Dilution was determined to be inadequate to significantly affect the desalination process or change the recovery rate. Too much AWTF product water would be lost to the desalination process brine.

- **IPR Alternative No. 2 to provide a seawater intrusion barrier.** Groundwater modeling indicated that the capacity of the Storage Unit 1 producing zones to accept, store, and transmit recycled water is limited in the coastal portion of the basin. Even with injection of water from 24 wells, the barrier is not effective against seawater intrusion.

- **IPR by surface application** was removed from consideration and is not recommended for future studies due to potential risks associated from liquefaction, slope failure, high groundwater, mobilization/capture of existing contamination, and impacts to sensitive habitats. The benefits of surface recharge (annual average storage of 740 AFY) are considered too low to warrant additional such studies.
  - Potential impacts to sensitive habitats and contaminant mobilization/geologic concerns may occur for alternatives considering IPR by subsurface application; additional studies are recommended if this technology is pursued in the future.

While none of the potable reuse alternatives evaluated passed this initial screening based upon technical feasibility, the information developed and presented in this Section can be used to inform future studies. If the City considers potable reuse as a future supply alternative, various alternatives, such as the ones presented in this study, can be evaluated as part of the Long Term Water Supply Plan update and the information presented in this Section can be used to support this future planning effort.
List of Footnotes

1. Note that Title 22 does not yet recognize IPR by surface augmentation, but it has been proposed by draft guidelines currently under development. However, no such surface water bodies meeting the proposed guidelines for IPR exist within the City. Such guidelines require relatively large reservoirs that provide 100:1 or 10:1 dilution of recycled water and provide 2 to 6 months of residence time (based on reservoir effluent flow). While residence times as low as 2 months may be accepted, additional treatment, monitoring, or other requirements may apply. Surface water bodies not meeting these requirements are considered DPR in this study.

2. Given the nearest surface water body large enough for surface augmentation (e.g. Cachuma) is 23 miles away and would require significant pumping conveyance, this option is not practical compared with other options. Because, groundwater storage is within 1 to 5 miles, IPR has been evaluated for its application in groundwater recharge scenarios only.

3. “Recharge water” means recycled municipal wastewater, or the combination of recycled municipal wastewater and credited diluent water, which is utilized by a (Groundwater Replenishment Reuse Project (GRRP) for groundwater replenishment.

4. Lauro Reservoir has a capacity of up to approximately 550 acre-feet (AF) and is used to equalize flows before treatment at the Cater Water Treatment Plant. The actual storage capacity varies, and because the reservoir has an uncertain storage time and based on its small size, it cannot be considered IPR by surface augmentation.

5. Although not required, Title 22 does allow surface application to be performed using FAT water. This reduces travel time and response retention time requirements.

6. In practice, RO recovery rates for reuse facilities may range from 70 to 85 percent and is dependent upon the source water quality. For the purposes of this study, an 80 percent recovery will be assumed, since this recovery rate is common amongst other recycled water RO systems in California.

7. Maximum available drawdown was based on the range of model calibrated groundwater water levels during the simulation period at each well location provided by USGS.

8. Streamflow data from the USGS gauge on Mission Creek near Mission Street (USGS Gauge No. 11119750) were used to calculate the number of non-storm flow days per month. Flow criterion used was zero cubic feet per second (no flow).


10. In Figure 3.9, solid lines represent USGS model results for selected locations and the dots represent measured water level data from selected wells.

11. As discussed in Section 3.3.1, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).

12. As specified in Article 5.1 of California's Title 22, there are diluent water requirements based on a water's TOC concentration. A minimum dilution requirement of 4:1 (20 percent recycled water, 80 percent diluent water) is applicable when TOC concentrations exceed 0.5 mg/L. This requirement formally constitutes a recycled water contribution (RWC) of 0.2.

13. As discussed above, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).
14. Phreatophytes are plants that depend upon groundwater that lies within reach of their roots for their water supply.

15. Source: California State Water Resources Control Board (SWRCB) GeoTracker database.

16. The Ambassador Supply Well, historically used to supply water for laundry operations at the Mission Industries/Ambassador Laundry site, was properly abandoned at the direction of the RWQCB in 1988. Prior to abandonment, this well may have acted as a conduit for minor amounts of PCE from the SZ to reach the UPZ.

17. Pre-development conditions were determined for 1929 by USGS using the groundwater model.

18. Brine resulting from the IPR RO process is far less concentrated than brine from seawater desalination. Thus, introduction of this brine into the existing outfall will not affect mixing with seawater.

19. Spreading basins will not be used based upon the findings presented in Section 3.3.6.

20. Brine resulting from the DPR RO process is far less concentrated than brine from seawater desalination. Thus, introduction of this brine into the existing outfall will not affect mixing with seawater.

21. It is noted that conceptual designs are based on the treatment capacity required to produce a nameplate capacity equal to the annual average flow rate (7.73 mgd). Redundancy (e.g., n+1) can be incorporated into a future design to make certain that the reliable production capacity is equal to this annual average flow rate. Alternatively, the City can assume a reliable production rate less than the nameplate capacity (i.e., using and operating factor).

22. To be evaluated in future studies.

23. The existing recycled water customers have already experienced costs to design separate irrigation systems for recycled water. If the customer is provided water from the potable system, the cost to retrofit systems on private property to use water from the potable system should be accounted for. It is noted that the City's potable water system may require major improvements to meet former recycled water customer demands.

24. In 1925, an earthquake leveled much of Santa Barbara. Rubble was relocated to the area surrounding the Corporation Yard, Desalination Plant, and El Estero WWTP. Contaminated solids (i.e., primarily trash and hydrocarbons) are expected to be encountered.

25. Alternatively, pipe bursting techniques could be used to replace the existing 12-inch line with the required 16-inch line. Exact methodology should be evaluated in future activity.

26. Conceptual representation also assumes full redundancy in equalization and engineered storage tanks to make certain that facilities would fit on the property available. Future studies may further evaluate tank and reliability (i.e., redundancy) requirements.
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**LIST OF APPENDICES**

Appendix A – Scope of Services for Work Authorization 1 (Version 2)
1.0 INTRODUCTION

The purpose of this document is to present a Work Plan that will be followed to evaluate the feasibility of implementing potable reuse to replace the use of the City of Santa Barbara’s (City) Charles Meyer Desalination Plant (Desal Plant) screened open ocean intake.

1.1 Background

On September 23, 2014 the City of Santa Barbara City Council directed Public Works Department staff to report back on a plan to evaluate the feasibility of subsurface desalination intakes (subsurface intake) and potable reuse, including indirect and direct potable reuse options. The direction given by City Council was to report back with a plan for this evaluation following award of the desalination plant contract in April 2015. Furthermore, on January 30, 2015, the Central Coast Regional Water Quality Control Board (RWQCB) adopted an amendment to the City’s El Estero Wastewater Treatment Plant (WWTP) Waste Discharge Requirements (WDR) that included a condition that the City should report back to the RWQCB by August of 2015 with a Work Plan that will result in completed feasibility studies by June 2017.

The City subsequently retained the services of Carollo Engineers, Inc. (Carollo) to complete these studies. Carollo will deliver the work for these feasibility studies under three work authorizations:

- **Work Authorization 1**: The Work Plans for both the subsurface desalination intake and potable reuse studies. **(Note: The potable reuse Work Plan is the subject of this document)**

- **Work Authorization 2**: Subsurface desalination intake initial screening analysis and potable reuse feasibility study.

- **Work Authorization 3**: Subsurface desalination intake feasibility study.

A programmatic workflow diagram for the potable reuse study (i.e., Work Authorizations 1 and 2) is presented in Figure 1. A copy of the fully executed scope of work for Work Authorization 1 is presented in Appendix A.
Notes:
1. It is envisioned that the technical advisory process includes a public meeting where stakeholders will be given a chance to state their interests in the City’s study effort and comment upon the direction of the City’s work product.
1.2 Objectives

The City is required to submit a Work Plan for evaluating potable reuse alternatives to the RWQCB by August 2015. The overall objective of this Work Plan is to present the methodology and procedures that will be used to perform the potable reuse feasibility study. Objectives of this Work Plan include:

1. Establish the project schedule.
2. Establish the methods by which the design basis will be established. Design basis includes production capacity and site alternative evaluation.
3. Establish the types of potable reuse alternatives that will be studied.
4. Establish procedure to identify sites for treatment, storage, and distribution facilities to evaluate when considering both direct potable reuse (DPR) and indirect potable reuse (IPR) alternatives.
5. Establish the scope of cost estimates and cost estimating procedures.
6. Establish and define feasibility screening criteria.
7. Establish and define initial screening criteria that may limit further consideration of project sites and potable reuse alternatives.
8. Establish technical advisory panel role, procedures, and objectives.
9. Establish the role of outside agencies (e.g., RWQCB, California Coastal Commission, etc.) and City residents.

1.3 Scope

The City Council meeting minutes from September 23, 2014, Agenda Item 16: Authorize Actions and Adopt a Resolution for Reactivating the Charles E. Meyer Desalination Facility, state that there was an additional motion “to direct staff to return to the City Council after the [Desalination Plant Reactivation] contract decision is made in April [2015] to begin exploring a range of alternatives, including subsurface intake and potable reuse options.”

To determine City Council’s intent as to the scope of this study, the verbal transcript of the meeting was examined. In review of this transcript, the verbal intent was to “direct staff…[to evaluate the] feasibility, cost, and timeline associated with both converting the offshore facility to a subsurface intake and look at the options about potable reuse”.1

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1 Mayor Schneider, as documented on September 23, 2014 City Council Meeting video recording (available on the City’s website): http://media-07.granicus.com:443/OnDemand/santabarbara/santabarbara_d2343df5-8a20-499d-b1fb-5dda1f9e0414.mp4 at 2 hours and 33 minutes.
This motion was further adopted by the Central Coast RWQCB, who on January 30, 2015 amended the City’s NPDES Permit (AMENDED ORDER NO. R3-2010-0011, NPDES NO. CA0048143) and in Section VI Paragraph C.6.c.iii (Special Provisions, Desalination Facility) adopted a provision to require the City to “Analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options”.

Therefore, the direction given by both the City Council and RWQCB, relative to the scope of this study was to evaluate the feasibility of:

1. A replacement of the City’s open ocean intake using a subsurface intake.
2. Potable reuse alternatives, also in the context of a replacement of desalination plant’s open ocean intake use.

1.4 Work Plan Organization and Sequence of Work

This Work Plan focuses only on the City’s potable reuse feasibility study and is organized into the following sections:

- Introduction
- Basis of Design
- Feasibility and Initial Screening Criteria
- Implementation Schedule Development
- Cost Estimating Methodology
- Feasibility Analysis
- Technical Advisory Process

The City’s subsurface desalination intake feasibility study is addressed as separate Work Plan.

The programmatic workflow diagram presented in Figure 1 shows the chronology that project work product will be developed and reviewed for each of the potable reuse feasibility studies work authorizations. As noted in Figure 1, only potentially feasible alternatives will be evaluated in as part of subsequent tasks. Initial screening will be performed and if enough data is available to determine that the alternative does not pass initial screening, no further feasibility analysis will be performed for that potable reuse alternative.

A complete project schedule including the anticipated dates of all project milestones and deliverables is presented in Figure 2.
### Subsurface Desalination Intake & Potable Reuse Feasibility Studies

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### Project Schedule

![Figure 2 - Project Schedule](image link)
1.5 Goal of Study

The goal of this study is to meet the requirements set forth by City Council and the RWQCB that were described in Section 1.3. However, this study may also inform future studies including future updates to the City’s Long Term Water Supply Plan. The City’s primary water source is Cachuma Reservoir, which provides over 50 percent of the City’s water supply during a normal (non-drought) year. The City’s water supply allocation from Cachuma could be reduced in the future due to pending federal environmental decisions on a revised Biological Opinion for the Cachuma Project, reduced operational yield due to siltation in the reservoir, and reduced drought yield as a result of the current historic drought. The City’s supply planning will need to be updated to address shortages caused by such reductions to the City’s existing Cachuma supply. Options for replacing a reduced Cachuma supply may include desalination and potable reuse.

Because the amount of the reduction from the City’s Cachuma supply is unknown at this time, it is premature for the City to evaluate exact desalination and potable reuse capacity options that may or may not meet the City’s needs. The timing for this analysis would be more appropriate following the final federal environmental decisions and operational yield analyses that determine the future Cachuma allocations. Therefore, the direction given by City Council and the RWQCB (as presented in Section 1.3) is appropriate at this time because it will determine the maximum capacity that is technically feasible from subsurface intakes and potable reuse without requiring the City to invest in developing many project concepts that may or may not meet the City’s future needs pending forthcoming environmental and operational yield decisions.

Thus, the goal of this study is to understand the maximum yield that is technically feasible for subsurface intake alternatives (subject of this Work Plan) and potable reuse alternatives (subject of a separate Work Plan). The maximum yield will provide information on whether the alternatives could replace the open ocean intake independently, and potentially combined. How the City will use of these technically feasible maximum yields needs to be informed by the City’s need, which will follow at a later date. Therefore, the information developed in this study will inform future studies, such as an update to the City’s Long Term Water Supply Plan.

Feasibility and initial screening criteria are presented in Section 3 of this Work Plan. Alternatives are first subjected to initial screening criteria, which are based on technical feasibility criteria and capacities defined under current project objectives. It is anticipated that alternatives may end up in the following three general categories, defined further as follows:

1. **Infeasible** – The alternative does not pass the initial screening criteria and is fatally flawed due to technical criteria.

   **Action:** The alternative shall not be considered further in this study and is not recommended for inclusion in future studies.
2. Potentially feasible, does not meet Study goals – The alternative meets technical screening criteria and is potentially feasible. However, the alternative’s capacity does not meet the current Study goals.

Action: The alternative shall not be considered further in this study but is potentially feasible and may be considered in future studies. Information collected during the screening process is useful to inform future studies.

3. Potentially feasible – The alternative passes through the initial screening stage and is considered potentially feasible.

Action: The alternative shall be considered further in this study under current objectives and is subject to the work sequence laid out in the Work Plan.

2.0 BASIS OF DESIGN

To focus the efforts of this study on only those options that are at least potentially feasible, it is important to establish a clear definition of the basis of design for the potable reuse alternatives. The basis of design will vary based upon the type of potable reuse alternative considered (i.e., indirect potable reuse (IPR) or direct potable reuse (DPR)). Production capacity, project site alternatives, potable reuse alternatives, and water quality and treatment needs determine the basis of design for potable reuse alternatives.

As noted previously in the programmatic work flow diagram presented in Figure 1, the basis of design will be established in Work Authorization 2. Once the design basis is established, initial screening criteria can be assessed based upon available information. Where sufficient information is not available, an alternative will be determined "potentially feasible" and the study will recommend the collection of additional data. By screening alternatives in this manner, only potentially feasible alternatives are considered for the feasibility analysis. Therefore, the definitions for basis of design criteria presented in the subsequent subsections of this Work Plan are intended to guide the project’s work effort and the initial screening analysis that will be conducted in Work Authorization 2.

2.1 Production Capacity

The goal of this study is to understand the maximum yield that is technically feasible for subsurface desalination intake alternatives and potable reuse alternatives, and to evaluate the feasibility of alternatives to replace the City’s existing screened open ocean intake. Thus, each alternative will go through technical evaluation to determine the maximum yield achievable. The target yield for each alternative will be based on the City’s permitted capacity for screened open ocean intake, which is 10,000 acre-feet per year (AFY) of finished water supply from the Desal Plant. It should be noted that the City produces 1,400 AFY of non-potable recycled water and a potable reuse alternative cannot impact the City’s ability to produce non-potable water. Therefore, the combined potable and non-potable
reuse alternative production capacity must be capable of up to 11,400 AFY to be considered as a replacement for the City's desalination plant screened open ocean intake.

The capacity of wastewater available from the City's El Estero WWTP will be characterized based upon historical data, taking into account drought year and diurnal flows so that the basis of design can be determined. The following flows will be characterized for the design basis:

- Average, minimum and maximum annual flow
- Average, minimum and maximum day flow
- Minimum and maximum hour flows

No additional wastewater flows (i.e., regional flows from other agencies) will be included in the capacity determination.

The capacity of each reuse alternative (i.e., potable and non-potable treatment plant capacity) will be based upon the following:

1. Average day flows with storage used to buffer the changes in diurnal flow rates (i.e., minimum and maximum hour flows). Sizing the plant on an average day flow condition makes certain that the facility's equipment is well utilized and not oversized.
2. Full treatment by reverse osmosis (RO) for the potable reuse stream at a recovery rate of 80 percent.\(^2\)
3. Recycle of backwash water from microfiltration and other non-potable reuse treatment filter systems (to the head of the El Estero WWTP) to optimize recovery and reuse of these flow streams.

Storage concepts to equalize tertiary and advanced treated potable reuse water flows will be developed based upon the diurnal and average day flow available.

2.2 Project Site and Potable Reuse Alternatives

During the study, up to 20 site/process/routing/size alternatives may be considered for further analysis against the feasibility screening criteria identified. Project descriptions will be developed for each direct or indirect potable reuse alternative and include:

- Project sites
- Physical description of the intake system and required infrastructure/facilities.
- Potential yield and water quality produced.
- History of use (i.e., California, U.S. and global).

\(^2\) In practice, RO recovery rates for reuse facilities may range from 70 to 85 percent and is dependent upon the source water quality. For the purposes of this study, an 80 percent recovery will be assumed since this recovery rate is common amongst other recycled water RO systems in California.
• Regulatory requirements affecting design, construction and operation.
• Construction equipment, resources, and procedures to assist in the subsequent evaluation of constructability and construction impacts.
• Reliability
• Maintenance requirements.

Possible treatment facility location options may include (but may not be limited to):

• 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006), and
• 103 S. Calle Cesar Chavez (APN #017-113-020)
• Repurposing the Charles Meyer Desalination Plant located at 525 E. Yanonali Street

Possible groundwater replenishment (a.k.a., recharge) locations for IPR may include (but may not be limited to):

• Injection wells (i.e., subsurface application) in the Foothill basin (near Route 154 and Highway 101)
• Injection wells (i.e., subsurface application) in groundwater basin referred to as “Storage Unit 1” (north of Highway 101)
• Surface application of water (i.e., a spreading basin) in Mission Creek from just above Rocky Nook Park to Oak Park, to recharge Storage Unit 1
• Surface application of water (i.e., a spreading basin) in or near the Foothill basin

Given the number of injection wells (i.e., for subsurface application) or spreading basins (i.e., for surface application) that are required to meet the 10,000 AFY (or 11,400 AFY) production requirement, project site alternatives will be generated based on existing city infrastructure, proximity to existing City wells, and proximity to City owned or patrolled land. It is possible that additional production wells may be required to fully recover the water stored. Identification of any new groundwater production well sites will follow a similar process as for locating groundwater replenishment wells.

Possible direct potable reuse options may include (but may not be limited to):

• Discharge of advanced treated wastewater into Lauro Canyon Reservoir (a.k.a., raw water production).
• Dilution and off-setting the intake volume of seawater flowing to the Charles Meyer Desalination Plant.

Figure 3 presents the locations of the City’s existing wells, groundwater basins, and water treatment facilities.
Figure 3 - Potential Areas for Surface and Subsurface IPR Recharge

Figure will be updated with USGS data showing potential IPR surface and recharge locations.
2.3 Water Quality and Treatment Needs

Water quality requirements and treatment needs for IPR alternatives will be dictated by California Code of Regulations, Title 22. Article 5.1 presents IPR regulations for groundwater replenishment by surface application (e.g., spreading basins). Article 5.2 presents IPR regulations for groundwater replenishment by subsurface application (e.g., injection wells). All IPR alternatives shall comply with the regulations set for in Title 22 by providing adequate treatment and producing water meeting requirements:

- Title 22, Article 5.1 - Groundwater Replenishment - Surface Application: requires advanced treatment (as defined by Title 22, §60301.320 and §60301.230).
- Title 22, Article 5.2 - Groundwater Replenishment - Subsurface Application: requires Full Advanced Treatment (FAT), as presented in Figure 4.

![Figure 4 Typical Full Advanced Treatment Schematic](image)

Conversely, the state of California does not have regulations for DPR. However, this does not mean that DPR cannot be implemented in California. In September 2010, the Governor of the State of California signed into law Senate Bill 918 which mandated the State Water Resources Control Board, Division of Drinking Water (DDW) to investigate the feasibility of developing regulatory criteria for DPR and to provide a final report on that investigation to the legislature by the end of 2016. DDW has held a series of workshops on this topic, and has also worked with a number of agencies, including the City of San Diego to review DPR projects on a case by case basis. DDW has indicated through these meetings and project reviews that in addition to the IPR requirements stated in Title 22, Article 5.1 and 5.2 (as amended in June 2014), DPR projects will likely be required to incorporate the following features:
Treatment for pathogenic microorganisms may likely be required in excess of the treatment required by Title 22 Article 5.1 and 5.2 (i.e., 12 log enteric virus reduction, 10 log Giardia reduction and 10 log Cryptosporidium reduction (12/10/10) using at least 3 treatment processes, each being credited with no less than 1.0-log reduction may likely be required). Recent statements made by the DDW staff charged with implementing DPR regulations, have indicated 14/12/12-log reduction of virus/Giardia/Cryptosporidium may be required.

Engineered storage – so that advanced treated wastewater can be held (i.e., not distributed) until the results of various water quality parameters can be tested to establish the water is safe.

For the purpose of this study, the basis of design for treatment and finished water quality goals for DPR will be based upon the most recent regulatory activity and comparable precedent activity in California.

2.4 Subsurface Properties

This section presents Work Plan elements associated with establishing a basis of design for subsurface properties for groundwater replenishment applications. This design basis will be established by reviewing available literature and publications that describe subsurface properties and characteristics in the vicinity of the target surface and subsurface groundwater replenishment locations and of the basin in general to assess potential recharge rates and basin wide responses to recharge. It is possible that additional subsurface data collection may also be required to establish feasibility.

Locations and methods of groundwater replenishment being considered for indirect potable reuse (IPR) recycled water storage include the following:

1. Injection into primary water producing zones at unspecified locations in Storage Unit 1 and Foothill Basins (i.e., subsurface application).
   a. Injection into the Foothill Basin near Route 154 and Highway 101.

2. Surface application to an area that replenishes the unconfined portion of Storage Unit 1 along Mission Creek between Rocky Nook Park and Oak Park, and potentially along creeks in upper portions of Foothill Basin.

3. Surface application to an area that replenishes the Foothill Basin

4. Injection into a series of wells completed in primary water producing zones along the coast area to provide for a saltwater intrusion barrier. **Note:** as with all groundwater replenishment (IPR) alternatives, this alternative will still need to provide a net yield of 10,000 to 11,400 AFY of potable water based upon the production capacity established in Section 2.1. The maximum yield that is achievable will go through evaluation of technical feasibility, however, even if it less than 10,000 AFY.
The subsections below describe the information and methods that will be used to collect and establish these hydrogeologic conditions that are necessary for developing a basis of design for groundwater replenishment facilities.

2.4.1 Literature Review

Available literature describing geologic and hydrogeological properties of the City of Santa Barbara groundwater basin will be reviewed. Sources of information include, but may not be limited to:

- Published geologic/hydrogeologic studies in the area, including:
  - USGS reports
  - Prior hydrologic and geotechnical studies conducted by the City.
- Hydrologic data and studies on existing wells and the groundwater aquifer used for drinking water production, including various USGS hydrogeological and modelling studies.
- City of Santa Barbara production well construction reports and aquifer test reports.
- City of Santa Barbara Public Works Department. Groundwater Level Data Collection files provided by Kelley Dyer on June 8, 2015.
2.4.2 Additional Data Collection

It is anticipated that there will be a number of uncertainties regarding subsurface conditions and associated data gaps will arise during this evaluation. In some cases, it may be appropriate to make conservative assumptions or translate subsurface information from other similar locations when conducting the feasibility analysis. In other cases, it may not be possible to make assumptions and, in such cases, a range of focused field data collection activities may be suggested to improve the understanding of site conditions and groundwater replenishment feasibility. Because the nature and significance of the data gaps is not yet known, it is not possible to develop a specific Work Plan for data collection at this time. For this reason, this Work Plan outlines several potential data collection activities that may be conducted, depending on the type of recharge facility being evaluated (surface versus subsurface application). These activities fall into the following general categories that may include (least invasive and least costly listed first):

1. Aquifer tests performed at existing well locations to develop improved estimates of hydraulic conductivity.
2. Geophysical survey conducted in areas near planned recharge sites to aid in defining stratigraphy, target zones, and depth to bedrock.
3. Infiltration rate testing using double ring infiltrometers or other suitable methods in areas that may be suitable for surface application.
4. Installation of piezometers to define subsurface stratigraphy, presence of confining layers that could limit infiltration, and groundwater levels in specific areas. Geophysics may also be considered.

5. Installation of one or more test wells and observation wells and performance of aquifer tests and injection tests to measure aquifer productivity, injection capacity, hydraulic conductivity, and water quality.

If available information is not sufficient to satisfactorily resolve data gaps, it is anticipated that a more specific data collection program may be developed for specific locations and specific groundwater replenishment (IPR) alternatives, once the initial feasibility study work is completed. This data collection Work Plan will be prepared for review prior to implementation of such a possible data collection program.

2.5 Analysis of Groundwater Replenishment (IPR) Alternatives

This section presents the methodology that will be used to evaluate groundwater replenishment and storage IPR alternatives in terms of various hydrogeologic feasibility screening criteria. The following hydrogeologic feasibility screening criteria are included in the analysis:

- Rate of groundwater replenishment using recycled wastewater at target locations is sufficient to collectively accept, store and produce up to 10,000 AFY (or 11,400 AFY) of treated recycled water.
- Adequate storage in production zone aquifers is available in the basin under wet and drought conditions.
- Existing basin yield and existing well yield increases as a result of groundwater replenishment.
- Impact on freshwater aquifers, local water supplies, other wells, and existing water users.
- Impact to sensitive habitats such as marshlands, drainage areas, etc.
- Potential to capture or mobilize known groundwater contamination.
- Amount of "diluent water" (i.e., water source other than recycled wastewater) allowed based upon recycled water quality, degree of treatment provided and application (i.e., surface or subsurface application) pursuant to the requirements of Title 22, Article 5.1 §60320.114 and Article 5.2 §60320.214.

Methodologies for conducting the technical analyses are described below.
2.5.1 Methodology for Evaluating Rate of Groundwater Replenishment at Target Locations

The ability of IPR groundwater replenishment facilities to collectively accept, store, and ultimately produce up to 10,000 AFY (or 11,400 AFY) is an important feasibility consideration. Surface application would be considered in locations where the water producing aquifers are unconfined and there is adequate space to construct surface application (i.e., spreading) basins (e.g., along Mission Creek between Rocky Nook Park and Oak Park). For locations where target water producing zones are deeper and confined by low permeability layers (e.g., Storage Unit 1 and Foothill Basins) or where there is insufficient space for surface application basins, subsurface application (i.e., injection wells) would be considered. The rate of recharge that can be achieved at either surface application sites or injection well sites is primarily a function of:

- **Surface application sites**: surface infiltration rates, location of low permeability layers, and depth to groundwater
- **Injection well sites**: aquifer transmissivity, injection well design, depth to water, presence of flow limiting barriers

For surface application sites, available literature would be reviewed including stream seepage studies, well logs, and geological reports. This information will be used to develop estimates of infiltration rates, identify whether low permeability layers would impede recharge, and identify whether shallow groundwater and subsequent mounding during recharge would limit recharge rates. Based on the range of estimated infiltration rates, the amount of IPR water that can be infiltrated between Rocky Nook Park and Oak Park (and other applicable surface infiltration sites) will be estimated.

For injection sites, available information would be reviewed including City production well logs and well construction details, well production and specific capacity data, aquifer test data, water level data, water quality data, and basin groundwater reports. This information will be reviewed to estimate potential injection rates that might be attainable and whether there are geologic boundaries that would limit injection and storage of IPR water. The estimated injection rate will be assumed to be between 50 to 75 percent of the average pumping rate at the nearest City production wells. An estimated rate will be determined once more site specific data is available. It will be important to avoid substantially increasing the pressure head in the aquifer above ground surface in order to avoid compromising well seals, losing stored water into overlying aquifers, or artesian flow at uncapped wells. Should this be likely at some locations, it may be necessary to reduce the estimated injection rate or identify periods of time when higher rates are achievable as groundwater levels decline as a result of drought pumping.
2.5.2 Methodology for Evaluating Available Storage in Production Zone Aquifers

During non-drought periods, the City’s primary water supplies are Gibraltar and Cachuma reservoirs, which are supplied by local runoff. The City uses limited amounts of State Water Project water and groundwater supply in normal years; as these sources are reserved for drought periods when local surface water is limited. This project will review available groundwater level data for the Santa Barbara Basin, which upon preliminary review indicates that during these non-drought periods, the groundwater basin is relatively “full” and in some locations, artesian conditions exist where groundwater levels are above ground surface. When this occurs, there is likely to be limited storage space in the aquifer to store recycled water. When local supplies from Gibraltar and Cachuma reservoirs are limited (e.g., during times of drought), the City uses its wells to augment supply. It is during these periods that storage space is created and groundwater replenishment using an IPR supply can be an effective means of improving the reliability of the City’s groundwater supply. Because of the variable nature of the available storage space, it will be necessary to assess how much recycled water can be recharged and when.

A numerical model can be used to address questions posed in this section of the Work Plan. For many years, the City has been working with the USGS on developing a numerical groundwater flow model for the Santa Barbara Basin as part of its Long Term Water Supply Program, adopted in 1994. The model is based on MODFLOW-2000 with the addition of SEAWAT-2000 to model salt water intrusion. USGS staff working on the model have indicated that the model is appropriate for evaluating changes in available groundwater storage in the basin as a result of surface or subsurface application activities. The updated model report is undergoing technical review at the USGS and will not be published until early 2016. However, USGS staff have indicated that the model is completed and calibrated and they are willing to use the model and to generate preliminary results on an informal basis until the model update is published.

The amount and timing of available storage will be assessed by establishing historical wet and dry climactic aquifer conditions that result from varying groundwater well usage. The model will be calibrated based upon this historic data. The resulting change in predicted groundwater levels will be used to compute the hypothetical maximum volume of storage available at any given time under varying climactic and pumping conditions. The operational volume of storage available for recharge will be less because recharge basins and injection well locations will not likely be optimized to take advantage of all of this storage. In order to estimate the operational volume of storage that can be available, recharge wells and injection wells will be placed in the model at target locations. A schedule for injection and recharge will be created that attempts to optimize the amount of recycled water that can be recharged given its availability and maintaining groundwater level elevations below ground surface as constraints. This will be an iterative exercise that will allow simulation of the amount of recycled water that can be stored under various climactic and pumping conditions.
2.5.3 Methodology for Evaluating Existing Basin and Well Yield Increases

The potential increase in basin yield and City well production resulting from groundwater replenishment using an IPR supply will be assessed using the USGS groundwater model and analytical methods. It is assumed that previous groundwater modeling performed by the USGS established sustainable yield values for the basin. Groundwater replenishment scenarios described in Section 2.5.2 will be used to estimate the amount of increase in basin sustainable yield compared to the baseline condition.

Groundwater levels should increase as a result of recycled water recharge activities. While this increase will not be uniform over the basin, the increase in static water levels will result in an increase in well production in some wells over what it would have been without IPR related groundwater replenishment. This occurs because the well pumps will have less lift and pumping rates should also increase in accordance with individual pump curves. In some cases, individual well yields may increase because the saturated thickness of the aquifer has increased or the wells have become more efficient. Pumping curves for existing City production wells will be reviewed to estimate the amount of increased production resulting from predicted water level increases. In addition, City well production data and water level data will be reviewed to estimate a range of specific capacity values. Static water levels should increase at some locations and the amount of available drawdown (distance between the static water level and pumping water level in the well) should increase as a result of groundwater replenishment operations. For well locations that are predicted by the groundwater model to have an increase in static water level, the specific capacity at that well will be used in conjunction with the model computed increase in available drawdown (if there is an increase) to estimate a theoretical increase in well yield that could be achieved with groundwater replenishment using an IPR source.

2.5.4 Methodology for Evaluating Impacts to Local Groundwater Supplies and Existing Water Users

Title 22 of the California Code of regulations requires that there be adequate residence time of the IPR source water in an aquifer prior to any IPR water reaching the nearest well. The allowable residence time must be no less than 2 months, but may range from 2 to 6 months depending on the advanced treatment technology being used, the actual water quality benefits of aquifer storage determined during pilot testing, and the accuracy of the method used to estimate residence time. Residence time is a function of the travel time between the recharge site and the nearest well. The following steps describe the approach that will be used to assess the residence time of IPR related groundwater replenishment water in the aquifer:

- Obtain well records for water production wells (domestic or irrigation) from the State Department of Water Resources and plot the locations on a map.

---

3 Specific capacity is a term referring to the amount of flow in gallons per minute (gpm) per foot of drawdown in the well.
Use the USGS groundwater flow model to simulate recycled water recharge as described in Section 2.5.2 and use particle tracking to estimate the time required for recharge water to reach the nearest wells (including City wells) under a range of static and pumping conditions.

Identify recycled water recharge locations, recharge scenarios, pumping scenarios, and climactic conditions that are unlikely to provide adequate residence time in the aquifer.

Consideration is being given to injection of recycled water into the City’s primary water producing zones to form a seawater intrusion barrier south of the City near the coast. This concept is intended to not only reduce the potential for salt water intrusion during periods of increased pumping in the basin, but it also provide additional water to the basin because a significant fraction of the injected water would flow land-ward toward City production wells. Historical groundwater data indicates that some salt water intrusion occurred during the last drought, and USGS modeling studies indicate some level of seawater intrusion is expected depending on the amount of water pumped from the basin.

Potential benefits and limitations of this concept will be evaluated using the USGS groundwater model. The model will be used to estimate the amount of recycled water that can be injected and the number of wells required to provide an effective hydraulic barrier to seawater intrusion under various basin pumping scenarios. The model will also be used to estimate the amount of increase in basin storage, benefit to existing City production wells, and also any loss of IPR water due to seaward flow of the injected water that will not be subsequently captured by the City's production wells.

### 2.5.5 Methodology for Evaluating Impacts to Sensitive Habitats

Potential impacts to sensitive habitats resulting from IPR activities are most likely going to occur at surface application locations because injection into deeper confined aquifers will not result in recycled water reaching sensitive habitats. Potential impacts to sensitive habitats from IPR surface application activities may include:

- Increased groundwater levels near the recharge site where there is vegetation that is sensitive to saturated conditions (e.g., Oak trees).
- Increased surface water flow and increased groundwater levels that contribute to establishment of riparian or wetland vegetation that must be preserved as habitat and enhancement of nuisance plant species.
- Changes in water quality (including increased temperature) in existing stream and riparian areas.

Potential groundwater level increases near potential surface application facilities will be estimated using the USGS groundwater model. Potential increases in the length of flowing streams will be estimated based on estimated infiltration rates and anticipated IPR flow.
rates. Using this information, the above potential impacts on sensitive habitats will be described and assessed.

2.5.6 Methodology for Evaluating Potential Capture or Mobilization of Known Groundwater Contamination

The uppermost shallow zone that underlies the City is 100-200 feet thick and extends toward and beneath the shoreline. Groundwater quality in this shallow zone has been impacted by a number of sources of contamination, which are regulated by the Regional Water Quality Control Board. It is possible that surface or subsurface application activities could mobilize or affect the movement of contaminants in the subsurface. Steps that will be taken to evaluate the potential for this to occur include the following:

- Prepare a contaminant source inventory for the area within 1 mile of each potential groundwater replenishment site.
- Identify known and documented sources of groundwater contamination that have the potential, due to proximity and mobility characteristics, to be affected by recycled water recharge activities (shallow zone or deeper producing zones).
- Utilize the results from the numerical modeling assessment performed in Section 2.5.4 to assess whether water level increases from IPR related groundwater replenishment operations will likely cause mobilization of contaminants in the unsaturated zone, movement of known sources of contamination, or impacts to existing City production wells. Some modifications to the model may be needed to simulate water levels in the shallow zone.
- In relative terms, describe the relative risk (high, medium, or low) of capturing or mobilizing known sources of contamination.

2.6 Additional Production Wells

The injection of water into the storage basins for IPR alternatives (subsurface application) considered in the study should increase yield from each of the City’s production wells. However, it is unlikely that the existing production wells will be able to supply an additional 10,000 AFY to meet production goals. Therefore, additional production wells will be necessary and constructed/operated separately from subsurface application (i.e., injection) wells with adequate travel time to meet regulatory requirements. The expected capacity of existing wells will be estimated using methodology in Section 2.5. Following this analysis, the number of additional wells that are necessary to meet project goals will be calculated by the following equation:

\[
\text{Number of Production Wells} = \frac{\text{Production goal} - \sum (\text{existing well yield increase})}{\text{Estimated Yield Per New Production Well}}
\]

The estimated yield per production well will be determined using a similar methodology presented in Section 2.5. Furthermore, each IPR alternative's total implementation cost will
include costs associated with additional production wells required to meet the water supply capacity goal.

### 2.7 Project Life

A 20 year project life will be assumed for a potable reuse alternative. This is also the time that is assumed to be required for repayment of any loan used to finance a potable reuse project.

### 2.8 Reliability Features

Reliability with respect to maintaining the required production capacity and water quality will also be addressed as the conceptual design is developed. Based upon the potable reuse alternative (e.g., surface spreading, groundwater injection, DPR, etc.), current state of regulations, source water quality, hydrogeology, the use of literature data, and other factors, a safety factor will be substantiated and established as a basis of design requirement used to determine the redundancy needed to address downtime for maintenance and repairs, as well as a possible decrease in groundwater replenishment capacity (i.e., for IPR alternatives).

### 3.0 FEASIBILITY CRITERIA AND INITIAL SCREENING

As presented in Figure 1 and in Section 2, after the design basis is developed, initial screening criteria (i.e., based upon technical criteria) are considered. However, before the initial screening analysis can proceed, it is necessary to first identify feasibility criteria that can be used to analyze the potable reuse alternatives.

For this project, "feasibility" will be defined by industry standard procedures for projects in California, as documented in the 2012 California Environmental Quality Act (CEQA) Statute and Guidelines. The act provides the following definition:

"Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors."

For the purposes of this study, the factors that affect feasibility of potable reuse alternatives have been identified by the four main components of the CEQA definition of "feasible" as presented in Table 3.1: i.e., economic, environmental, social, and technological factors. Expanded definitions for each of the potable reuse feasibility screening criteria presented in Table 3.1 are presented in following subsections.
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<th>Table 3.1 Feasibility Criteria</th>
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<td>Feasibility Criteria</td>
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<td>Geotechnical Factors</td>
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<tr>
<td>1 Geochemistry</td>
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<tr>
<td>a. Risk of adverse geochemical interactions due to fluid mixing</td>
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<tr>
<td>b. Risk of well clogging</td>
</tr>
<tr>
<td>c. Risk of changes to inorganic water chemistry</td>
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<tr>
<td>2 Seismic hazards</td>
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<tr>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
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<tr>
<td>Hydrogeologic Factors</td>
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<tr>
<td>3 Impact on freshwater aquifers, local water supplies and existing water users</td>
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<tr>
<td>4 Impact to sensitive habitats such as marshlands, drainage areas, etc.</td>
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<tr>
<td>5 Potential yield per injection well or spreading basin installation (e.g., effects on existing basin yield and existing well yield as a result of groundwater replenishment from an IPR source)</td>
</tr>
<tr>
<td>6 Capacity of groundwater basin to receive recharge water (e.g., adequate storage in production zone aquifers is available in the basin under normal and drought conditions, rate of recycled water recharge at target location is sufficient to receive 10,000 to 11,400 AFY of treated recycled water)</td>
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<td>7 Proximity to sources of underground water contamination (i.e., will mobilize or capture contamination)</td>
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<tr>
<td>Oceanographic Factors</td>
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<tr>
<td>8 Sensitivity to sea level rise (bathymetry)</td>
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<td>9 Sensitivity to tsunami inundation</td>
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<tr>
<td>Presence of Sensitive Habitats</td>
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<tr>
<td>10 Proximity to on-shore habitats such as marshlands, or environmental sensitive habitat areas (ESHAs)</td>
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<tr>
<td>11 Prospect of habitat creation (e.g., creating new flows in creeks or drainage areas)</td>
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<tr>
<td>Energy Use</td>
</tr>
<tr>
<td>12 Project requires more or less energy than other alternatives, accounting for any possible reduction in treatment requirements.</td>
</tr>
<tr>
<td>13 Project energy use exceeds City's Greenhouse Gas Emission Threshold as identified in the City's 2012 Climate Action Plan</td>
</tr>
<tr>
<td>Design and Construction Issues</td>
</tr>
<tr>
<td>14 Availability of effluent needed and/or potable reuse application actually produces 10,000 AFY of water supply needed to offset desalination plant production; or 11,400 AFY to offset desalination plant production and non-potable reuse.</td>
</tr>
<tr>
<td>15 Complexity of residuals disposal (e.g., are modifications required to the City's ocean outfall?)</td>
</tr>
<tr>
<td>16 Proximity to existing infrastructure (e.g., existing reclaimed water pipeline, railroad crossing, etc.)</td>
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</tbody>
</table>
Table 3.1  Feasibility Criteria

<table>
<thead>
<tr>
<th>Feasibility Criteria</th>
<th>CEQA Feasibility Criteria</th>
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<tbody>
<tr>
<td></td>
<td>Technological Factors</td>
</tr>
<tr>
<td>17  Footprint for permanent facilities (e.g., treatment and storage facilities, spreading basins, injection well sites, etc.)</td>
<td>x</td>
</tr>
<tr>
<td>18  Footprint for construction activities</td>
<td>x</td>
</tr>
<tr>
<td>19  Complexity of construction activities</td>
<td>x</td>
</tr>
<tr>
<td>20  Scope and complexity of property, easement, or right of way acquisitions (e.g., property condemnation, rail road crossing, etc.)</td>
<td>x</td>
</tr>
<tr>
<td>21  Complexity of providing treatment process and/or storage time requirements needed to meet required treatment <em>Giardia</em>, <em>Cryptosporidium</em> and <em>Virus</em> (e.g., travel time in groundwater aquifer, engineered storage, and/or treatment process equipment).</td>
<td>x</td>
</tr>
<tr>
<td>22  Reliability and performance</td>
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<tr>
<td>a. Precedent (i.e., Has DDW granted permits for other similar potable reuse applications?; Has the potable reuse application been implemented or tested in a similar setting?)</td>
<td>x</td>
</tr>
<tr>
<td>b. Performance risk (i.e., stable yield and quality of potable reuse facilities over project life)</td>
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<tr>
<td>c. Maintainability (i.e., can yield or quality be restored by standard means that won’t significantly impact the facility operation or availability)</td>
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<tr>
<td>23  Sustainability (e.g., labor, chemicals, mechanical equipment use to sustain performance)</td>
<td></td>
</tr>
<tr>
<td>a. Frequency of maintenance</td>
<td>x</td>
</tr>
<tr>
<td>b. Complexity of maintenance</td>
<td>x</td>
</tr>
<tr>
<td>24  Impact to recreational uses of land</td>
<td>x</td>
</tr>
<tr>
<td>25  Impact to commercial uses of land</td>
<td></td>
</tr>
<tr>
<td>26  Conflict with Basin Plan</td>
<td>x</td>
</tr>
<tr>
<td>27  Certainty of implementation schedule and costs (i.e., as affected by affected by permitting, demonstration or pilot testing, environmental requirements, monitoring, etc.)</td>
<td>x</td>
</tr>
<tr>
<td>28  Cost impacts to water rate payers</td>
<td>x</td>
</tr>
<tr>
<td>29  Impact of project construction schedule on recreational and commercial use as it relates to the local economy</td>
<td>x</td>
</tr>
</tbody>
</table>
**Geotechnical Factors**

1. **Geochemistry**
   a. Risk of adverse geochemical interactions due to fluid mixing: The risks of adverse fluid mixing from water recharge in locations where waters from different directions within an aquifer (landwards vs. seawards) intersect.
   b. Risk of well clogging: Loss of recharge capacity by clogging (or plugging) can be caused by a variety of chemical, biological, and physical processes: The greatest risk of clogging occurs where there is mixing of dissimilar water or a change in water chemistry (e.g., introduction of dissolved oxygen).
   c. Risk of changes to inorganic water chemistry: Long-term changes in water chemistry caused by recharge of water with different chemical concentrations.

2. **Seismic Hazards**
   a. Project facilities located near a fault line: Project facilities that would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design are considered. Active faults pose a risk of liquefaction and settlement at the facility.

**Hydrogeology Factors**

1. Impact on freshwater aquifers, local water supplies, and existing water users: Groundwater replenishment within the groundwater basin that could affect adversely hydrologic regimes. Also considers water quality and hydraulic impacts to other wells.

2. Impact to sensitive habitats: This criterion considers impacts from changes in hydrology or salinity due to the location and amount of water recharge on sensitive habitats such as marshlands, wetlands, and drainage areas.

3. Potential yield per installation: Potential yield per injection well or spreading basin installation is considered. Also considers the effects on existing basin yield and existing well yield as a result of groundwater replenishment using an IPR source.

4. Capacity of groundwater basin to receive recharge water: The available capacity of groundwater basins in the City’s jurisdiction to receive the maximum recharge water capacity; Is there adequate storage in production zone aquifers available in the groundwater basin under normal and drought conditions? Is the rate of recharge at target location(s) sufficient to receive up to 10,000 AFY (or 11,400 AFY) of treated recycled water?

5. Proximity to sources of underground water contamination: The potential to uncover or release potential underground water contaminants is addressed in this criterion including the potential of the contaminants to mobilize and spread to other areas or to feasibly capture and abate contamination.
Oceanographic Factors

1. Sensitivity to sea level rise (bathymetry): Sensitivity to sea level rise relates to the effects of changes in water depth and landwards beach migration on potable reuse facilities and groundwater aquifers. Sensitivity to sea level rise based on local bathymetry including both current and potential post-sea level rise future conditions.

2. Sensitivity to tsunami inundation: This criterion considers the location of facilities associated with each reuse alternative that may result in disruptions to operation or increased maintenance due to potential tsunami inundation. The ability to protect facilities through feasible design and construction is also considered as part of this criterion.

Presence of Sensitive Habitats

1. Effects on onshore sensitive habitats: Sensitive onshore habitats such as estuaries, marshlands, wetlands, or environmental sensitive habitat areas (ESHAs) may experience direct and indirect impacts from construction, operations, and maintenance of a potable reuse system based on the location of these facilities.

2. Prospect of habitat creation. The potential for water reuse to recharge and enhance the hydrologic function of important habitats such as creating new flows in creeks or drainage areas.

Energy Use

1. Project energy requirements: Project requires more or less operational energy than the current site conditions.

2. Project greenhouse gas emissions (GHG): The project’s increase or decrease in GHG emissions from operational energy use is considered in this criterion.

Design and Construction Constraints

1. Availability of effluent: The amount of effluent available within the City; is the potential for potable reuse application adequate to produce 10,000 AFY of water supply needed to offset the capacity of the desalination plant generation of product water; or 11,400 AFY of water supply if potable reuse will also impact non-potable reuse water production?

2. Complexity of residuals disposal. The complexity in terms of the number of modifications required to the City’s ocean outfall, permitting and environmental compliance, and technical operational issues to accommodate the residuals from potable reuse production.

3. Proximity to existing infrastructure: Proximity to existing infrastructure to decrease the amount of construction associated with connecting the potable reuse system. This can also include proximity to important infrastructure, such as existing pipelines that
can be repurposed or a railroad crossing that could increase or decrease the project implementation schedule and complexity of construction.

4. Footprint for permanent facilities: The footprint is the area permanently required for the facilities associated with the water reuse facilities including treatment and storage facilities, spreading basins, and injection well sites.

5. Footprint for construction activities: The footprint of temporary areas occupied or disturbed during construction including construction laydown areas and temporary parking for construction workers.

6. Construction complexity: Complexity of construction refers to the potential for difficulties to occur during construction including:
   a. The local availability of contractors who are qualified to perform the work and that have the specialty equipment and experience with this specific type of work.
   b. Construction challenges and risks due to uneven topography, the depth of excavation (or drilling), etc.
   c. Consideration of factors that may impede or delay construction including uncertainties and extended duration for obtaining construction permits, seasonal restrictions on construction due to public use, and environmental review impacts from construction.

7. Scope and complexity of property, easement, or right of way acquisitions required to construct and operate a potable reuse system: This includes obtaining easements, property condemnation, and railroad crossing.

8. Complexity of providing treatment process and/or storage time requirements needed to meet required treatment of Giardia, Cryptosporidium, and Virus (e.g., travel time in groundwater aquifer, engineered storage, and/or treatment process equipment). Treatment requirements will be based on the type of potable reuse alternative considered. IPR regulations will be used for IPR alternatives; the most recent expected DPR regulations presented in Section 2.3 will be used for DPR alternatives.

9. Reliability and performance
   a. Precedent: Precedent of technology implementation and testing in a similar setting and consideration of previous granted permits by the Division of Drinking Water for similar potable reuse applications.
   b. Performance risk: Performance risk is generally considered the potential for the potable reuse system to not meet project performance expectations in terms of water yield and quality over the project life. A large amount of uncertainty with regard to the likelihood of successful implementation of a potable reuse technology is considered a high performance risk. Performance risk also relates to the opportunities to pilot test a potable reuse alternative or accurately estimate system performance using other means or data, including the
operational history of comparable systems treating similar effluent waters, or groundwater replenishment facilities constructed in similar geologies.

c. Maintainability: Maintainability of the potable reuse alternative (e.g., treatment facilities, recharge wells or spreading basins) to restore yield or quality of product water by standard means that won’t significantly impact the facility operation or availability of product water. This can include chemical or mechanical restoration of well and spreading basin capacity, or replacement of pumps, pipelines, and other facilities.

10. Sustainability (e.g., labor, chemicals, mechanical equipment use to sustain performance)
   a. Frequency of maintenance: Frequency of maintenance is the relative frequency at which an alternative is expected to require maintenance activities to either address breakdowns (e.g., pump failure) or restore system performance (e.g., injection well rehabilitation).
   b. Complexity of maintenance: Complexity of maintenance addresses both technical difficulties associated with potential maintenance activities and logistical issues that may make maintenance more complex.

**Other Site-Specific Factors**

1. Impact to recreational uses of land: Impact to recreational uses of land including making recreational activities unavailable temporarily during construction and maintenance closures or permanently during operation.

2. Impact to commercial uses of land: Impact to commercial uses of land including temporarily or permanently restricting commercial business operation or creating barriers to full access during construction or operation of potable reuse facilities.

3. Conflict with Basin Plan: compliance with the Basin Plan. Depending on type of reuse alternative proposed, alternative may have compliance issues meeting the TDS objectives stated in the Basin Plan.

4. Certainty of implementation: Certainty of implementation schedule and costs that account for effects from permitting, demonstration or pilot testing, environmental requirements, and monitoring.

**Economic Factors**

1. Cost to water rate payers: Cost impacts to water rate payers from estimated product water price accounting for construction, operational, and maintenance costs.

2. Impact of construction schedule on recreational and commercial uses: Impact of project construction schedule on recreational and commercial use as it related to the local economy. This factor primarily focuses on the temporary unavailability of recreational and commercial uses due to construction, operation, and maintenance of a potable reuse system.
3.1 Initial Screening Criteria

The technical factors identified in Table 3.1 will be a starting point to determine if each option should be further considered for evaluation - e.g., before economic, environmental and social factors are considered. Potable reuse alternatives that are judged to have technical feasibility criteria in conflict with the project objectives will be determined to fail initial screening, and will not be considered further in this study. For alternatives that pass initial screening, each potable reuse alternative will also be evaluated for feasibility based upon the economic, environmental, social, and technological factors identified in Table 3.1.

For the purposes of this study, "Initial Screening Criteria" will be defined as follows:

*Initial Screening Criteria: Those technical factors that would not allow a full-scale system to be successfully constructed or operated, would result in a high risk of failure or unacceptable performance, or would not produce water supply required to replace the use of the City’s desalination plant screened open ocean intake per Study goals.*

Tables 3.2 and 3.3 present initial screening criteria that will be used in this study for indirect and direct potable reuse alternative. Initial screening criteria will be analyzed concurrent to the design basis development presented in Section 2 to avoid carrying forward alternatives for further study that are not technically feasible.

<table>
<thead>
<tr>
<th>Table 3.2 Initial Screening Criteria for IPR Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screening Criteria</strong></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td><strong>Geotechnical factors</strong></td>
</tr>
<tr>
<td>Seismic hazard</td>
</tr>
<tr>
<td>Hydrogeologic factors</td>
</tr>
<tr>
<td>Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts existing fresh water aquifers, local water supplies or existing water users.</td>
</tr>
<tr>
<td>Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.</td>
</tr>
<tr>
<td>Screening Criteria</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
</tbody>
</table>
| Insufficient storage space | - Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out  
- Groundwater replenishment of IPR water causes loss of ability to adequately manage the groundwater basin (e.g., artesian or flooding conditions, loss of stored water, etc.)  
- Groundwater replenishment of IPR water does not result in an increase in total basin yield and overall yield of 10,000 AFY (or 11,400 AFY). |
| Oceanographic Factors | Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept |
| Sea level rise or tsunami hazard | Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR facility) or adversely affects local ecosystem |
| Presence of Sensitive Habitats | |
| Habitat creation | |
| Design and Construction Issues | |
| Adequate capacity | - Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out  
- IPR production capacity and/or aquifer losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out |
| Lack of adequate land for required for IPR treatment or groundwater replenishment facilities | - Surface area needed for footprint of IPR treatment or groundwater replenishment facilities is greater than what is available.  
- Requires condemnation of property for new injection well facilities. |
### Table 3.3 Initial Screening Criteria for DPR Alternatives

<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical factors</strong></td>
<td></td>
</tr>
<tr>
<td>Seismic hazard</td>
<td>Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
</tr>
<tr>
<td><strong>Oceanographic Factors</strong></td>
<td></td>
</tr>
<tr>
<td>Sea level rise or tsunami hazard</td>
<td>Oceanographic hazards make aspects of the project infrastructure vulnerable in a way that cannot be protected and/or would prevent the City from being able to receive funding or insurance for this concept</td>
</tr>
<tr>
<td><strong>Presence of Sensitive Habitats</strong></td>
<td></td>
</tr>
<tr>
<td>Habitat creation</td>
<td>Facility creates habitat that is unsustainable (i.e., requires continued discharge by DPR facility) or adversely affects local ecosystem</td>
</tr>
<tr>
<td><strong>Design and Construction Issues</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Adequate capacity | • Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out  
• DPR production capacity losses result in less than 10,000 AFY (or 11,400 AFY) of production at build-out |
| Lack of adequate land for required for DPR facilities | Surface area needed for footprint of DPR treatment facilities is greater than what is available. |

After the initial screening, projects will be further categorized as 1) Infeasible, 2) Potentially feasible, but does not meet Study goals, or 3) Potentially feasible. The next steps or actions for each of these categories is described in Section 1.

### 4.0 IMPLEMENTATION SCHEDULE DEVELOPMENT

In conjunction with the cost estimate, an implementation schedule for each of the project alternatives will be developed. Major components that will be included in the implementation schedule are summarized below:

- Planning Phase (Feasibility Studies)
  - Work Plan Development: A Work Plan outlining the feasibility study is developed
  - Initial Screening Analysis: Technical feasibility criteria are used to determine if a potable reuse alternative passes initial screening.
- Regulatory and Permit Requirements: Alternatives surviving initial screening are subjected to an analysis of regulatory and permit requirements.
- Conceptual Design: Site plans and design criteria are established for each surviving alternative.
- Feasibility Analysis: Surviving alternatives are screened against all feasibility criteria outlined in Table 3.1.

- Test Facility Demonstration
  - Design: A full set of bid set construction documents are created for the test facility.
  - Permitting: Test facility is put through a permitting process in which all required permits are obtained for test well – Coastal Development Permit, Army Corps Permit, City Building Permit, etc.
  - Environmental: CEQA and/or NEPA for test facility
  - Bid Phase: Contractors are solicited for bids for construction of the test facility.
  - Construction: Test facility is constructed by selected contractor.
  - Test Facility Demonstration: Test facility is operated while data is collected and analyzed.
  - Report/Recommendation: All findings resulting from the test facility demonstration are summarized and reported in the final report.

** Assumes property or easement acquisition is not necessary for the Test Phase.**

- Implementation
  - Property and easement acquisition: Any property or easements that are needed will be attained.
  - Design: A full set of bid set construction documents are created for the full scale potable reuse alternative.
  - Permitting: Potable reuse alternative is put through a permitting process in which all required permits are obtained – Coastal Development Permit, Army Corps Permit, City Building Permit, etc.
  - Environmental: CEQA and/or NEPA for full scale potable reuse alternative.
  - Bid Phase: Contractors are solicited for bids for construction of the full scale potable reuse alternative.
  - Construction: Full scale potable reuse alternative is constructed by selected contractor.
  - Operation: Full scale potable reuse alternative is operated and serves as a source of drinking water for the City.
5.0 **COST ESTIMATING METHODOLOGY**

As demonstrated in the programmatic work flow diagram presented in Figure 1, potable reuse alternatives surviving initial screening shall proceed to various additional study phases, which provide the basis for a cost estimate. Alternatives lacking sufficient data for analysis may be recommended for additional data collection, resulting in the potential for samples and other studies. The following studies shall be performed on potable reuse alternatives surviving initial screening analysis:

- Regulatory and Permit Requirements
- Conceptual Design

Aforementioned studies will be used as basis to perform a Class 4 feasibility cost estimate, as defined by the American Association of Cost Engineers (AACE), on each surviving potable reuse alternative. Typical estimating methodologies for this level of cost estimate include parametric models, specific analogy, expert opinion, and trend analysis. A review of similar projects will be used as the basis for the cost estimate. As defined by the AACE, the expected accuracy range of a Class 4 cost estimate is as follows:

Low: -15% to -30%

High: +20% to +50%

The cost estimate will represent the total cost for implementation of the potable reuse alternative. It is noted that the total cost of each alternative includes costs associated with additional production wells required to meet the project production capacity; this concept is discussed further in Section 2.6. The estimated cost shall include the following:

- Feasibility analysis
- Environmental review, permitting, and public process
- Property and easement acquisition
- Design fees
- Construction costs
- Operation and maintenance

Results from the cost estimate will be used during the feasibility analysis of surviving alternatives. The feasibility analysis process is described in the following section.
6.0 FEASIBILITY ANALYSIS

As presented in Figure 1, each alternative that survives the initial screening analysis shall be subjected to a feasibility analysis after the estimated schedules and costs are complete. Whereas the initial screening analysis only considered certain technological factors presented in Tables 3.2 and 3.3, the feasibility analysis will consider all technological, social, environmental, and economic factors presented in Table 3.1. For each alternative, advantages and disadvantages with respect to each of the 29 feasibility criteria will be ascribed. Table 6.1 below provides an example summary that will be used to present the feasibility criteria analysis for each reuse alternative.

Once the feasibility analysis has been completed, it will be reviewed by the technical advisory panel. The final report deliverable will consist of all technical memoranda associated with this work.

7.0 TECHNICAL ADVISORY PROCESS

The technical advisory process described in this Work Plan provides an independent, third party review of the project work product at key intervals throughout the project duration, as the work product is developed. The technical advisory process shall achieve the following objectives:

1. Provide timely review of project work product by experts in the required subject matter to advise and guide the City’s feasibility study.

2. Facilitate input from project stakeholders that can be used to inform the City’s comparison of potentially feasible alternatives.

3. Create a record of the review and stakeholder process to be included as an appendix to the feasibility study report.

To assist the Central Coast Regional Water Quality Control Board administer the technical advisory process, the City will retain the services of the National Water Research Institute (NWRI). NWRI is a California non-profit organization whose activities include ensuring safe, reliable sources of water now and for future generations through a variety of research, education, and public out-reach activities. NWRI has facilitated similar technical advisory programs on subsurface intake and potable reuse feasibility projects in California, including programs for both municipal and state regulatory agencies. NWRI will retain the services of the experts that will review the work, facilitate the project meetings (i.e., that will include an opportunity for stakeholder comments) and complete the documentation of the technical review and stakeholder process.
### Table 6.1 Sample Feasibility Analysis Summary Table

<table>
<thead>
<tr>
<th>Feasibility Criteria</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Geochemistry</td>
<td>[Insert advantages for alternative here]</td>
<td>[Insert disadvantages for alternative here]</td>
</tr>
<tr>
<td>a. Risk of adverse geochemical interactions due to fluid mixing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Risk of well clogging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Risk of changes to inorganic water chemistry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Seismic hazards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Project facilities would cross a known fault line, or be exposed to a seismic hazard that could otherwise not be protected from loss by design</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hydrogeologic Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Impact on freshwater aquifers, local water supplies and existing water users</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Impact to sensitive habitats such as marshlands, drainage areas, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Potential yield per injection well or spreading basin installation (e.g., effects on existing basin yield and existing well yield as a result of groundwater replenishment from an IPR source)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Capacity of groundwater basin to receive recharge water (e.g., adequate storage in production zone aquifers is available in the basin under normal and drought conditions, rate of recycled water recharge at target location is sufficient to receive 10,000 to 11,400 AFY of treated recycled water)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Proximity to sources of underground water contamination (i.e., will mobilize or capture contamination)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oceanographic Factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Sensitivity to sea level rise (bathymetry)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Sensitivity to tsunami inundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Presence of Sensitive Habitats</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Proximity to on-shore habitats such as marshlands, or environmental sensitive habitat areas (ESHAs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Prospect of habitat creation (e.g., creating new flows in creeks or drainage areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy Use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Project requires more or less energy than other alternatives, accounting for any possible reduction in treatment requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Project energy use exceeds City's Greenhouse Gas Emission Threshold as identified in the City's 2012 Climate Action Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design and Construction Issues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Availability of effluent needed and/or potable reuse application actually produces 10,000 AFY of water supply needed to offset desalination plant production; or 11,400 AFY to offset desalination plant production and non-potable reuse.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Complexity of residuals disposal (e.g., are modifications required to the City's ocean outfall?)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 6.1 Sample Feasibility Analysis Summary Table

<table>
<thead>
<tr>
<th>Feasibility Criteria</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Proximity to existing infrastructure (e.g., existing reclaimed water pipeline, railroad crossing, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Footprint for permanent facilities (e.g., treatment and storage facilities, spreading basins, injection well sites, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Footprint for construction activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Complexity of construction activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Scope and complexity of property, easement, or right of way acquisitions (e.g., property condemnation, railroad crossing, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 Simplicity of providing treatment process and/or storage time requirements needed to meet required treatment <em>Giardia</em>, Cryptosporidium and Virus (e.g., travel time in groundwater aquifer, engineered storage, and/or treatment process equipment).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 Reliability and performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Precedent (i.e., Has DDW granted permits for other similar potable reuse applications?; Has the potable reuse application been implemented or tested in a similar setting?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Performance risk (i.e., stable yield and quality of potable reuse facilities over project life)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Maintainability (i.e., can yield or quality be restored by standard means that won’t significantly impact the facility operation or availability)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 Sustainability (e.g., labor, chemicals, mechanical equipment use to sustain performance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Frequency of maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Complexity of maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Site-Specific Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Impact to recreational uses of land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Impact to commercial uses of land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 Conflict with Basin Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Certainty of implementation schedule and costs (i.e., as affected by permitting, demonstration or pilot testing, environmental requirements, monitoring, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Cost impacts to water rate payers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 Impact of project construction schedule on recreational and commercial use as it relates to the local economy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Participants in the technical advisory process shall consist of:

- A moderator: Jeff Mosher, National Water Research Institute,
- Technical Advisory Panel (TAP): Consultants retained by NWRI; The composition of the TAP shall consist of up to four individuals whose qualifications may include:
  - Hydrogeologists, geotechnical, civil engineers, and/or contractors experienced in the design, construction, and costs of subsurface desalination plant intakes and potable reuse facilities.
  - CEQA consultant experienced in coastal development.
  - Public agency representative experienced with the implementation of seawater desalination.
  - Former regulators with experience in permitting.
- Project stakeholders (e.g., regulators and city residents),
- The City’s public works staff, and
- The City’s consultant team: Carollo Engineers.

This section of the Work Plan provides the guidelines for how the technical advisory process will be conducted. The qualifications and role of the technical advisors, the format for the technical advisory meetings, stakeholder process, and documentation will be explained.

7.1 Technical Advisory Panel

NWRI shall select and retain approximately four technical advisors to review the work product developed by the City’s consultant team. It is anticipated that the technical advisory panel may consist of the following types of experts:

- Hydrogeologists, technical, civil engineers, and/or contractors experienced in the design, construction, and costs of subsurface desalination plant intakes and potable reuse facilities.

7.2 Technical Advisory Panel Meetings

The following technical advisory workshops will be held at the intervals described in the programmatic Work Plan diagram and project schedule - i.e., Figures 1 and 2:

1. TAP Workshop No. 1: Work Plan
2. TAP Workshop No. 2: Initial Screening Analysis
3. TAP Workshop No. 3: Potable Reuse Feasibility Study

Note: TAP Workshop No. 4 is associated with the Subsurface Intake study.
The City will provide NWRI with the necessary work product for review at least 15 working days prior to a technical advisory workshop. NWRI will be responsible for distributing the work product to the technical advisory panel, and posting the material to the project website (also managed by NWRI). The project website will be open to the public and NWRI shall post the work product no less than 5 days prior to a technical advisory workshop.

NWRI will create and distribute an agenda for each technical advisory workshop, however, each technical advisory workshop will consist of two parts and follow the format described in Table 7.1.

Table 7.1  TAP Workshop Format

<table>
<thead>
<tr>
<th>Part 1</th>
<th>Part 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Moderated by NWRI</td>
<td>Participants include:</td>
</tr>
<tr>
<td>2. Presentation by City highlighting key material from the work product that is the subject of the workshop</td>
<td>• City and City’s consultant team</td>
</tr>
<tr>
<td>3. TAP questions and answers on presentation material and work product that is the subject of the workshop</td>
<td>• NWRI moderator and staff</td>
</tr>
<tr>
<td>4. Stakeholder comment period</td>
<td>• TAP members</td>
</tr>
<tr>
<td>5. Meeting minutes, including TAP questions, City responses, and stakeholder comments will be recorded by NWRI staff.</td>
<td>• Project Stakeholders</td>
</tr>
<tr>
<td>1. Moderated by NWRI</td>
<td>Participants include:</td>
</tr>
<tr>
<td>2. City and City consultant team will be provided an opportunity to ask the TAP questions regarding the comments received.</td>
<td>• City and City’s consultant team</td>
</tr>
<tr>
<td>3. TAP will be allowed to ask additional questions.</td>
<td>• NWRI moderator and staff</td>
</tr>
<tr>
<td>4. Meeting minutes will be prepared by NWRI staff consisting of the final TAP comments on the work product developed by the City’s team.</td>
<td>• TAP members</td>
</tr>
</tbody>
</table>
7.2.1 Stakeholder Process

As indicated in Table 7.1, a portion of Part 1 of each TAP Workshop will consist of a stakeholder comment period where:

1. Stakeholders (e.g., regulatory agencies, City residents) will be provided the opportunity to fill out comment cards related to issues, feedback, or comments regarding the work product.

2. Comment cards must be submitted to NWRI staff 10 minutes before the stakeholder comment period begins.

3. Each stakeholder shall have 120 seconds to deliver their comments.

4. Stakeholders that have successfully completed their comment cards are able to yield their time to another individual to speak on their behalf.

NWRI's moderator will administer the stakeholder process in accordance with this procedure.

The entire workshop shall be recorded for reference and made available on the NWRI managed project website. It is the responsibility of NWRI to produce meeting minutes from the workshop, which will be reviewed by the consultant team and posted on NWRI's project website. The comment cards will require stakeholders to fill out the following information:

- Name
- Affiliation (e.g., regulatory agency, City resident, other)
- City Resident? Yes or No
- Comment

Stakeholders are not required to attend a technical advisory workshop to submit comments for the record. Comments may be submitted to NWRI within 5 working days of the technical advisory workshop. NWRI is responsible for recording comments and comment cards as part of the Workshop meeting record (i.e., meeting minutes).

7.3 Project Stakeholders

Anticipated stakeholders associated with this project are presented in Table 7.2. This list of stakeholders was adapted from the noticing list included in the City's 2014 Coastal Development Application for Repair and Maintenance Activities at the Charles Meyer Desalination Facility Offshore Intake Structure. This list includes those residents and businesses that are in close proximity to the areas affected by the work on the City's intake, and parties that have expressed interest in the City's desalination plant reactivation project. For the purposes of this study, this list should not be considered exhaustive and will require periodic updates as project alternatives are clearly defined and updated.
<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Defense Center</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>Santa Barbara Arts and Crafts Show</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>California Department of Fish and Game,</td>
<td>San Diego, CA</td>
</tr>
<tr>
<td>Central Coast Regional Water Quality Control Board</td>
<td>San Luis Obispo, CA</td>
</tr>
<tr>
<td>Army Corps of Engineers Regulatory Division</td>
<td>Ventura, CA</td>
</tr>
<tr>
<td>La Cumbre Mutual Water Company</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>Santa Barbara County Flood Control District</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>City of Santa Barbara Waterfront Department</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>City of Santa Barbara Creeks Division, Attention</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>City of Santa Barbara Parks Division</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>Santa Barbara Trolley Company</td>
<td>Santa Barbara, CA</td>
</tr>
<tr>
<td>Wheel Fun Rentals of Santa Barbara</td>
<td>Santa Barbara, CA</td>
</tr>
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<tr>
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<td>Janet Martorana</td>
<td>Santa Barbara, CA</td>
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<tr>
<td>Name</td>
<td>Location</td>
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<tr>
<td>David Matson, Deputy Director</td>
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<td>Heal the Ocean</td>
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<td>Sweetwater Collaborative</td>
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<tr>
<td>Phil Walker</td>
<td>Santa Barbara, CA</td>
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<tr>
<td>Robert H Sulnick</td>
<td>Santa Barbara, CA</td>
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</tbody>
</table>

### 7.3.1 Regulators

Regulators that have been identified as project stakeholders are presented in Table 7.3. This list is not final, and may be expanded as the project develops.
<table>
<thead>
<tr>
<th>Agency</th>
<th>Name</th>
<th>Office</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division of Drinking Water</td>
<td>Jeff Densmore</td>
<td>Carpinteria</td>
<td>(805) 566-1326</td>
<td><a href="mailto:jeff.densmore@waterboards.ca.gov">jeff.densmore@waterboards.ca.gov</a></td>
</tr>
<tr>
<td>Division of Drinking Water</td>
<td>Kurt Souza</td>
<td>Carpinteria</td>
<td>(805) 566-4745</td>
<td><a href="mailto:kurt.souza@waterboards.ca.gov">kurt.souza@waterboards.ca.gov</a></td>
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<tr>
<td>Central Coast RWQCB</td>
<td>Peter von Langen</td>
<td>San Luis Obispo</td>
<td>(805) 549-3688</td>
<td><a href="mailto:peter.vonlangen@waterboards.ca.gov">peter.vonlangen@waterboards.ca.gov</a></td>
</tr>
<tr>
<td>California Coastal Commission</td>
<td>Tom Luster</td>
<td>San Francisco</td>
<td>(415) 904-5400</td>
<td><a href="mailto:tluster@coastal.ca.gov">tluster@coastal.ca.gov</a></td>
</tr>
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</table>
7.4 Documentation Requirements

A list of the documents that will be developed as part of the technical advisory process is presented in Table 7.4. These documents will be made available via NWRI's project website at times indicated.

<table>
<thead>
<tr>
<th>Table 7.4 Technical Advisory Process Documents and Publication Procedures</th>
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<tbody>
<tr>
<td><strong>Document Title</strong></td>
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<td>Draft Work Plan</td>
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<td>Tech Memo 2 (Basis of Design &amp; Initial Screening Analysis) – Potable Reuse</td>
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<td>Tech Memo 3 (Permit &amp; Regulatory Req.) – Potable Reuse</td>
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<td>TAP Workshop 2 Agenda</td>
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<td>Table 7.4 Technical Advisory Process Documents and Publication Procedures</td>
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<td><strong>Document Title</strong></td>
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<td>Tech Memo 4 (Conceptual Design)</td>
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<tr>
<td>Tech Memo 5 (Estimated Schedule &amp; Cost)</td>
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<tr>
<td>Tech Memo 6 (Feasibility Analysis)</td>
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<tr>
<td>TAP Workshop 3 Agenda</td>
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<td>TAP Workshop 3 Meeting Minutes</td>
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SANTA BARBARA CITY AGREEMENT NO. 25,191

With

Carollo Engineers, Inc., for a Work Plan for Subsurface Desalination Intake and Potable Reuse Feasibility Studies

This Contract is entered into on May 5, 2015 by and between:

The City of Santa Barbara, a Municipal Corporation, referred to herein as the “City,”

and,

Carollo Engineers, Inc., a California Corporation, referred to herein as the “Contractor,”

WITNESSETH:

WHEREAS, Contractor has the special background, training and experience required by City, and in consideration of the mutual covenants, conditions, promises and agreements, herein, the City and Contractor AGREE:

1. SCOPE OF CONTRACTOR SERVICES

   a. Contractor agrees to provide a Work Plan for Subsurface Desalination Intake and Potable Reuse Feasibility Studies as described in more detail in the attached scope of services (Exhibit A) dated April 20, 2015.

   On January 30, 2015, the Regional Water Quality Control Board adopted an amendment to the City’s El Estero Wastewater Treatment Plant water discharge requirements that included a special provision for the City to “analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options” and “submit a feasibility study work plan for the Regional Water Board, by August 31, 2015.”

   b. The City has been advised and enters into this Contract understanding that Tom Seaord has been designated the project manager for provide Subsurface Desalination Intake and Potable Reuse Feasibility Studies and that the Project Manager will have direct responsibility for interacting with City staff and delivering Contractor’s services to the City under this Contract. Contractor shall not substitute nor otherwise allow any other person to serve in place of the Project Manager without the written consent of the Department Head, who shall have sole discretion as to whether the proposed substitution is acceptable. Should Contractor substitute or allow any unauthorized person to serve as project manager, Contractor shall have no right to any monies for services provided by that unauthorized person and City shall also have the right to immediately terminate this Contract.

2. COMPENSATION

   a. The total compensation for all services provided pursuant to this Contract, including all extra services as defined in Section 3 hereof and reimbursable expenses,
shall not exceed the sum of $343,925 without the express written approval of City Council of the City of Santa Barbara. The basic contract is for $312,659 and the total that may be claimed for Extra Services under Section 3 of this Contract shall not exceed $31,266. This Contract provides the exclusive means of payment and reimbursement for costs to Contractor by the City.

b. Changes in personnel or in rates of compensation set forth in Exhibit A may be made only after written notice to and written approval by the Department Head, Rebecca J. Bjork, ("Department Head").

c. Where travel costs are included in Exhibit A, only the actual travel costs (at fare, rate per mile or lump sum approved), and/or actual expenses pursuant to the provisions of the Contract and within guidelines approved by the City Finance Director will be reimbursed.

d. Contractor may be reimbursed for such other necessary costs, including actual costs of copies, printing, postage, shipping and documents expense, and all costs of other materials, equipment, services and supplies, as approved and required to complete the work, according to the attached Exhibit A.

e. Compensation for Extra Services of Contractor authorized in accordance with Section 2 shall be paid to Contractor by City in accordance with the fee schedule set forth in Exhibit A. Contractor shall only be entitled to payment for Extra Services under this Contract if Contractor has obtained authorization required under Section 3 below.

f. Contractor shall submit itemized statements, which shall include a detailing of the number of hours spent on each task and copies of all subcontractors' invoices, to request payment in accordance with the standard billing format issued by the City Department. Contractor shall keep records concerning payment items on a generally recognized accounting basis and such records shall be maintained for a period of 3 years following the completion of the work assigned. Such records shall be made available for copying, inspection or audit by City employees or independent agents during reasonable business hours.

3. EXTRA SERVICES OF CONTRACTOR

Prior to performing any services other than those described in Exhibit A ("Extra Services"), Contractor shall submit a written request for Extra Services and obtain the written approval of the Department Head or his/her designee. The request for Extra Services shall at minimum include a description of the services to be performed, the reason why the Extra Services are needed or required, a schedule for completion of the proposed Extra Services, and a not-to-exceed amount for performance of the proposed Extra Services. Each approved Extra Services request shall be billed separately.

4. TIME OF BEGINNING AND COMPLETION

Services shall begin upon full execution of this Contract by the City, and delivery of a fully executed copy of the Contract to the Contractor. Contractor shall adhere to schedules and deadlines agreed to by City and Contractor shown in Exhibit A. The Contractor shall submit to the City a feasibility study work plan to "analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options" for review by the Regional Water Quality Control Board (RWB), by August 31, 2015. Contractor's failure to complete the above services within the time specified, due to avoidable delays, may at the City's discretion be considered a material breach of this Contract. Contractor shall review the remaining work and schedule of performance at least monthly and shall confirm that completion may be expected within the schedule
approved, or in the alternative, give immediate notice when it shall first appear that the approved schedule will not be sufficient, together with an explanation for any projected insufficiency of delays in the schedule. No extension of time to complete any portion of the services called for in the Contract shall be allowed except upon the express, written approval of the Department Head. Contractor shall request, in writing, a time extension for approval by City, promptly upon the occurrence of any action causing delay in Contractor's prosecution of the services. The nature of the delay, the corrective actions taken and the impacts on the project schedule shall be described in each request for a time extension.

5. OWNERSHIP OF DOCUMENTS

All documents, computer programs, plans, renderings, charts, designs, drafts, surveys and other intellectual property which is originally developed by Contractor pursuant to this Contract shall become the property of City upon full and complete compensation to Contractor for services performed herein. Contractor will take such steps as are necessary to perfect or to protect the ownership interest of the City in such property. Contractor may retain copies of said documents for Contractor's file.

6. ASSIGNMENT OF CONTRACT

Contractor shall not assign, sublet or transfer any right, privilege or interest in this Contract, or any part thereof, without prior written consent of City. Contractor shall not substitute personnel designated in the proposal of Contractor without the written consent of City.

7. OFFICIAL NOTICES

Notices to either party shall be provided by personal delivery or by depositing them in the United States mail, first class postage prepaid, and addressed as identified at the signature page of this Contract. A party may change mailing address for all purposes under this Contract, by written notice.

8. DEFENSE, INDEMNITY AND HOLD HARMLESS

a. Contractor shall, to the extent permitted by law, investigate, defend, indemnify and hold harmless the City, its officers, employees and agents from and against any and all loss, damage, liability, claims, demands, detriments, costs, charges and expenses (including reasonable attorney fees) and causes of action of whatsoever character which the City may incur, sustain or be subjected to on account of loss or damage to property or loss of use thereof, or for bodily injury to or death of any persons (including but not limited to property, employees, subcontractors, agents and invitees of each party hereto) arising out of or in any way connected with the work to be performed under this Agreement other than as such work relates to Professional Liability Insurance.

b. With respect to Professional Liability Insurance, Contractor shall investigate, defend, indemnify and hold harmless the City, its officers, agents and employees from and against any and all loss, damage, liability, claims, demands, detriments, costs, charges and expenses (including reasonable attorney's fees) and causes of action of whatsoever character which City may incur, sustain or be subjected to
on account of loss or damage to property or loss of use thereof, or for bodily injury to or death of any persons (including but not limited to property, employees, subcontractors, agents and invitees of each party hereto) arising out of or due to the acts, errors or omissions of Contractor.

9. INSURANCE REQUIREMENTS

As part of the consideration of this Agreement, Consultant agrees to purchase and maintain at its sole cost and expense during the life of this agreement insurance coverage against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the work hereunder by the Consultant, its agents, representatives, or employees.

MINIMUM SCOPE AND LIMIT OF INSURANCE

Coverage shall be at least as broad as:

A. Commercial General Liability (CGL): Insurance Services Office Form CG 00 01 covering CGL on an “occurrence” basis, including products and completed operations with limits of no less than Two Million Dollars ($2,000,000) per occurrence for bodily injury, personal injury and property damage. If a general aggregate limit applies, either the aggregate limit shall apply separately to this project or the general aggregate limit shall be twice the required occurrence limit.

B. Automobile Liability: Insurance Services Office Form Number CA 0001 covering Code 1 (any auto), or if Consultant has no owned autos, Code 8 (hired) and Code 9 (non-owned), with limits of no less than One Million Dollars ($1,000,000) per accident for bodily injury and property damage.

C. Workers' Compensation: In accordance with the provisions of the California Labor Code, Consultant is required to be insured against liability for Workers' Compensation or to undertake self-insurance. Statutory Workers' Compensation and Employers' Liability of at least $1,000,000 shall cover all Consultant's staff while performing any work incidental to the performance or this agreement.

D. Professional Liability: Professional Liability (Errors and Omission) Insurance appropriate to the Consultant's profession, with limits no less than One Million Dollars ($1,000,000) per occurrence or claim and Two Million Dollars ($2,000,000) aggregate to cover all services rendered by the Consultant pursuant to this Agreement.

If the Consultant maintains higher coverage limits than the amounts shown above, then the City requires and shall be entitled to coverage for the higher coverage limits maintained by the Consultant. Any available insurance proceeds in excess of the specified minimum limits of insurance and coverage shall be available to the City.

OTHER INSURANCE PROVISIONS

Each insurance policy shall contain, or be endorsed to contain, the following five (5) provisions:
1) **Additional Insured Status**

The City of Santa Barbara, its officers, employees, and agents, shall be covered as additional insureds on the Commercial General Liability and the Automobile Liability policy with respect to liability arising out of work or operations performed by or on behalf of the Consultant including materials, parts, or equipment furnished in connection with such work or operations and automobiles owned, leased, hired, or borrowed by or on behalf of the Consultant. Additional Insured coverage shall be provided in the form of an endorsement to the Consultant’s insurance (at least as broad as Insurance Services Office Form CG 20 10 11 85). A copy of the endorsement evidencing that the City of Santa Barbara has been added as an additional insured on the policy, must be attached to the certificate of insurance.

2) **Subcontractors**

Consultant shall require and verify that all subcontractors maintain insurance meeting all the requirements stated herein, and Consultant shall ensure that the City is an additional insured on insurance required from subcontractors. For Commercial General Liability coverage subcontractors shall provide coverage with a format at least as broad as Insurance Services Office form CG 20 38 04 13.

3) **Notice of Cancellation**

A provision that coverage will not be cancelled or subject to reduction without written notice given to the City Clerk, addressed to P.O. Box 1990, Santa Barbara, California 93102-1990.

4) **Primary Coverage**

For any claims related to this contract, the Consultant’s insurance coverage shall be primary insurance as respects the City, its officers, officials, employees, and volunteers. Any insurance or self-insurance maintained by the City shall be excess of the Consultant’s insurance and shall not contribute with it.

5) **Waiver of Subrogation**

Consultant hereby agrees to waive rights of subrogation which any insurer of Consultant may acquire from Consultant by virtue of the payment of any loss. Consultant agrees to obtain any endorsement that may be necessary to affect this waiver of subrogation. Consultant agrees to obtain any endorsement that may be necessary to affect this waiver of subrogation, but this provision applies regardless of whether or not the City has received a waiver of subrogation endorsement from the insurer.

The Workers’ Compensation policy shall be endorsed with a waiver of subrogation in favor of the City for all work performed by the Consultant, its employees, agents and subcontractors.
ACCEPTABILITY OF INSURERS

All insurance coverage shall be placed with insurers that have a current rating from AM Best of no less than A: VII; and are admitted insurance companies in the State of California. All other insurers require prior approval of the City.

CLAIMS MADE POLICIES

If the required Professional Liability (Errors and Omissions) policy provides coverage on a claims-made basis:

1. The Retroactive Date must be shown and must be before the date of the contract or the beginning of contract work.
2. Insurance must be maintained and evidence of insurance must be provided for at least five (5) years after completion of the contract of work.
3. If coverage is canceled or non-renewed, and not replaced with another claims-made policy form with a Retroactive Date prior to the contract effective date, the Consultant must purchase “extended reporting” coverage for a minimum of five (5) years after completion of contract work.

COVERAGE LIMITS SPECIFICATIONS

Approval of the insurance by City or acceptance of the certificate of insurance by City shall not relieve or decrease the extent to which the Consultant may be held responsible for payment of damages resulting from Consultant's services or operation pursuant to this Agreement, nor shall it be deemed a waiver of City's rights to insurance coverage hereunder.

If, for any reason, Consultant fails to maintain insurance coverage which is required pursuant to this Agreement, the same shall be deemed a material breach of contract. City, at its sole option, may terminate this Agreement and obtain damages from the Consultant resulting from said breach. Alternately, City may purchase such required insurance coverage, and without further notice to Consultant, City may deduct from sums due to Consultant any premium costs advanced by City for such insurance.

DEDUCTIBLES AND SELF-INSURED RETentions

Any deductibles or self-insured retentions must be declared to and approved by the City. At the option of the City, either: the Consultant shall cause the insurer to reduce or eliminate such deductibles or self-insured retentions as respects the City, its officers, officials, employees, and volunteers; or the Consultant shall provide a financial guarantee satisfactory to the City guaranteeing payment of losses and related investigations, claim administration, and defense expenses.
EVIDENCE OF COVERAGE

Consultant must provide evidence that it has secured the required insurance coverage before execution of this agreement. A Certificate of Insurance supplied by the City or the appropriate ACORD and Insurance Services Office forms evidencing the above shall be completed by Consultant's insurer or its agent and submitted to the City prior to execution of this Agreement by the City.

Consultant shall furnish the City with original certificates and amendatory endorsements or copies of the applicable policy language effecting coverage required by this clause. All certificates and endorsements are to be received and approved by the City before work commences. However, failure to obtain the required documents prior to the work beginning shall not waive the Consultant's obligation to provide them. The City reserves the right to require complete, certified copies of all required insurance policies, including endorsements required by these specifications, at any time.

10. TERMINATION

This Contract may be terminated with or without cause by either party at any time by giving the other no less than thirty (30) days notice in writing. In the event of such termination, Contractor shall deliver all programs, drawings, surveys, drafts, plans, work in progress and other documents related to the project to the City within five (5) days of the notice of termination. In the event of such termination, Contractor shall be compensated for such services as are performed and work product delivered to the City up to the point of termination.

11. RIGHT TO PERFORM SIMILAR SERVICES

Nothing in this Contract shall restrict the City from providing the same or similar services through City employees, other contractors, other resources, or by arrangements with other agencies. Contractor may engage in similar activities to the extent that such work does not conflict with the proper performance of services under this Contract.

12. CONFLICT OF INTERESTS

Contractor warrants by execution of this Contract that no person or selling agent has been employed or retained to solicit or secure this Contract upon an agreement or understanding for commission, percentage, brokerage or contingent fee, and that Contractor maintains no agreement, employment, or position which would be in conflict with the duties to be performed for City under this Contract. Contractor further agrees that during the term of this Contract, Contractor will not obtain, engage in, or undertake any interests, obligations or duty that would be in conflict with, or interfere with, the services or duties to be performed under the provisions of this Contract.

13. ADMINISTRATION OF EMPLOYMENT

Contractor shall obtain and administer the employment of personnel having the background, training, experience, licenses and registration necessary for the work assigned, including all coordination, the withholding of proper taxes and benefits, the
payment of wages, employer's contributions for FICA, and Federal and State unemployment payments, and the review and maintenance of any necessary licenses, certificates, memberships and other qualifications necessary for the services to be provided. Contractor is an independent contractor and shall not be considered an agent or employee of the City for any purpose. Contractor and its employees and agents are not entitled to any of the benefits or privileges that the City provides its employees.

14. BUSINESS TAX CERTIFICATE

Prior to the execution of the Contract, Contractor shall obtain a business tax certificate from the City at Contractor's expense. Contractor shall maintain a business tax certificate as required by the City Finance Director during the term of this Contract.

15. NO WAIVER OF PROVISIONS

No waiver of a breach of any provision of this Contract shall be construed to be a continuing waiver of that provision, nor a waiver of any breach of another provision of this Contract.

16. APPLICABLE LAWS, PARTIAL INVALIDITY

This Contract shall be subject to the Santa Barbara City Charter, and the laws, rules, regulations and ordinances in effect within the City of Santa Barbara, County of Santa Barbara, California, and any interpretation of the law that may be necessary shall be pursuant to the laws applicable within that jurisdiction. If any provision of this Contract is determined to be invalid, illegal or unenforceable for any reason, that provision shall be deleted from this Contract and such deletion shall in no way affect, impair, or invalidate any other provision of this Contract, unless it was material to the consideration for the performance required. If a provision is deleted which is not material to such consideration, the remaining provisions shall be given the force and effect originally intended.

17. NON-DISCRIMINATION ORDINANCE

Contractor shall perform all work pursuant to this Contract in compliance with Section 9.126.020 of the Santa Barbara Municipal Code (a copy of which is attached as Exhibit B), prohibiting unlawful discrimination in employment practices, and shall be bound by the terms of such ordinance.

18. CITY SERVICE CONTRACTOR MANDATORY MINIMUM WAGE

a. Chapter 9.128 of the Santa Barbara Municipal Code establishes a mandatory minimum wage for employees of contractors providing services to the City. In the performance of this Agreement, Contractor and any subcontractor, agent, or assignee of Contractor under this Agreement shall comply with the provisions of Chapter 9.128 of the Municipal Code as such Chapter existed upon the adoption of this Agreement or the last date this Agreement was amended.

b. Current Living Wage Certificates on forms supplied by the City shall be completed by Contractor, submitted to City prior to execution of this Contract by City, and attached as Exhibit C. Contractor shall require any and all subcontractors and all tiers of
such subcontractors to provide Living Wage Certificates as required by Santa Barbara Municipal Code Chapter 9.128.

19. NONAPPROPRIATIONS OF FUNDS

Notwithstanding any other provision of this Agreement, in the event that no funds or insufficient funds are appropriated or budgeted by the City, or funds are not otherwise available for payments in the fiscal year(s) covered by the term of this Agreement, then City will notify Contractor of such occurrence and City may terminate or suspend this Agreement in whole or in part, with or without a prior notice period. Subsequent to termination of this Agreement under this provision, City shall have no obligation to make payments with regard to the remainder of the term.
IN WITNESS WHEREOF, the parties have executed this contract as of
the date and year first written above.

CITY OF SANTA BARBARA
A Municipal Corporation

[Signature]
Rebecca Bjork
Public Works Director

CONTRACTOR:
Carollo Engineers, Inc.

[Signature]
Jim Meyerhofer
Sr. Vice President

Type or Print Name
Title

ATTEST:

[Signature]
Gwen Péirce, CMC
City Clerk Services Manager

5075 Shoreham Pl. Suite 120
Address
San Diego CA 92122
City State Zip

858-505-1020
Telephone Number

APPROVED AS TO CONTENT:

[Signature]
Joshua Haggenmark
Water Resources Manager

APPROVED AS TO FORM:
Ariel Pierre Calonne
City Attorney

By

[Signature]

Business Tax Compliance:
Certificate No. 32050

By

[Signature]

Approved as to Insurance:

[Signature]
Mark Howard
Risk Manager
EXHIBIT A

Scope of Services
SCOPE OF SERVICES

PRELIMINARY DESIGN SERVICES FOR
RECOMMISSIONING THE CITY'S DESALINATION PLANT
(Subsurface Desalination Intake and Potable Reuse Feasibility Studies).
(Project)

AUTHORIZATION #1: WORK PLAN DEVELOPMENT

BACKGROUND
On September 23, 2014 the City of Santa Barbara City Council directed Public Works Department staff to report back on a plan to evaluate the feasibility of subsurface desalination intake and potable reuse, including indirect and direct potable reuse options. The direction given by CITY Council was to report back on a plan for this evaluation following award of the desalination plant contract in April 2015. Furthermore, on January 30, 2015, the Central Coast Regional Water Quality Control Board (RWQCB) adopted an amendment to the CITY’s El Estero Wastewater Treatment Plant (WWTP) Waste Discharge Requirements (WDR) that included a condition that the CITY should report back to the RWQCB by August of 2015 with a Work Plan for these studies that will have the work completed by June 2017. This scope of services was therefore developed to satisfy the direction of City Council and the RWQCB by preparing a feasibility analysis for subsurface desalination intakes and potable reuse alternatives. This information can be used as part of future planning efforts designed to help the CITY plan for future drought emergencies.

PURPOSE
The purpose of this scope of services is to present the initial tasks required for evaluating the feasibility of subsurface desalination plant intakes and potable reuse alternatives. The feasibility study work product will be developed in a manner so as to accomplish the following objectives:

- Satisfy the requirements of the CITY’s amended Waste Discharge Requirements for the El Estero WWTP.
- Support a future updates to the CITY’s Long Term Water Supply Plan.

This scope of services is the first of three authorizations required to complete this study effort. The three separate authorizations include:

- Authorization #1: Work plan development and literature review.
- Authorization #2: Subsurface desalination intake basis of design and failure analysis; Potable Reuse Feasibility Study.
- Authorization #3: Subsurface desalination intake feasibility study.

The steps involved in this study are described graphically in the programmatic work flow diagrams presented in Figures 1 and 2.
CAROLLO'S SERVICES

TASK 1 – SUBSURFACE DESALINATION INTAKE FEASIBILITY STUDY
The tasks required to perform the services associated with TASK 1 – Subsurface Desalination Intake Feasibility Study are presented below and summarized graphically in the attached Programmatic Work Plan.

1.1 – Work Plan Development
The CITY of Santa Barbara is required to submit a Work Plan for evaluating subsurface desalination intakes to the Central Coast Regional Water Quality Control Board (RWQCB) by August 2015. As part of CAROLLO's services included in this Scope of Work, CAROLLO will conduct a kickoff meeting with the CITY to develop a Work Plan that has the following objectives:

- Establish the project schedule.
- Establish technical advisory panel role, procedures and objectives.
  - It is anticipated that the technical advisory process will be facilitated by the National Water Research Institute (NWRI). The technical advisors will include a panel of approximately four (4) experts (chosen and retained by NWRI).
  - It is anticipated that up to three (3) technical advisory workshops will be included in the Work Plan. These workshops will occur throughout the project at points that coincide with project work product development and completion. The points at which these technical advisory workshops occur will be established in the Work Plan.
  - It is anticipated that the panel will review and advise on technical studies and conclusions of CAROLLO and CITY.
  - It is anticipated that public comments will be facilitated by NWRI as part of the Technical Advisory Panel meetings. Applicable public comments/sentiment (i.e., consistent with regulatory framework) will be incorporated thereafter into the feasibility screening analysis.
- Establish the role of outside agencies (e.g., RWQCB, California Coastal Commission, etc.) and City residents.
- Establish the methods by which the design basis will be established. Design basis includes:
  - Intake capacity
  - Candidate sites for study
- Establish the types of subsurface intakes that will be studied (e.g., vertical wells, lateral beach wells, horizontal collector wells (i.e., Ranney wells), slant wells, subsurface infiltration galleries (SIG), and horizontally directionally drilled (HDD) wells (i.e., Neodren))
- Establish and define fatal flaws that may limit further consideration of project sites, which may include: available land, known geologic hazards/conditions (e.g., proximity of faults, depth to bedrock, transmissivity of soils, etc.), proximity to marshes that may be affected by intake use, anticipated loss of facilities due to erosion, etc.
- Establish and define feasibility screening criteria (e.g., constructability, permitability, impact to the CITY’s drinking water aquifers, estimated environmental impacts during construction, impact to rate payers, etc.).
- Establish sequencing of analyses and application of feasibility screening criteria.
- Establish procedure to identify sites for subsurface intakes and raw water conveyance piping
- Procedure to determine subsurface properties (if applicable). Examples include:
- Review literature data to establish sites to focus study.
- Collect new data:
  - Identify permits required and establish application procedure
  - Sequence of subsurface data collection.
- Establish procedure to model subsurface intake's influence on the sustainability of the CITY's drinking water aquifer.
- Establish procedure to estimate subsurface intake water quality and additional treatment needs.
- Establish and define metrics to compare subsurface intake alternatives to the CITY's current open ocean intake. These metrics may include:
  - Reliability of intake water supply
  - Benefit to treatment process costs
  - Impact to CITY's groundwater supply
  - Construction phase environmental impact (monetized)
  - Operation phase treatment impacts (monetized)
  - Impact to rate payers
- Establish scoring methodology to use.

To maximize the Work Plan development / kickoff meeting's potential, CAROLLO will distribute kickoff meeting agenda, which will include some assignments for CITY staff to consider before the meeting date (e.g., possible feasibility screening criteria and their definitions, site alternatives for facilities and conveyance of raw water, etc.). Following the kickoff meeting, CAROLLO will:
- Prepare meeting minutes to identify action items and data needs.
- Develop a draft Work Plan that will be submitted to the Central Coast RWQCB staff for review.
  - Upon receipt of the RWQCB's comments, CAROLLO will prepare a final Work Plan.

Following acceptance of the Work Plan by the RWQCB, in concert with the data collected as part of Task 1.2 (Literature Review), CAROLLO will prepare a draft Technical Memorandum (TM) that will be used as part of the technical advisory process (TM 1 (Revision 0)) and summarizes the pertinent background information, definitions for feasibility screening criteria that were established, and the subsurface desalination intake alternatives that will be evaluated. The CITY will review this TM and provide comments back to CAROLLO within 1 week following submission of the draft TM. CAROLLO will incorporate any comments into a revised TM (TM 1 (Revision 1)) that will be used as supporting material for the technical advisory process discussed in Task 4.1 (Technical Advisory Process). After the technical advisory process is complete, the final TM contents will be used as chapters in the Desalination Subsurface Intake Feasibility Report.

**Task 1.1 Deliverables by CAROLLO**

1. Kickoff Meeting Agenda and Assignments
2. Kickoff Meeting Minutes
3. Draft Work Plan
4. Final Work Plan
5. TM 1 (Revision 0): Introduction, Background and Project Alternatives
6. TM 1 (Revision 1): Introduction, Background and Project Alternatives
1.2 – Literature Review
CAROLLO will collect, review and prepare data to evaluate the subsurface intake alternatives identified. CAROLLO will prepare a formal list of data needs that are either independently collected or requested from the CITY. CAROLLO will provide weekly data gathering list updates during the first month of the project and monthly updates thereafter. It is anticipated that the list will include items such as, but not limited to:

- Published geologic/hydrogeologic studies in the area, including:
  - USGS reports
  - Prior hydrologic and geotechnical studies conducted by the CITY.
- The CITY's 1989 and 1990 subsurface intake studies conducted on East, West and Ledbetter Beaches.
- Geotechnical data associated with the design and installation of piles supporting Stearns Warf.
- Any data related to tsunami hazards, sea level rise and sediment transport (i.e., erosion and deposition) in the areas of East, West and Ledbetter Beaches that may be associated with harbor dredging and mooring. The CITY Waterfront Department may be consulted for this information.
- Basis of design reports for the CITY’s desalination plant (after reactivation and associated improvements).
- Water, sewer, (existing) recycled water and stormwater atlas data in GIS format
- Current or anticipated flood plain maps
- Hydrologic data and studies on existing wells and the groundwater aquifer used for drinking water production, including various USGS hydrogeological and modelling studies.
- Data related to baseline environmental conditions that could be affected by one or more of the intake options.
- California State Waters Map Series—Offshore of Santa Barbara, California

CAROLLO will use the CITY’s Map Analysis and Printing System ([http://gismaps.santabarbararaca.gov/](http://gismaps.santabarbararaca.gov/)) to facilitate development of scaled site plans and graphics.

**Task 1.2 Deliverables by CAROLLO**

1. Data collection lists and updates

### Summary of TASK 1 Project Meetings

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Meeting Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Kickoff Meeting</td>
<td>CAROLLO and CITY will meet to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Discuss CAROLLO’s proposal for Work Plan content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Identify candidate project sites for initial feasibility screening</td>
</tr>
<tr>
<td></td>
<td>Draft Work Plan Meeting</td>
<td>(This meeting will be held at the same time as the kickoff meeting in Task 3.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CAROLLO and CITY will meet to review draft work plan before it is submitted to the RWQCB and Technical Advisory Panel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(This meeting will be held at the same time as the Draft Work Plan Meeting in Task 3.1)</td>
</tr>
</tbody>
</table>
TASK 3 – POTABLE REUSE FEASIBILITY STUDY
The tasks required to perform the services associated with TASK 3 – Potable Reuse Feasibility Study are presented below and summarized graphically in the attached Programmatic Work Plan.

3.1 – Work Plan Development
The CITY of Santa Barbara is required to submit a Work Plan for evaluating potable reuse alternatives to the Central Coast Regional Water Quality Control Board (RWQCB) by August 2015. As part of CAROLLO’s services included in this Scope of Work, CAROLLO will conduct a kickoff meeting with the CITY to develop a Work Plan that has the following objectives:

- Establish the project schedule.
- Establish technical advisory panel role, procedures and objectives.
  - It is anticipated that the technical advisory process will be facilitated by the National Water Research Institute (NWRI). The technical advisory panel will include a panel of approximately four (4) experts (chosen and retained by NWRI) as well as representatives from various regulatory agencies as determined appropriate.
  - It is anticipated that up to three (3) technical advisory panel workshops will be included in the Work Plan. These workshops will occur throughout the project at points that coincide with project work product development and completion. The points at which these technical advisory panel workshops occur will be established in the Work Plan.
  - It is anticipated that the panel will review and advise on technical studies and conclusions of CAROLLO and CITY.
  - It is anticipated that public comments will be facilitated by NWRI as part of the Technical Advisory Panel meetings. Public comments/sentiment will be incorporated thereafter into the feasibility screening analysis.
- Establish the role of outside agencies (e.g., RWQCB, California Coastal Commission, etc.) and City residents.
- Establish and define fatal flaws that may limit further consideration of project sites, which may include: poor aquifer transmissivity, known geologic hazards, small site, etc.
- Establish and define feasibility screening criteria (e.g., estimated environmental impacts, permitability, improves the reliability of the CITY’s water supply, impact to rate payers, potable water quality benefits, etc.).
- Establish sequencing of analyses and application of feasibility screening criteria.
- Procedure to identify the capacity of potable reuse supply that is available.
- Identify possible sites for treatment, storage and distribution facilities to evaluate when considering both Direct Potable Reuse (DPR) and Indirect Potable Reuse (IPR) alternatives.
  - It is anticipated that up to twenty (20) site/process/routing/size alternatives may be considered for further analysis against the feasibility screening criteria identified. Possible treatment facility location options may include (but may not be limited to):
    - 401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006), and
    - 103 S. Calle Cesar Chavez (APN #017-113-020)
    - Repurposing the Charles Meyer Desalination Plant located at 525 E. Yanonali Street
- Possible indirect potable recharge locations may include (but may not be limited to):
  - Recharge wells in the foothills basin (near Route 154 and Highway 101)
  - Recharge wells in groundwater basin referred to as “Unit 1” (north of Highway 101)
Infiltration of water (i.e., like a spreading basin) in Mission Creek before Oak Park. Possible potable reuse options may include (but may not be limited to):
- Discharge of advanced treated wastewater into Lauro Canyon Reservoir (a.k.a., raw water production).
- Dilution and off-setting the intake volume of seawater flowing to the Charles Meyer Desalination Plant
- Establish and define metrics to compare potable reuse alternatives to the CITY’s current drought plan (i.e., desalination).
- Establish scoring methodology to use

To maximize the Work Plan development / kickoff meeting’s potential, CAROLLO will distribute kickoff meeting agenda, which will include some assignments for CITY staff to consider before the meeting date (e.g., possible feasibility screening criteria and their definitions, site alternatives for facilities and distribution of treated water, etc.). Following the kickoff meeting, CAROLLO will:
- Prepare meeting minutes to identify action items and data needs.
- Develop a draft Work Plan that will be submitted to the Central Coast RWQCB staff for review.
  - Upon receipt of the RWQCB’s comments, CAROLLO will prepare a final Work Plan.

Following acceptance of the Work Plan by the RWQCB, in concert with the data collected as part of Task 3.2 (Data Gathering), CAROLLO will prepare a draft Technical Memorandum (TM) that will be used as part of the technical advisory process (TM 1 (Revision 0)) and summarizes the pertinent background information, definitions for feasibility screening criteria that were established, and the IPR/DPR alternatives that will be evaluated. The CITY will review this TM and provide comments back to CAROLLO within 1 week following submission of the draft TM. CAROLLO will incorporate any comments into a revised TM (TM 1 (Revision 1)) that will be used as supporting material for the technical advisory process discussed in Task 4.1 (Technical Advisory Process). After the technical advisory process is complete, the final TM contents will be used as chapters in the Potable Reuse Feasibility Report.

Task 3.1 Deliverables by CAROLLO
1. Kickoff Meeting Agenda and Assignments
2. Kickoff Meeting Minutes
3. Draft Work Plan
4. Final Work Plan
5. TM 1 (Revision 0): Introduction, Background and Project Alternatives
6. TM 1 (Revision 1): Introduction, Background and Project Alternatives

3.2 – Data Gathering
CAROLLO will collect, review and prepare data to evaluate the study alternatives identified. CAROLLO will prepare a formal list of data requested and provide weekly data gathering list updates during the first month of the project and monthly updates thereafter. It is anticipated that the list will include items such as, but not limited to:
- Basis of design reports for the CITY’s recycled water treatment system, which should include:
  - Historical effluent flow data (hourly flows over previous 10 years, including drought periods)
4/23/2015

- Existing and projected recycled water demands
- Recycled water quality, including regulated primary and secondary drinking water standards, non-regulated treatment goals, and irrigation water standards (e.g., boron and sodium adsorption ratio).
- Water, sewer, (existing) recycled water and stormwater atlas data in GIS format
- Current or anticipated flood plain maps
- Hydrologic data, aquifer characteristics (thickness, orientation, extent, degree of confinement), estimates of aquifer properties (e.g., T, S), confining layer extent and properties, production well pumping rates, water quality, well logs, and studies on existing wells and the groundwater aquifer used for drinking water production.
- Location and nature of all existing wells in the study area including well logs, geophysical logs, water quality data, water level data, and yield data.
- Soil infiltration rates (for use in estimating infiltration basin capacities)
- Hydrologic data and studies on existing wells and the groundwater aquifer used for drinking water production (e.g., USGS Report).
- Regional (County-wide) reports on potable reuse opportunities that describe:
  - Regional groundwater balance that addresses sustainable yield of groundwater aquifers that are shared by more than one agency.
  - Aquifer adjudication between the City and neighboring agencies.
  - How excess groundwater use by one agency may be balanced by IPR.

CAROLLO will use the CITY's Map Analysis and Printing System (http://gismaps.santabarbararaca.gov/) to facilitate development of scaled site plans and graphics.

**Task 3.2 Deliverables by CAROLLO**

1. Data collection lists and updates

### Summary of TASK 3 Project Meetings

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Meeting Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Kickoff Meeting</td>
<td>CAROLLO and CITY will meet to:</td>
</tr>
<tr>
<td></td>
<td>Draft Work Plan Meeting</td>
<td><em>Discuss CAROLLO's proposals for Work Plan content</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Identify candidate project sites for initial feasibility screening</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>(This meeting will be held at the same time as the kickoff meeting in Task 1.1)</em></td>
</tr>
<tr>
<td></td>
<td>Draft Work Plan Meeting</td>
<td>CAROLLO and CITY will meet to review draft work plan before it is submitted to the RWQCB and Technical Advisory Panel.</td>
</tr>
<tr>
<td></td>
<td>Draft Work Plan Meeting</td>
<td><em>(This meeting will be held at the same time as the Draft Work Plan Meeting in Task 1.1)</em></td>
</tr>
</tbody>
</table>
TASK 4 – PROJECT REVIEW

4.1 – Technical Advisory Process
CAROLLO will retain the services of NWRI to facilitate a technical advisory process that will be defined in the Work Plan developed in Task 1.1 and Task 3.1. It is anticipated the technical advisory process will consist of:
- Approximately four (4) technical advisors (selected and retained by NWRI) with the following qualifications in the areas of both potable reuse and subsurface desalination intakes:
  - Hydrogeologist
  - Engineer or contractor
  - Regulatory/permitting (e.g., CEQA consultant)
  - Water Quality
- Up to four (4) technical advisory panel workshops consisting of the following topics:
  - Workshop 1: Work Plan Review (Task 1 and Task 3) – Included in this Scope of Services (Authorization #1)
  - Workshop 2: Fatal Flaw Analysis (Task 1 and Task 3) – Included in a separate Scope of Services (Authorization #2)
  - Workshop 3: Feasibility Analysis (Potable Reuse) – Included in a separate Scope of Services (Authorization #2)
  - Workshop 4: Feasibility Analysis (Subsurface Desalination Intake) – Included in a separate Scope of Services (Authorization #3)
CAROLLO will prepare technical materials and make presentations to the technical advisory panel.
- NWRI will facilitate technical advisory workshops and public comment.

The Technical Advisory Process will be formally adopted in the Work Plan developed in Task 3.1.

CAROLLO will be responsible for:
- Coordination of workshop dates with workshop participants.
- Preparing and distributing workshop materials to the technical advisors and workshop participants a minimum of 2 weeks prior to the workshop meetings.

CAROLLO’s subconsultant (NWRI) will be responsible for:
- Facilitating the technical advisory panel workshops and public comment.
- Preparing draft and final meeting minutes.

Task 4.1 Deliverables
1. Meeting Agendas and Workshop Materials
2. Draft meeting minutes
3. Final meeting minutes

4.2 – CITY Council Workshops/Meetings
CAROLLO will attend up to three (3) CITY Council workshops or meetings to assist CITY staff in presenting the progress and findings of the studies completed in Tasks 1, 2 and 3.

Task 4.2 Deliverables by CAROLLO
1. Powerpoint presentation for City Council workshop or meeting
Summary of TASK 4 Project Meetings (Authorization #1)

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Meeting Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Technical Advisory Panel Workshop #1 (Task 1.1 and 3.1)</td>
<td>This meeting will be facilitated by NWRI and have the following objectives:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Following meeting with CITY staff to review Draft Work Plans submitted under Tasks 1.1 and 3.1, CAROLLO and CITY will meet with Technical Advisory Panel to review Draft Work Plans. CAROLLO will present Draft Work Plan to technical advisory panel and interested parties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- NWRI will facilitate and receive comments from the audience on work plan approach.</td>
</tr>
</tbody>
</table>

TIME OF PERFORMANCE
The project schedule will be further refined during the work plan development, however the CITY is required to submit a draft work plan to the RWQCB by August 2015 and a final Feasibility Study Report by June 2017. It is anticipated that CAROLLO will provide services based upon the schedule presented in Attachment A.

PAYMENT
Payment will be based upon the terms stated in the contract Agreement between CAROLLO and the CITY. Invoices will be submitted by CAROLLO to the CITY on a monthly basis and will include CAROLLO’s labor hours and direct costs, along with supporting invoices and the CITY’s invoice cover sheet. Refer to the attached table for a schedule of fees involved with this Scope of Services.
<table>
<thead>
<tr>
<th>Task</th>
<th>Details</th>
<th>Duration (months)</th>
<th>Cost (USD)</th>
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<tr>
<td>Task 1</td>
<td>Description 1</td>
<td>2</td>
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<tr>
<td>Task 2</td>
<td>Description 2</td>
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</tr>
<tr>
<td>Task 3</td>
<td>Description 3</td>
<td>4</td>
<td>18,000</td>
</tr>
<tr>
<td>Task 4</td>
<td>Description 4</td>
<td>5</td>
<td>20,000</td>
</tr>
</tbody>
</table>

1. Task Description 1 is a detailed plan that will require significant effort and will incur a cost of $12,000.
2. Task Description 2 involves complex engineering work and will cost $15,000.
3. Task Description 3 requires detailed analysis and planning, estimated at $18,000.
4. Task Description 4 is a comprehensive project and will cost $20,000.

Note: All tasks are subject to change based on the project's needs and budget constraints.
EXHIBIT B

Contractor's Nondiscriminatory Employment Certificate
CONTRACTOR'S NONDISCRIMINATORY EMPLOYMENT CERTIFICATE
Santa Barbara Municipal Code § 9.126.020

A. Certificate Generally

Consistent with a policy of nondiscrimination in employment on contracts of the City of Santa Barbara and in furtherance of the provisions of Section 1735 and 1777.6 of the California Labor Code a "contractor's obligation for nondiscriminatory employment certificate" as hereinafter set forth shall be attached and incorporated by reference as an indispensable and integral term of all bid specifications and contracts of the City for purchases, services, and the construction, repair, or improvement of public works.

B. Contents of Certificate

The Contractor's obligation for nondiscriminatory employment is as follows:

1. The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, national origin, ancestry, sexual orientation, political affiliation or beliefs, sex, age, physical handicap, medical condition, marital status or pregnancy (as those terms are defined by the California Fair Employment and Housing Act -- Government Code Section 12900-12996), except where such discrimination is based on a bona fide occupational qualification. The Contractor will take positive action or ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, national origin, ancestry, sexual orientation, political affiliation or beliefs, sex, age, physical handicap, medical condition, marital status or pregnancy (as those terms are defined by the California Fair Employment and Housing Act -- Government Code Section 12900-12996), except where such discrimination is based on a bona fide occupational qualification. Such action shall include but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the City setting forth the provisions of this nondiscrimination clause.

2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, national origin, ancestry, sexual orientation, political affiliation or beliefs, sex, age, physical handicap, medical condition, marital status or pregnancy (as those terms are defined by the California Fair Employment and Housing Act -- Government Code Section 12900-12996), except where such discrimination is based on a bona fide occupational qualification.

3. The Contractor will send to each labor union or representative of workers, with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided by the City advising the said labor union or workers' representative of the Contractor's commitments under this provision, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The Contractor will permit access to his records of employment, employment advertisements, application forms, and other pertinent data and records by the City, the Fair Employment Practices Commission, or any other appropriate agency of the State designated by the City for the purposes of investigation to ascertain compliance with the Contractor's Obligation for Nondiscriminatory Employment provisions of this contract, or Fair Employment Practices statute.
5. A finding of willful violation of the nondiscriminatory employment practices article of this contract or of the Fair Employment Practices Act shall be regarded by the City as a basis for determining that as to future contracts for which the Contractor may submit bids, the Contractor is a "disqualified bidder" for being "nonresponsible".

The City shall deem a finding of willful violation of the Fair Employment Practices Act to have occurred upon receipt of written notice from the Fair Employment Practices Commission that it has investigated and determined that the Contractor has violated the Fair Employment Practices Act and has issued an order under Labor Code Section 1426 or obtained an injunction under Labor Code Section 1429.

Upon receipt of any such written notice, the City shall notify the Contractor that unless he demonstrates to the satisfaction of the City within a stated period that the violation has been corrected, he shall be declared a "disqualified bidder" until such time as the Contractor can demonstrate that he has implemented remedial measures, satisfactory to the City, to eliminate the discriminatory employment practices which constituted the violation found by the Fair Employment Practices Commission.

6. Upon receipt from any person of a complaint of alleged discrimination under any City contract, the City Administrator shall ascertain whether probable cause for such complaint exists. If probable cause for the complaint is found, the City Administrator shall request the City Council to hold a public hearing to determine the existence of a discriminatory practice in violation of this contract.

In addition to any other remedy or action provided by law or the terms of this contract, the Contractor agrees that, should the City Council determine after a public hearing duly noticed to the Contractor that the Contractor has not complied with the nondiscriminatory employment practices provisions of this contract or has willfully violated such provisions, the City may, without liability of any kind, terminate, cancel, or suspend this contract, in whole or in part. In addition, upon such determination the Contractor shall, as a penalty to the City, forfeit a penalty of $25.00 for each calendar day, or portion thereof, for each person who was denied employment as a result of such noncompliance. Such moneys shall be recovered from the Contractor. The City may deduct any such penalties from any moneys due the Contractor from the City.

7. The Contractor certifies to the City that he has met or will meet the following standards for positive compliance, which shall be evaluated in each case by the City:

   a. The Contractor shall notify all supervisors, foremen and other personnel officers in writing of the content of the nondiscrimination provision and their responsibilities under it.

   b. The Contractor shall notify all sources of employee referrals (including unions, employment agencies, advertisements, Department of Employment) of the content of the nondiscrimination provision.

   c. The Contractor shall file a basic compliance report as required by the City. Willfully false statements made in such reports shall be punishable as provided by law. The compliance report shall also specify the sources of the work force and who has the responsibility for determining whom to hire, or whether or not to hire.

   d. The Contractor shall notify the City of opposition to the nondiscrimination provision by individuals, firms or organizations during the period of this contract.

8. Nothing contained in this Contractor's Obligation for Nondiscriminatory Employment Certificate shall be construed in any manner to prevent the City from pursuing any other remedies that may be available at law.
9. The Contractor certifies to the City that he will comply with the following requirements with regard to all subcontractors and suppliers:

a. In the performance of the work under this contract, the Contractor will include the provisions of the foregoing paragraphs (1) through (8) in all subcontracts and in any supply contract to be performed within the State of California, so that such provisions will be equally binding upon each subcontractor and each supplier.

b. Contractor will take such action with respect to any subcontract or purchase order as the City may direct as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction by the City, the Contractor may request the City to enter into such litigation to protect the interests of the City.
EXHIBIT C

Contractor's Living Wage Certificate
LIVING WAGE CERTIFICATION

Official notification to: ________________________________.

__________________________________________.

The service contract that is pending between your company and the City of Santa Barbara is subject to the City of Santa Barbara Living Wage Ordinance, SBMC Chapter 9.128 (hereinafter referred to as "the Ordinance"). Pursuant to this ordinance, you are hereby notified that your company is required to demonstrate compliance by completing and returning the attached compliance statement. This statement must be completed and returned before contract commencement. You may fax the compliance statement to: either the requesting department or to the City of Santa Barbara Finance Department (Purchasing) at (805) 897-1977.

Please Note: Current living wage rates will apply to all subsequent contracts and amendments during the remainder of the current fiscal year ending June 30, 2015.

The City of Santa Barbara Living Wage Ordinance was adopted on April 4, 2006 (Ordinance number 5384). All capitalized terms used herein are used as defined in the Ordinance. The Ordinance requires that persons directly working or City of Santa Barbara contracts, for services specified in the ordinance, are to be paid a living wage while working on the City of Santa Barbara contract. The Ordinance only applies to those persons directly providing services to the City and does not apply to administrative or support staff employees of a Service Contract, such as administrators, payroll, personnel, or similar employees. The Ordinance also does not apply to employees who are Handicapped, Apprentices, Learners, or Student Interns, who are otherwise part of an employer's training program as those terms are defined in the Ordinance. The Ordinance also states that employees have the right to expressly negotiate and agree to wage and benefit levels different than those required by the Ordinance.

The Ordinance requires that employees working for your firm on this contract be notified that the City of Santa Barbara Living Wage Ordinance applies to them. As part of compliance for this contract, you are required to notify affected employees.

Effective from July 1, 2014, through June 30, 2015, the current rate for minimum compensation to employees is:

1. If benefits are not provided to an Employee, a wage of no less than $16.70 per hour.

2. If Basic Medical Insurance and Compensated Holidays are provided to the Employee, a wage of no less than $14.32 per hour.

3. If Supplemental Employee Benefits are provided to the Employee, a wage of no less than $13.12 per hour.

(All capitalized terms used herein are used as defined in the Ordinance, SBMC Chapter 9.128)

Also be advised that the City may request any or all certified payrolls associated with this contract, however, any such request will be made to your firm in writing and provide fourteen calendar days to respond. The City may also conduct on-site audits to verify compliance. These audits may include, but are not limited to, employee interviews.

Direct questions regarding this Ordinance to General Services Manager, City of Santa Barbara Finance Department, P.O. Box 1990, Santa Barbara, CA 93102.
1. * Select A, B C or D below.

☐ A. The Living Wage Ordinance does not apply to this contract because:
   ☐ Exemption for Handicapped Individuals and Apprentices. For the purposes of this form, an employee shall not include a "handicapped employee" employed pursuant to a special license issued under Sections 1191 and 1191.5 of the state Labor Code or an "apprentice" or "learner" employed pursuant to a special license issued under Section 1192 of the state Labor Code.
   ☐ Exemption for Student Interns. For the purposes of this form, an employee shall also not include a student intern which shall be defined as a person receiving educational or school credit at a duly licensed and accredited school or educational institution as part of or in connection with his or her employment or service with the City Service Contractor.
   ☐ Public Entity.
   ☐ Non-profit exemption.
   ☐ Workers are part of a bona fide collective bargaining agreement.
   ☐ Persons employed are defined as executive or professional as used in the federal Fair Labors Standards Act of 1938 (29 USC Section 201 et. seq.).
   ☐ Services are incidental. Explain: __________________________________________

* Complete the certification portion on page 3.

☐ B. Employees working on City of Santa Barbara contracts receive a pay rate that meets or exceeds the City of Santa Barbara Living Wage requirement of $16.70 per hour without benefits.
   * Complete items #2, #3, #4, #5 and the certification portion on page 3.

☐ C. Employees working on City of Santa Barbara contracts receive a pay rate that meets the City of Santa Barbara Living Wage requirement of $14.32 per hour with the following benefits:
   1. A combined twelve days compensated leave time annually for full-time employees, and prorated leave for employees working less than full time
   2. Basic Medical Insurance Coverage for the Employee.
   * Complete items #2, #3, #4, #5, #6 and the certification portion on page 3.

☐ D. Employees working on City of Santa Barbara contracts receive a pay rate that meets the City of Santa Barbara Living Wage requirement of $13.12 per hour with all of the following benefits:
   1. A combined twelve days compensated leave time annually for full-time employees, and prorated leave for employees working less than full time
   2. Basic Medical Insurance Coverage for the Employee.
3. Basic Medical Insurance Coverage for the Employee’s spouse, domestic partner or family.

4. One additional Supplemental Benefit as defined in the Ordinance.
   - Pension or deferred compensation retirement plan.
   - Childcare or dependent care.
   - Equivalent of ten (10) eight hour days of compensated leave over and above the compensated leave in item 1.
   - Other: ________________________________

   * Complete items #2, #3, #4, #5, #6 and the certification portion on page 3.

2. Will any subcontractors perform work on this contract? ☑ Yes ☐ No
   If yes, please indicate company(s) on an additional page.

3. Will you post employee notification form in an area accessible to employees working on City of Santa Barbara contracts? ☑ Yes ☐ No

4. You may be required to provide certified payroll records, time cards, and other records any time during the contract period to demonstrate compliance. These payroll records must include the following information for each employee working on this contract: employee name, job classification, employer benefit contribution, and hourly pay under this contract.

   Do you agree to provide this information within 14 calendar days when requested? ☑ Yes ☐ No

   The City may also perform on site payroll audits that may include, but are not limited to, employee interviews.

5. a) Please provide the total affect that the Living Wage requirements had on your bid price (i.e., no cost affect, increase bid price by $..., etc.)?
   ☐ No AFFECT
   ☑ Yes

   b) How many employees benefited from the living wage requirement? ☑ Yes

   c) How much did the above employees benefit in aggregate during the contract:
   $0.00

6. The City has several insurance plans. To qualify for a lower wage tier, you must offer insurance at no cost to your employees and match one of the following plans in terms of co-pays/out-of-pocket expenses.

   ☐ Aetna HMO: No deductible, $100 co-pay for emergency room visits, no charge for preventative care, $25 co-pay for office visits to Primary Care Physicians/$35 co-pay to Specialists; Prescriptions: $20 co-pay for generics; $30 co-pay for brand, & $45 co-pay for non-formulary.

   ☐ Kaiser HMO: No deductible, $35 co-pay for emergency room visits, no charge for preventative care, $10 co-pay for office visits; Prescriptions: $5 co-pay for generics; $15 co-pay for brand & non-formulary is not covered.
☐ Aetna Open Access Managed Care PPO: Deductibles: $500/individual
$1,000/family, $100 co-pay + 20% coinsurance for emergency room visits, no charge for preventative care, $25 co-pay for office visits; Prescriptions: $20 co-pay for generics; $30 co-pay for brand, & $45 for non-formulary.

☐ Aetna Health Reimbursement PPO: Deductibles: $2,000/individual $4,000/family, 20% coinsurance for emergency room visits, no charge for preventative care, 20% coinsurance for office visits; Prescriptions: $10 co-pay for generics; $20 co-pay for brand, & $35 for non-formulary.

☐ Aetna Health Savings Account PPO: Deductibles: $2,500/employee only coverage, $5,000/family, 20% coinsurance for emergency room visits, no charge for preventative care, 20% coinsurance for office visits; Prescriptions: $15 co-pay for generics; $25 co-pay for brand, & $40 for non-formulary.

The signatory below hereby certifies, under penalty of perjury, that the forgoing information is correct:

Company Name

Company Address

City, State, Zip

Contact Name

Phone number

Fax number

Name and Title (Please print)

Signature

Date

April 17, 2015

You may fax the compliance statement to: City of Santa Barbara Finance Department (Purchasing) at (805) 897-1977.
List of Subcontractors/Subconsultants

DUDEK
605 Third Street
Encinitas, CA 92024
Phone: (760) 479-4296
Contact: Joe Monaco

FUGRO WEST, INC.
660 Clarion Court, Suite A
San Luis Obispo, CA 93401
Phone: (805) 542-0797
Contact: Paul Sorensen

GSI WATER SOLUTIONS, INC.
418 Chapala St. Suite F
Santa Barbara, CA 93101
Phone: (805) 895-3956
Contact: Jeff Barry

MICHAEL BAKER INTERNATIONAL
9755 Claremont Mesa Blvd
San Diego, CA 92124
Phone: (858) 614-5000
Contact: Scott Jenkins

NATIONAL WATER RESEARCH INSTITUTE
18770 Ward St
Fountain Valley, CA 92708-0896
Phone: (714) 378-3278
Contact: Jeff Moshier

TENERA
971 Dewing Ave, Suite 101
Lafayette, CA 94549
Phone: (915) 962-9769
Contact: David Mayer

WATER GLOBE CONSULTING
824 Contravest Lane
Winter Springs, FL 32708
Phone: (203) 253-1312
Contact: Nikolay Voutchkov
APPENDIX B – EXAMPLE CHEMICAL MONITORING LISTS
FOR POTABLE WATER REUSE
### Table B-1  Inorganics with Primary MCLs

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Primary MCL (in mg/L)</th>
<th>Constituents</th>
<th>Primary MCL (in mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>1.0</td>
<td>Fluoride</td>
<td>2</td>
</tr>
<tr>
<td>Antimony</td>
<td>0.2</td>
<td>Lead</td>
<td>0.015</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.006</td>
<td>Mercury</td>
<td>0.002</td>
</tr>
<tr>
<td>Asbestos</td>
<td>7 (MFL)</td>
<td>Nickel</td>
<td>0.1</td>
</tr>
<tr>
<td>Barium</td>
<td>1</td>
<td>Nitrate (as NO₃⁺)</td>
<td>45</td>
</tr>
<tr>
<td>Beryllium</td>
<td>0.004</td>
<td>Nitrite (as N)</td>
<td>1</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.005</td>
<td>Total Nitrogen (as N)</td>
<td>10</td>
</tr>
<tr>
<td>Hexavalent Chromium</td>
<td>0.010</td>
<td>Selenium</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper</td>
<td>1.3</td>
<td>Thallium</td>
<td>0.02</td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- MFL = Million fibers per liter, with fiber lengths > 10 microns.
- Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL. The MCL for lead was rescinded with the adoption of the regulatory action level.

### Table B-2  Constituents / Parameters with Secondary MCLs

<table>
<thead>
<tr>
<th>Constituents</th>
<th>MCL (in mg/L)</th>
<th>Constituents(2)</th>
<th>MCL (in mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>0.2</td>
<td>TDS</td>
<td>500</td>
</tr>
<tr>
<td>Color</td>
<td>15 (units)</td>
<td>Specific Conductance</td>
<td>900 μS/cm</td>
</tr>
<tr>
<td>Copper</td>
<td>1</td>
<td>Chloride</td>
<td>250</td>
</tr>
<tr>
<td>Foaming Agents (MBAS)</td>
<td>0.5</td>
<td>Sulfate</td>
<td>250</td>
</tr>
<tr>
<td>Iron</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl-tert-butyl-ether (MTBE)</td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>3 (units)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiobencarb</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>5 (NTU)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table B-3  Radioactivity

<table>
<thead>
<tr>
<th>Constituents</th>
<th>MCL (in pCi/L)</th>
<th>Constituents</th>
<th>MCL (in pCi/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium</td>
<td>20</td>
<td>Gross Beta particle activity</td>
<td>50(^{(2)})</td>
</tr>
<tr>
<td>Combined radium-226 &amp; 228</td>
<td>5</td>
<td>Strontium-90</td>
<td>8(^{(2)})</td>
</tr>
<tr>
<td>Gross alpha particle activity</td>
<td>15</td>
<td>Tritium</td>
<td>20,000(^{(2)})</td>
</tr>
</tbody>
</table>

Notes:
MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

### Table B-4  Regulated Organics

<table>
<thead>
<tr>
<th>Constituents</th>
<th>MCL (in mg/L)</th>
<th>Constituents</th>
<th>MCL (in mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volatile Organic Compounds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>0.001</td>
<td>Monochlorobenzene</td>
<td>0.07</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>0.0005</td>
<td>Styrene</td>
<td>0.1</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>0.6</td>
<td>1,1,2,2-Tetrachloroethane</td>
<td>0.001</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>0.005</td>
<td>Tetrachloroethylene</td>
<td>0.005</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>0.005</td>
<td>Toluene</td>
<td>0.15</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>0.0005</td>
<td>1,2,4 Trichlorobenzene</td>
<td>0.005</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>0.006</td>
<td>1,1,1-Trichloroethane</td>
<td>0.2</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethylene</td>
<td>0.006</td>
<td>1,1,2-Trichloroethane</td>
<td>0.005</td>
</tr>
<tr>
<td>trans-1,2-Dichloroethylene</td>
<td>0.01</td>
<td>Trichloroethylene</td>
<td>0.005</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>0.005</td>
<td>Trichlorofluoromethane</td>
<td>0.15</td>
</tr>
<tr>
<td>1,3-Dichloropropene</td>
<td>0.0005</td>
<td>1,1,2-Trichloro-1,2,2-Trifluoroethane</td>
<td>1.2</td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>0.005</td>
<td>Vinyl chloride</td>
<td>0.0005</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>0.3</td>
<td>Xylenes</td>
<td>1.75</td>
</tr>
<tr>
<td>Methyl-tert-butyl ether (MTBE)</td>
<td>0.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SVOCs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alachlor</td>
<td>0.002</td>
<td>Hexachlorobenzene</td>
<td>0.001</td>
</tr>
<tr>
<td>Atrazine</td>
<td>0.001</td>
<td>Hexachlorocyclopentadiene</td>
<td>0.05</td>
</tr>
<tr>
<td>Bentazon</td>
<td>0.018</td>
<td>Lindane</td>
<td>0.0002</td>
</tr>
<tr>
<td>Benzo(a) Pyrene</td>
<td>0.0002</td>
<td>Methoxychlor</td>
<td>0.03</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>0.018</td>
<td>Molinate</td>
<td>0.02</td>
</tr>
<tr>
<td>Chlordane</td>
<td>0.0001</td>
<td>Oxamyl</td>
<td>0.05</td>
</tr>
<tr>
<td>Dalapon</td>
<td>0.2</td>
<td>Pentachlorophenol</td>
<td>0.001</td>
</tr>
<tr>
<td>Constituents</td>
<td>MCL (in mg/L)</td>
<td>Constituents</td>
<td>MCL (in mg/L)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------</td>
<td>------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Dibromochloropropane</td>
<td>0.0002</td>
<td>Picloram</td>
<td>0.5</td>
</tr>
<tr>
<td>Di(2-ethylhexyl)adipate</td>
<td>0.4</td>
<td>Polychlorinated</td>
<td>0.0005</td>
</tr>
<tr>
<td>Di(2-ethylhexyl)phthalate</td>
<td>0.004</td>
<td>Pentachlorophenol</td>
<td>0.001</td>
</tr>
<tr>
<td>2,4-D</td>
<td>0.07</td>
<td>Picloram</td>
<td>0.5</td>
</tr>
<tr>
<td>Dinoseb</td>
<td>0.007</td>
<td>Polychlorinated</td>
<td>0.0005</td>
</tr>
<tr>
<td>Diquat</td>
<td>0.02</td>
<td>Simazine</td>
<td>0.004</td>
</tr>
<tr>
<td>Endothall</td>
<td>0.1</td>
<td>Thiobencarb</td>
<td>0.07/0.001(2)</td>
</tr>
<tr>
<td>Endrin</td>
<td>0.002</td>
<td>Toxaphene</td>
<td>0.003</td>
</tr>
<tr>
<td>Ethylene Dibromide</td>
<td>0.00005</td>
<td>2,3,7,8-TCDD (Dioxin)</td>
<td>3x10^-8</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>0.7</td>
<td>2,4,5-TP (Silvex)</td>
<td>0.05</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.00001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heptachlor Epoxide</td>
<td>0.00001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
second value is listed as a Secondary MCL
### Table B-5  Disinfection By-products

<table>
<thead>
<tr>
<th>Constituents</th>
<th>MCL (in mg/L)</th>
<th>Constituents</th>
<th>MCL (in mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Trihalomethanes</td>
<td>0.080</td>
<td>Bromate</td>
<td>0.010</td>
</tr>
<tr>
<td>Total haloacetic acids</td>
<td>0.060</td>
<td>Chlorite</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### Table B-6  Constituents with Notification Levels

<table>
<thead>
<tr>
<th>Constituents</th>
<th>NL (in μg/L)</th>
<th>Constituents</th>
<th>NL (in μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boron</td>
<td>1000</td>
<td>Manganese</td>
<td>500(2)</td>
</tr>
<tr>
<td>n-Butylbenzene</td>
<td>260</td>
<td>Methyl isobutyl ketone (MIBK)</td>
<td>120</td>
</tr>
<tr>
<td>sec-Butylbenzene</td>
<td>260</td>
<td>Naphthalene</td>
<td>17</td>
</tr>
<tr>
<td>tert-Butylbenzene</td>
<td>260</td>
<td>N-Nitrosodiethylamine (NDEA)</td>
<td>0.01</td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>160</td>
<td>N-Nitrosodimethylamine (NDMA)</td>
<td>0.01</td>
</tr>
<tr>
<td>Chlorate</td>
<td>800</td>
<td>N-Nitrosodi-n-propylamine (NDPA)</td>
<td>0.01</td>
</tr>
<tr>
<td>2-Chlorotoluene</td>
<td>140</td>
<td>Propachlor**</td>
<td>90</td>
</tr>
<tr>
<td>4-Chlorotoluene</td>
<td>140</td>
<td>n-Propylbenzene</td>
<td>260</td>
</tr>
<tr>
<td>Diazinon</td>
<td>1.2</td>
<td>RDX</td>
<td>3</td>
</tr>
<tr>
<td>Dichlorodifluoromethane</td>
<td>1000</td>
<td>Tertiary butyl alcohol (TBA)</td>
<td>12</td>
</tr>
<tr>
<td>1,4-Dioxane(3)</td>
<td>1(3)</td>
<td>1,2,3-Trichloropropane (1,2,3-TCP)</td>
<td>0.005</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>14000</td>
<td>1,2,4-Trimethylbenzene</td>
<td>330</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>100</td>
<td>1,3,5-Trimethylbenzene</td>
<td>330</td>
</tr>
<tr>
<td>HMX</td>
<td>350</td>
<td>2,4,6-Trinitrotoluene (TNT)</td>
<td>1</td>
</tr>
<tr>
<td>Isopropylbenzene</td>
<td>770</td>
<td>Vanadium</td>
<td>50</td>
</tr>
</tbody>
</table>

Notes:


The web link above also contains the levels of the pollutants in this table that must result in a removal of the water source from service.
Technical Feasibility Evaluation

Hydrogeologic Analysis of Indirect Potable Reuse Alternatives, Santa Barbara Desalination Project

Prepared for:
Carollo Engineers

July 14, 2016
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Executive Summary

In coordination with Carollo Engineers and Fugro Consultants, this technical report provides the results of an evaluation of two indirect potable reuse (IPR) alternatives (groundwater replenishment). These alternatives would eliminate the use of the City of Santa Barbara’s (City) existing desalination supply that currently uses a screened open ocean intake and supplies seawater to the City’s Charles Meyer Desalination Plant (Desal Plant), which is permitted to produce 10,000 acre-feet per year (AFY) of potable water. In accordance with the Potable Reuse Work Plan (Carollo, 2015), this report provides technical analyses of whether any single IPR alternative can fully replace the City's desalination supply, and thereby eliminate the use of the City's ocean intake. The study area focused on the two groundwater basins underlying the City – the Foothill Basin and the groundwater basin referred to as “Storage Unit I.” Groundwater replenishment may be achieved via surface application of recycled water (percolation) or via subsurface application of recycled water (direct injection into the primary groundwater production zones). The groundwater replenishment methods and locations were organized into two IPR alternatives for evaluation using a preliminary numerical groundwater flow and transport model developed by the U.S. Geological Survey (USGS) for the City.

The IPR alternatives considered included:

1. Surface and subsurface application of recycled water in upgradient portions of the Foothill Basin and Storage Unit I (IPR Alternative No. 1)

2. Subsurface application of recycled water to create a seawater intrusion injection barrier (IPR Alternative No. 2)

IPR Alternative No. 1 (Upgradient Recycled Water Recharge and Recovery)

Groundwater modeling results indicate that the basins are capable of accepting approximately 250 AFY of recycled water recharge on average without increasing pumping above historical amounts. In this scenario (without increased pumping), all of the recycled water recharge is achieved via surface application with tertiary treated recycled water and the majority of the recycled water recharge (87 percent) occurred in the Foothill Basin. If basin-wide pumping is increased simultaneously with recycled water recharge, the modeling results indicate that approximately 8,500 AFY of recycled water recharge, on average, can be accepted by the basins\(^1\). Approximately 9 percent of this simulated recharge volume (with increased basin pumping) is via surface application with tertiary treated recycled water and 91 percent via subsurface application with fully advanced treated (FAT) recycled water. In both cases, when recharging with tertiary treated recycled water, the City would need to demonstrate that total organic carbon (TOC) concentrations do not exceed 0.5 milligram per liter (mg/L) in the source water or that sufficient TOC removal is achieved via soil-aquifer treatment or dilution from mixing with groundwater or surface water. If this requirement is not met, the City would be required to blend the tertiary treated recycled water with potable water or FAT water, thereby reducing the effective yield of

\(^{1}\) Approximately 5,400 and 3,100 AFY in Storage Unit I and Foothill Basin, respectively.
surface recharge with tertiary treated recycled water project by up to 80 percent. If this were the case, the overall yield of the increased pumping scenario would be reduced to approximately 7,900 AFY.

There are additional restrictions to the overall implementation of IPR within Storage Unit I and the Foothill Basin associated with pre-existing contaminated areas and various geologic hazards (liquefaction, slope failure, and high groundwater) as described in Sections 4.2.3 thru 4.2.5.

Considerations of risks associated with proximity of pre-existing contaminated areas to injection or recovery wells is minimized by the presence of the low permeability confining layer that exists above the Upper Producing Zone (UPZ) throughout both basins except in the uppermost (mountain front) portions where new wells are not planned. Because the proposed well locations are based on a series of hydrogeologic criteria, some of the planning-level locations of injection or recovery wells may be near sites with known shallow groundwater or soil contamination. If IPR planning is carried forward into a more detailed design, permitting, and planning phase, all of the proposed sites would undergo more rigorous consideration. Based on the hydrogeologic considerations used in this preliminary injection and recovery well site selection, alternative sites likely could be identified if issues such as potential risk to existing contaminated sites are identified.

Consideration of risks associated with geologic hazards is primarily related to the water level effects of surface infiltration recharge; injection into deep, confined aquifers is not anticipated to change water levels in the near surface, Shallow Zone, sediments. The yield associated with surface infiltration is approximately 740 AFY and, for the following reasons, is considered to be not technically feasible:

1. Risks to property and buildings cannot be adequately quantified in this screening-level analysis.
2. Potential undesirable effects on native habitat or creation of new habitat along the streambeds.
3. A lengthy, dedicated non-potable pipeline extension would be required to convey the tertiary treated water to the potential recharge sites.
4. Uncertainty regarding the ability to meet the TOC requirement, and the associated potential need to provide diluent water.

**IPR Alternative No. 2 (Seawater Intrusion Barrier)**

The groundwater modeling results indicate that the capacity of the Storage Unit I producing zones to accept, store, and transmit recycled water, is limited in the coastal portion of the basin. The modeling results indicate that even with increased pumping inland of the barrier, only approximately 740 AFY of recycled water can be injected to form a seawater intrusion barrier before excessive head buildup occurs at the injection sites. Additionally, the model results indicate that the barrier would *not* completely prevent seawater intrusion even with 24 simulated barrier wells. Although it may be possible to create an effective seawater intrusion barrier with even more wells, the total volume of injected recycled water and associated recovered groundwater would not increase materially. The modeling results indicate that the IPR Alternative No. 2 is not technically feasible.
1 Introduction

On behalf of the City of Santa Barbara (City) and in coordination with Carollo Engineers and Fugro Consultants, this technical report provides the results of an evaluation of two indirect potable reuse (IPR) alternatives (groundwater replenishment). These alternatives would eliminate the use of the City’s existing desalination supply that currently uses a screened open ocean intake and supplies seawater to the City’s Charles Meyer Desalination Plant (Desal Plant), which is permitted to produce 10,000 acre-feet per year (AFY) of potable water. This work was completed in accordance with the Potable Reuse Work Plan (Carollo, 2015) (the Work Plan). The basis of design for the Desal Plant intake and the full permitted capacity of the City’s existing ocean intake is 15,898 gallons per minute (gpm) (22.9 million gallons per day [mgd]), which is the intake flow required to produce 10,000 AFY of desalinated water. This report provides technical analyses to determine the maximum yield of each IPR alternative and whether any single IPR alternative can fully replace the 10,000 AFY target yield of the Desal Plant.

2 Background

The following sections describe the study area and IPR alternatives considered in this technical feasibility evaluation.

2.1 Study Area

The study area for the hydrogeologic analysis of the IPR alternatives includes the Foothill Groundwater Basin (Foothill Basin) and Storage Unit I of the Santa Barbara Groundwater Basin (Storage Unit I). A map of the study area is presented as Figure 1.

2.2 Groundwater Replenishment Methods and IPR Alternatives

As described in the Work Plan, the groundwater replenishment methods for IPR evaluation include surface application of water (percolation in creek beds) and subsurface application (injection wells) at various locations within the basins. The groundwater replenishment methods and locations were organized into two IPR alternatives for evaluation. The IPR alternatives are:

1. Surface and subsurface application of recycled water in the upgradient portions of the Foothill Basin and Storage Unit I (IPR Alternative No. 1)

2. Subsurface application of recycled water to create a seawater intrusion injection barrier (IPR Alternative No. 2)

The final recharge locations for each IPR alternative that were evaluated using the groundwater modeling described in this technical memorandum are shown on Figure 2a and Figure 3. As described in more detail in this report, the seawater intrusion barrier alternative was identified as not technically feasible because it would not create a complete barrier to seawater intrusion without an unreasonable number of wells (more than the 24 used in the modeling exercise) and a
portion of the injected water would be lost via underflow to the ocean. If the seawater intrusion barrier alternative had been identified as feasible, a combination of recycled water recharge for that purpose along with the overall basin injection and recovery IPR wells would have been considered. However, given that the seawater intrusion barrier alternative is not technically feasible (see Section 4.3.1), only IPR Alternative No. 1, the injection – recovery well alternative, is evaluated further.
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2.2.1 IPR Alternative No. 1

IPR Alternative No. 1 includes both surface and subsurface application of recycled water in the upgradient portions of the Foothill Basin and Storage Unit I to increase the yield of the basins (Figure 2a).

Surface application sites include portions of the following streams:

- San Roque Creek (Foothill Basin)
- Arroyo Burro (Foothill Basin)
- Cieneguitas Creek (Foothill Basin)
- Atascadero Creek (Foothill Basin)
- Mission Creek (recharges both basins)

For San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek, surface application sites are the upper reaches of each creek along the northern boundary of the Foothill Basin. This is an area where the confining layer within the Santa Barbara Formation is thin, creating opportunities for direct recharge to the principal aquifer zone within the Santa Barbara Formation (hydrogeology of the Foothill Basin is described in Section 3.1.2). For Mission Creek, the surface application site is between Rocky Nook Park and Oak Park, which is the reach of Mission Creek having the highest reported infiltration rates (Martin, 1984).

Subsurface applications sites (injection wells) for both basins were located in the upgradient portions of both basins. The final simulated injection wells are presented in Figure 2a. Additionally, Figure 2b provides a generalized, schematic illustration of groundwater system and IPR components considered in this analysis.

The rationale for selection of the surface and subsurface application sites is described in Section 4.

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2 Pursuant to the U.S. Geological Survey (USGS) model.
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2.2.2 IPR Alternative No. 2

IPR Alternative No. 2 includes subsurface application of recycled water near the coast to provide an effective hydraulic barrier to seawater intrusion in the primary water-producing zones in Storage Unit I of the Santa Barbara Basin. This concept is intended to not only reduce the potential for salt water intrusion during periods of increased pumping in the basin, but it also provides additional water to the basin because a significant fraction of the injected water would flow land-ward toward City production wells. Historical groundwater data indicate that some salt water intrusion occurred during the last drought, and USGS studies indicate some level of seawater intrusion may occur depending on the amount of water pumped from the basin (Martin, 1984). The assumed seawater barrier location is along E. Cabrillo Blvd. The final simulated injection well locations are presented in Figure 3. The injection well locations were determined by completing a series of model runs to determine the well spacing and flow rates necessary to create the hydraulic barrier, as described in Section 4.
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FIGURE 3
IPR Alternative No.2
Recharge Locations
Hydrogeologic Analysis of
Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
City Production Well
IPR Seawater Barrier Well
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Pacific Ocean
San Antioch Creek
Arroyo Burro
Cieneguitas Creek
Atascadero Creek
Sycamore Creek
San Roque Creek
Mission Creek

Date: June 3, 2016
Data Sources: Santa Barbara County, USGS, ESRI
All photos taken on June 1, 2016 by the USA
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3 Subsurface Properties

This section describes the basis of design for subsurface properties that were used to assess groundwater replenishment applications using the preliminary USGS numerical model. The design basis was established by reviewing available literature and publications that describe subsurface properties and characteristics in the vicinity of the target surface and subsurface groundwater replenishment locations and of the basins in general to assess potential recharge rates and basinwide responses to recharge.

3.1 Hydrogeologic Setting

The study area lies within the Santa Barbara and Foothill Groundwater Basins (California Department of Water Resources Bulletin 118 – Basin Nos. 3-17 and 3-53, respectively (DWR, 2003)).

3.1.1 Santa Barbara Groundwater Basin – Storage Unit I

The Santa Barbara Groundwater Basin includes two subbasins referred to as Storage Units I and III (Martin, 1984). There is little groundwater production in Storage Unit III (a single well) because of poor production capability and quality. Thus, the study area does not include Storage Unit III.

The generalized hydrogeologic setting for the portion of the study area located in Storage Unit I is based on USGS Water-Supply Paper 2197 (Martin, 1984). Storage Unit I is a fault-bounded block that is down-dropped relative to Storage Unit III along the Mesa Fault (Martin, 1984). The greatest thickness of unconsolidated deposits in Storage Unit I is approximately 1,000 feet in the area adjacent to the northeast side of the Mesa Fault near the Santa Barbara Harbor (Martin, 1984). Although the unconsolidated deposits in Storage Unit I area progressively thin to the northwest and northeast, the consolidated bedrock contact occurs far beneath the zone of interest for this study.

The unconsolidated deposits of Storage Unit I are subdivided into four zones including, from top to bottom: The Shallow Zone, the Upper Producing Zone (UPZ), the Middle Zone (MZ), and the Lower Producing Zone (LPZ), as illustrated in Figure 4a and 4b. The Shallow Zone is composed of Holocene-and Pleistocene-aged unconsolidated deposits. Water-bearing deposits are present in the Shallow Zone, but are laterally discontinuous. Fine-grained deposits are prevalent in the Shallow Zone, which confine or partly confine the underlying UPZ (Martin, 1984). The Shallow Zone is approximately 200 feet thick in the study area and generally thicken toward the south (seaward), presumably continuing offshore in the study area. The bottom portion of the Shallow Zone is fine-grained and confines the underlying UPZ. The Shallow Zone is not a primary aquifer and is not developed for water supply purposes.

The UPZ underlies the Shallow Zone and is composed of medium to coarse sand with some fine gravel and is generally continuous throughout Storage Unit I (Martin, 1984). The UPZ is underlain by the Middle Zone, which consists of fine-grained deposits interspersed with occasional coarse-grained water-bearing deposits of the upper part of the Santa Barbara Formation (Martin, 1984). The LPZ is composed of medium to coarse sand with fine gravel and shell fragments (Martin, 1984). Most of the groundwater pumping in Storage Unit I is from the LPZ at inland wells located north of Highway 101 (Martin, 1984).

The target zones within Storage Unit I for IPR alternatives include the UPZ, MZ, and LPZ as these are the primary aquifer zones that supply water to the City’s production wells. Surface application of IPR water
percolates through the Shallow Zone and recharges the UPZ. Subsurface application of IPR water (injection) directly targets the UPZ, MZ, and LPZ, where present within the basin.

Figure 4a. Storage Unit I Cross Section Locations

Reprinted from Martin (1984)
Figure 4b. Storage Unit I Cross Sections

Reprinted from Martin (1984)
3.1.2 Foothill Groundwater Basin

The generalized hydrogeologic setting for the portion of the study area located in the Foothill Basin is based on USGS Water-Resources Investigations Report 89-4017 (Freckleton, 1989). The Foothill Basin is bounded by Tertiary sedimentary rocks of the Santa Ynez Mountains on the north and east, the Goleta Groundwater Basin to the west, and Storage Unit I of the Santa Barbara Groundwater Basin to the south. The Goleta, Modoc, and More Ranch faults form the basin boundaries with the Goleta Groundwater Basin. The Mission Ridge fault forms the basin boundary with Storage Unit I. The bounding faults act as groundwater flow barriers that restrict groundwater flow between the basins (Freckleton, 1989).

Water-bearing deposits in the Foothill Basin include Holocene and Pleistocene-aged unconsolidated alluvial deposits, and the water-producing zones within the underlying Santa Barbara Formation (Freckleton, 1989). Figure 5a and 5b depict these units along several cross sections. Groundwater in the Santa Barbara Formation is separated from the alluvium and is confined by a zone of fine-grained deposits in the upper part of the formation that is equivalent to the Middle Zone of Storage Unit I of the Santa Barbara Groundwater Basin (Freckleton, 1989). The Santa Barbara Formation is the principal aquifer in the Foothill Basin (Freckleton, 1989). The greatest thickness of unconsolidated deposits in the Foothill Basin is approximately 700 feet near Mission Ridge fault (Freckleton, 1989). The alluvium and Santa Barbara Formation progressively thin to the north where they contact consolidated bedrock along the basin boundary. The confining layer is thin or absent along much of the northern basing boundary, creating opportunities for direct recharge to the principal aquifer zone within the Santa Barbara Formation.

The target zones within the Foothill Basin for IPR alternatives include the alluvium and Santa Barbara Formation, as these are the primary aquifer zones that supply water to the City’s production wells. Surface application of IPR water percolates through the alluvium and recharges the Santa Barbara Formation. Subsurface application of IPR water (injection) and directly targets the alluvium and Santa Barbara Formation.
Figure 5a. Foothill Basin Cross Section Locations

Reprinted from Freckleton (1989)
Figure 5b. Foothill Basin Cross Sections
Figure 5b. (continued) Foothill Basin Cross Sections

Reprinted from Freckleton (1989)
3.1.3 Data Sources for Subsurface Properties

A literature review was conducted to identify available data sources concerning the hydrogeology in the study area, and, specifically, to assess the subsurface properties in the vicinity of the target surface and subsurface groundwater replenishment locations and in general to assess potential recharge rates and basin wide responses to recharge. An exhaustive list of references was provided in the Work Plan. The extensive knowledge of the basins has been synthesized by the USGS over time and is comprehensively represented in the various groundwater models developed by USGS for the basins that have been developed and refined over the last three decades. The latest groundwater model of the basins is currently being finalized by USGS and was used for the quantitative evaluations of the IPR alternatives.

Table 1 presents the key analysis inputs required for the quantitative evaluations of the IPR alternatives and the corresponding data source utilized in this technical feasibility evaluation:

<table>
<thead>
<tr>
<th>Analysis Input</th>
<th>Primary Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer and Aquitard Hydraulic Properties</td>
<td>USGS Model</td>
</tr>
<tr>
<td>Groundwater Recharge and Discharge (non-IPR)</td>
<td>USGS Model</td>
</tr>
<tr>
<td>Well Production Rates</td>
<td>City Production Wells City of Santa Barbara production well capacity spreadsheet</td>
</tr>
<tr>
<td></td>
<td>Private Wells USGS Model³</td>
</tr>
<tr>
<td>IPR Recovery Wells</td>
<td>Pueblo Water Resources (2013) and USGS Groundwater Model¹</td>
</tr>
<tr>
<td>Injection Rates for Subsurface Application</td>
<td>Pueblo Water Resources (2013), City of Santa Barbara production well capacity spreadsheet, and USGS Groundwater Model¹</td>
</tr>
<tr>
<td>Percolation Rates for Surface Application</td>
<td>Mission Creek Infiltration Rate Martin (1984)</td>
</tr>
<tr>
<td></td>
<td>Infiltration Rates for San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek Freckleton (1989)</td>
</tr>
<tr>
<td></td>
<td>Number of Days Per Month Without Storm Runoff² USGS Gage Data for USGS 11119750 MISSION C NR MISSION ST NR SANTA BARBARA CA <a href="http://waterdata.usgs.gov/ca/nwis/uv?site_no=11119750">http://waterdata.usgs.gov/ca/nwis/uv?site_no=11119750</a></td>
</tr>
</tbody>
</table>

Notes:
1. Surface application of IPR water in creek beds is not effective during periods of storm runoff.
2. See text for further explanation.
3. Historical production rates are already built into the groundwater model.
As noted Table 1 and described in the sections below, several of the analysis inputs were taken directly from or derived from the draft Santa Barbara Groundwater Flow and Solute Transport Model prepared by USGS (the model). This is appropriate because the model has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basin. Further description of the model is provided in Section 4.1.

3.1.4 Evaluation of Analysis Inputs

The following sections describe the evaluation of the data sources listed in Table 1 to arrive at the key analysis inputs for or the quantitative evaluations of the IPR alternatives described in this technical feasibility evaluation.

3.1.4.1 Aquifer and Aquitard Properties

Aquifer and aquitard properties were taken from the model. This is appropriate because the model has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basins.

3.1.4.2 Groundwater Recharge and Discharge

Groundwater recharge and discharge from the basins are calculated by the model during the simulations of the IPR alternatives. This is appropriate because the model has been calibrated to measured historical groundwater levels and chloride concentrations in Storage Unit I and the Foothill Basin.

3.1.4.3 Well Production Rates

Three different types or well production rates were needed for this technical feasibility evaluation:

1. Historical pumping rates for City and private wells during the simulation period. Historical pumping rates were identified by USGS and are incorporated into the groundwater model. Additional evaluation of historical pumping rates was not necessary.

2. Maximum pumping rates for City wells. Maximum pumping rates were taken from the City’s production well capacity spreadsheet. The maximum annual pumping capacities for the City’s wells were calculated assuming the wells are operated 90 percent of the time during each year (~7,900 hours per year) at their respective instantaneous pumping rates. The 90 percent factor is used to account for typical production well maintenance and downtime.

3. Pumping rates for IPR recovery wells. Pumping rates for IPR recovery wells were established by developing a relationship between pumping specific capacity and calibrated model transmissivity at each IPR recovery well location in the model. Pumping specific capacity was based on the City’s newest production well (Corporation Yard #2) (Pueblo Water Resources, 2013). The ratio was calculated of Corporation Yard #2 specific capacity and the calibrated model transmissivity in the model cell where the Corporation Yard #2 well is located. This ratio then was multiplied by the calibrated model transmissivity at each particular IPR recovery well location to estimate the pumping specific capacity for each IPR recovery well. The estimated specific capacity of each IPR recovery well then was multiplied by the maximum available
drawdown\(^3\) during the simulation period to estimate the maximum pumping rate for each well. The results were used to provide an upper limit on IPR recovery well pumping rates for the IPR Alternative No. 1 model simulations. No factor of safety was used to reduce the anticipated production capacity, therefore, the production volumes used for the modeling analysis are likely optimistic/maximum expected values.

3.1.4.4 Injection Rates for Subsurface Application

Injection rates for the injection wells were calculated using the same methodology described above for the IPR recovery wells, except that, based on experience with many injection well projects, the injection specific capacity was assumed to be 50 percent of the pumping specific capacity. Maximum draw-up was established on the basis of drought water levels plus a maximum of 25 pounds per square inch (psi) of pipeline injection pressure.

3.1.4.5 Percolation Volumes for Surface Application

Percolations volumes for surface application of recycled water were calculated using measured infiltration rates reported by Martin (1984) for Mission Creek and reported by Freckleton (1989) for San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek.

The infiltration rate of Mission Creek between Rocky Nook and Oak Parks (the surface application site for Mission Creek) was measured directly during an 8-day controlled release in 1979 (Martin, 1984). The reported infiltration rate is 1.75 acre-feet per day (AF/day).

The infiltration rates for the surface application sites along San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek were calculated using data in Freckleton (1989) and the measured length of each surface application site. An average unit infiltration rate of 0.8 foot/ day was calculated for the creeks using the data reported in Freckleton (1989). The measured length of each surface application site then was multiplied by the unit percolation rate and stream widths reported by Freckleton (1989). The resulting infiltration rates are 0.71, 0.15, 0.31, and 0.55 AF/day for the San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek surface application sites, respectively.

The above-described infiltration rates were then multiplied by the number of days per month without storm runoff to determine monthly percolation volumes for each surface application site\(^4\). The resulting monthly recycled water percolation volumes were used to provide an upper limit on surface recharge for the IPR Alternative No. 1 model simulations. A summary of the annualized upper limits on recycled water percolation rates is provided in Table 2. These percolation rates are based on USGS published reports and have not been adjusted or reduced for operational considerations (clogging or other percolation rate reducing conditions), geologic hazard considerations (liquefaction, slope failure, high groundwater), or habitat-related considerations. As described in Sections 4.2.3 thru 4.2.5, the range of potential negative conditions associated with surface recharge outweighs the potential benefits, and the technique is considered not technically feasible.

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\(^3\) Maximum available drawdown was based on the range of model calibrated groundwater water levels during the simulation period at each well location provided by USGS.

\(^4\) Streamflow data from the USGS gauge on Mission Creek near Mission Street (USGS Gauge No. 11119750) were used to calculate the number of non-storm flow days per month. Flow criterion used was zero cubic feet per second (no flow).
Table 2. Upper Limits of Recycled Water Percolation Rates

<table>
<thead>
<tr>
<th>Subsurface Application Site</th>
<th>Recycled Water Percolation Rate Upper Limits (AFY)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Creek</td>
<td>96 – 616</td>
</tr>
<tr>
<td>San Roque Creek</td>
<td>39 – 250</td>
</tr>
<tr>
<td>Arroyo Burro</td>
<td>8 – 54</td>
</tr>
<tr>
<td>Cieneguitas Creek</td>
<td>17 - 107</td>
</tr>
<tr>
<td>Atascadero Creek</td>
<td>30 -195</td>
</tr>
</tbody>
</table>

Notes:
1. Upper limits calculated for simulation period March 1986 through January 2004. Lower values occur in wet years and higher values occur in dry years.
2. AFY = acre-feet per year

4 Hydrogeologic Analysis of IPR Alternatives

IPR Alternatives Nos. 1 and 2 were evaluated using the preliminary USGS groundwater flow and transport model to determine if either alternative is capable of fully replacing the City’s desalination supply (i.e., permitted at 10,000 AFY), thereby eliminating the use of the Desal Plant’s screened open ocean intake by increasing the yield of the basins through groundwater replenishment with recycled water.

The IPR alternatives considered included:

1. Surface and subsurface application of recycled water in upgradient portions of the Foothill Basin and Storage Unit I (IPR Alternative No. 1)

2. Subsurface application of recycled water to create a seawater intrusion injection barrier (IPR Alternative No. 2)

The IPR alternatives are described more completely in Section 2.2.

4.1 Evaluation Approach

The evaluation approach consisted of using a preliminary numerical groundwater flow and transport model of the Santa Barbara and Foothill Basins to determine the potential increase in basin yield for each IPR alternative.

The numerical model used for the evaluation is the draft Santa Barbara Groundwater Flow and Transport Model (SBFTM) currently under development by USGS (the model). The model is the latest
version of the numerical groundwater flow model that was originally developed for the City’s Long Term Water Supply Program, adopted in 1994. The model is based on SEAWAT-2000, which simulates groundwater flow and seawater intrusion by coupling MODFLOW-2000 with MT3D. A preliminary, draft model abstract, as prepared by USGS (personal comm., Tracy Nishikawa, June 1, 2016) is provided here:

“The City of Santa Barbara, located in coastal southern California, is concerned that excessive groundwater pumping and climate change will lead to chloride (Cl) contamination of its groundwater system from seawater intrusion (SWI). In addition, the city wishes to estimate the effect of continued pumping on the groundwater basin under a variety of initial and climatic conditions. To help address these concerns, the USGS, in cooperation with the city, recently developed the Santa Barbara Flow and Transport Model (SBFTM). SBFTM was developed to simulate SWI under various water-management scenarios, estimate sustainable yield for the groundwater basin, and determine optimal strategies to operate the groundwater basin. The model is based on an existing groundwater-flow model that simulated flow in the Storage Unit I, Storage Unit III, and Foothill groundwater subbasins. To simulate SWI across the offshore fault into Storage Unit I, updates to the existing model were necessary, including the simulation of Cl transport and variable-density flow. As a result, the existing model was updated to SEAWAT, a groundwater-flow and solute-transport modeling program based on MODFLOW-2000 and MT3DMS. The SBFTM is spatially discretized on a grid with 58 rows, 152 columns, and 56 layers for a total of 113,072 active cells. The horizontal discretization is 250 feet by 250 feet and the vertical discretization is variable. Most model cells are approximately 20 feet thick. The 56 model layers follow the contours of the land surface and do not represent specific geologic layers or water-bearing units; however, only the upper, middle, and lower producing zones are simulated. Note that the shallow zone is not simulated. The transient SBFTM is temporally discretized into 43 one-year stress periods from 1929 to 1971 and an additional 504 one-month stress periods from 1972 to 2013. One-year stress periods were used from 1929 to 1971 due to limited pumpage data during these years. One-month stress periods were chosen for the 1972 to 2013 period to simulate monthly and seasonal changes in pumpage and recharge. Five types of observation data were used during model calibration: water levels, water-level drawdowns, chloride concentrations, changes in chloride concentrations, and Mission Creek infiltration rates. The calibrated model can be used to test injection and pumping scenarios; climate change and sea-level rise scenarios; or be coupled with an optimization algorithm to identify optimal water-management strategies.”

USGS staff working on the model indicated that the model is appropriate for evaluating changes in available groundwater storage in the basin as a result of surface or subsurface application of recycled water. The model update was recently completed and the corresponding model report is undergoing technical review at the USGS and will be published in late 2016. USGS staff indicated that the model is completed and calibrated and they were willing to use the model and to generate preliminary results for this technical feasibility evaluation on an informal basis. USGS staff provided the modeling results described later in this report with the following disclaimer:
“These data are preliminary and are subject to revision. They are being provided to meet the need for timely best science. The data are provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the data.”

Thus, it should be understood that the SBFTM and any results derived therefrom are to be considered and represented as preliminary until the USGS finalizes its modeling report.

The simulation period for both alternatives is March 1986 through January 2004 (Figure 6). This period spans the range of potential water levels and, therefore, the ranges of potential recycled water storage in Storage Unit I and the Foothill Basin. The period begins during the drought of the late 1980s/early 1990s and includes the subsequent wet period during which groundwater levels recovered (Storage Unit and Foothill Basin peak groundwater levels were reached in 1999 and 2004, respectively).

Figure 6. Example Hydrographs and Simulation Period

4.1.1 IPR Alternative No. 1

IPR Alternative No. 1 includes both surface and subsurface application of recycled water in the upgradient portions of the Foothill Basin and Storage Unit I (Figure 2a).

4.1.1.1 Recharge Site Selection

Surface application sites include:

- San Roque Creek (Foothill Basin);
- Arroyo Burro (Foothill Basin);
- Cieneguitas Creek (Foothill Basin);
- Atascadero Creek (Foothill Basin); and
• Mission Creek between Rocky Nook Park and Oak Park (recharges both basins\(^5\)).

For San Roque Creek, Arroyo Burro, Cieneguitas Creek, and Atascadero Creek, surface application sites are the upper reaches of each creek along the northern boundary of the Foothill Basin. This is an area where the confining layer within the Santa Barbara Formation is thin, creating opportunities for direct recharge to the principal aquifer zone within the Santa Barbara Formation (the hydrogeology of the Foothill Basin is described in Section 3.1.2). For Mission Creek, the surface application site is between Rocky Nook and Oak Parks, which is the reach of Mission Creek having the highest reported infiltration rates (Martin, 1984).

Subsurface applications sites (injection wells) for both basins are sited in the upgradient portions of each basin. Injection well locations were selected based on two primary criteria. One criterion was model-calibrated transmissivity of the main groundwater producing zones. Areas with greater transmissivity were preferentially selected to minimize the overall number of injection wells needed to maximize recycled water recharge. The other criterion was spacing to allow for the 4-month residence time, which fully advanced treated (FAT) recycled water is required to meet when the residence time is determined via "complex" numerical modeling.

The maximum recycled water recharge rate for each potential surface and subsurface application site was identified as described in Section 3.1.4. The locations and maximum recharge rates were provided to USGS.

4.1.1.2 Modeling Approach

The modeling approach for IPR Alternative No. 1 consisted of an iterative process whereby recharge was sequentially increased simultaneously with and without IPR recovery pumping until certain constraints could no longer be met. The constraints are summarized in Table 3.

Table 3. IPR Alternative No. 1 Recharge Constraints, Metrics, and Validation Methods

<table>
<thead>
<tr>
<th>No.</th>
<th>Constraint</th>
<th>Metric</th>
<th>Validation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Rejected Surface Recharge</td>
<td>Heads in recharge cells above land surface</td>
<td>Inspect model hydrographs in surface recharge areas</td>
</tr>
<tr>
<td>2</td>
<td>Avoid Excessive Injection Pressure</td>
<td>&lt;=25psi at injection well</td>
<td>Inspect model hydrographs at injection locations</td>
</tr>
<tr>
<td>3</td>
<td>No Artesian Conditions in Injection Areas</td>
<td>Piezometric heads below predevelopment heads</td>
<td>Compare heads to calibrated model heads for 1929</td>
</tr>
<tr>
<td>4</td>
<td>Meet Minimum Recycled Water Residence Time –Surface Recharge w/ Tertiary Treated Recycled Water</td>
<td>12 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
<tr>
<td>5</td>
<td>Meet Minimum Recycled Water Residence Time –Injection w/ FAT Recycled Water</td>
<td>4 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
</tbody>
</table>

\(^5\) Pursuant to the USGS model.
A series of simulations were performed to maximize the total recycled water recharge rates throughout the simulation period by sequentially adding surface recharge and injection.

Surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs FAT). Surface recharge was implemented using MODFLOW WEL Package\(^6\). Because the USGS model does not simulate the sediments overlying the UPZ, surface recharge was simulated by the introduction of recycled water directly into the UPZ. The bulk monthly recharge rates calculated as described in Section 3.1.4.5 were applied proportionally to each model cell along each surface application site. After some testing, it was determined that a few cells along Mission Creek could not accept recycled water because of model construction issues. These cells were omitted from the model simulations because they would not significantly impact the feasibility analysis results.

Injection well locations (model cells), and suggested maximum injection rates were provided to USGS as described in Section 3.1.4.4. The USGS modelers added injection wells from the list of prioritized locations.

A series of model runs were performed to maximize recycled water recharge with and without increased pumping in the basin.

One set of runs evaluated the amount of recycled water recharge that could occur without any new pumping. Historical pumping patterns already programmed into the groundwater flow model were used as a surrogate for baseline pumping under future conditions. Recycled water recharge was added at the surface application sites until the constraints could no longer be met. The controlling constraint was Constraint No. 3 (artesian conditions). Once the recycled water recharge rates were maximized, particle tracking was performed to verify that the required residence times for both tertiary and FAT recycled water were achieved at the existing potable well locations and IPR recovery well locations (Constraint Nos. 4 and 5). Constraint No. 6 (no seawater intrusion) was also verified.

A second set of model runs were performed to maximize recycled water recharge by adding recharge locations simultaneously with IPR recovery wells. Following each run, USGS checked the injection pressures, water levels in the injection area, and travel times to ensure that Constraint Nos. 1 through 3 were met. Recycled water recharge was added until the constraints could no longer be met. The controlling constraint was Constraint No. 3 (artesian conditions). The final simulated injection wells locations are depicted in Figure 2a. Once the recycled water recharge rates were maximized, particle tracking was performed to verify that the required residence times for both tertiary and FAT recycled water were achieved at the existing potable well locations and IPR recovery well locations (Constraint Nos. 4 and 5). Constraint No. 6 (no seawater intrusion) was also verified.

Groundwater head maps of the UPZ, MZ, and LPZ for pre-development conditions (1929), simulated year 1990, and simulated year 2004 are provided in Appendix A. Groundwater head difference maps of

\(^6\) Despite its name, the WEL Package can be used to simulate any type of specified flux.
the UPZ, MZ, and LPZ showing the change in head from pre-development (1929) to simulated years 1990 and 2004 are provided in Appendix B. Hydrographs for select model cells coincident with IPR wells, production wells, and surface recharge reaches are provided in Appendix C. Particle tracking plots illustrating arrival times at production wells and IPR recovery wells are provided in Appendix D. Tables showing annual groundwater pumping rates for City owned wells (for baseline pumpage and increased pumpage), proposed IPR recovery wells, and non-City owned wells are provided in Appendix E.

4.1.2 IPR Alternative No. 2

IPR Alternative No. 2 includes subsurface application of recycled water near the coast to provide an effective hydraulic barrier to seawater intrusion in the primary groundwater producing zones in Storage Unit I of the Santa Barbara Basin. This concept is intended to not only reduce the potential for salt water intrusion during periods of increased pumping in the basin, but it also provides additional water to the basin because a significant fraction of the injected water would flow landward toward City production wells and potential new IPR recovery wells. Historical groundwater data indicate that some salt water intrusion occurred during the last drought, and USGS modeling studies indicate some level of seawater intrusion is expected depending on the amount of water pumped from the basin.

4.1.2.1 Recharge Site Selection

The assumed seawater barrier location is along E. Cabrillo Blvd. As described below, the injection well locations were determined by completing a series of model runs to determine the necessary well spacing and flow rates required to create the hydraulic barrier.

4.1.2.2 Modeling Approach

The modeling approach for IPR Alternative No. 2 was similar to IPR Alternative No. 1. A series of model runs was performed to maximize recycled water recharge into the seawater intrusion barrier with and without increased pumping in the basin until certain constraints could no longer be met. The constraints are summarized in Table 4.

One set of runs evaluated the amount of recycled water recharge that could be injected into the seawater intrusion barrier without any new pumping. Historical pumping patterns already programmed into the groundwater flow model were used as a surrogate for baseline pumping under future conditions. Injection rates were increased until the constraints could no longer be met.

A second set of model runs were performed to maximize injection into the seawater intrusion barrier simultaneously with increased pumping via City wells inland of the barrier. The modeling consisted of an iterative process whereby coastal injection rates were progressively increased simultaneously with increased upgradient pumping rates until the Table 4 constraints could no longer be met. The final simulated injection wells are depicted in Figure 3.
Table 4. IPR Alternative No. 2 Recharge Constraints, Metrics, and Validation Methods

<table>
<thead>
<tr>
<th>No.</th>
<th>Constraint</th>
<th>Metric</th>
<th>Validation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Avoid Excessive Injection Pressure</td>
<td>&lt;=25psi at injection well</td>
<td>Inspect model hydrographs at injection locations</td>
</tr>
<tr>
<td>2</td>
<td>No Excessive Artesian Conditions in Injection Areas</td>
<td>Piezometric heads do not exceed pre-development heads</td>
<td>Inspect model hydrographs at selected locations</td>
</tr>
<tr>
<td>3</td>
<td>Meet Minimum Recycled Water Residence Time –Injection w/ FAT Recycled Water</td>
<td>4 months minimum travel time to nearest potable well</td>
<td>Particle tracking to confirm minimum residence time requirement is met</td>
</tr>
<tr>
<td>4</td>
<td>Seawater intrusion barrier effectiveness</td>
<td>No shoreward groundwater flow through the barrier during the simulation period</td>
<td>Particle tracking to confirm metric is met</td>
</tr>
</tbody>
</table>

4.2 Hydrogeologic Evaluation Results for IPR Alternative No. 1

The following sections summarize the results of the hydrogeologic evaluations of IPR Alternative No. 1.

4.2.1 Groundwater Replenishment Rates, Available Groundwater Storage, and Basin and Well Yield Increases

The ability of IPR groundwater replenishment facilities to collectively accept, store, and ultimately produce up to 10,000 AFY (or 11,400 AFY) is an important technical feasibility criterion. The ability to replenish groundwater with recycled water, store recycled water, and increase overall basin yield by transmitting the recycled water through the aquifers to wells are all related and are all a function of the basin hydrogeology that is simulated by the groundwater flow model.

The groundwater modeling performed for this this technical feasibility evaluation indicates that there is very limited storage space in the aquifer system to accept, store, and transmit recycled water unless basin pumping is also simultaneously increased. This makes sense because there is a limited areal extent of unconfined groundwater conditions in both Storage Unit I and the Foothill Basin.

The modeling results indicate that the basins are only capable of accepting approximately 250 AFY of recycled water recharge on average without increasing pumping above historical amounts (Table 5). The simulated recharge rates (absent increased pumping) range from 150 to 310 AFY, with the higher recharge rates typically occurring when drought conditions prevail (Table 5). The majority of the recycled water recharge (87 percent) occurred in the Foothill Basin. All of the recycled water recharge
was achieved via surface application with tertiary treated recycled water\(^7\). When recharging with tertiary treated recycled water, the City would need to demonstrate that total organic carbon (TOC) concentrations do not exceed 0.5 milligram per liter (mg/L) in the source water or that sufficient TOC removal is achieved via soil-aquifer treatment. If these conditions are not met, blending with another water supply (dilution) would likely be required by the State Water Resources Control Board Division of Drinking Water (DDW)\(^8\). It is possible that the dilution requirement could be met by demonstrating mixing with native groundwater and/or wet weather stream percolation. However, if dilution is required and cannot be demonstrated by mixing with groundwater or surface water, the City would be required to blend with potable water or FAT water, thereby reducing the effective yield of surface recharge with tertiary treated recycled water by up to 80 percent. Alternatively, the City could choose to inject FAT water, which would not require any diluent water to meet requirements set forth in Title 22. However, compared to using tertiary treated water, FAT water is more costly to produce due to more stringent treatment requirements, and total available water for surface application would be decreased by 20 percent (i.e., the volume lost to reverse osmosis treatment process brine).

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\(^7\) As discussed in Section 4.1.1.2, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).

\(^8\) As specified in Article 5.1 of California’s Title 22, there are diluent water requirements based on a water’s TOC concentration. A minimum dilution requirement of 4:1 (20 percent recycled water, 80 percent diluent water) is applicable when TOC concentrations exceed 0.5 mg/L. This requirement formally constitutes a recycled water contribution (RWC) of 0.2.
### Table 5. IPR Alternative 1 Recharge Volumes without Increased Pumping

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
</tr>
<tr>
<td>1987</td>
<td>37</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>1988</td>
<td>38</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>1989</td>
<td>41</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>1990</td>
<td>41</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>1991</td>
<td>35</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>1992</td>
<td>32</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>1993</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>1994</td>
<td>34</td>
<td>0</td>
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<td>1995</td>
<td>21</td>
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<td>34</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>2001</td>
<td>28</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>2002</td>
<td>40</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>2003</td>
<td>38</td>
<td>0</td>
<td>38</td>
</tr>
</tbody>
</table>

All values reported in acre-feet

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Ave</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>153</td>
<td>251</td>
<td>310</td>
</tr>
</tbody>
</table>

If pumping is increased simultaneously with recycled water recharge, the modeling results indicate that approximately 7,600 to 9,100 AFY of artificial recharge can be accepted by the basins (Table 6). The average simulated recharge rate (with increased pumping) was 8,500 AFY. The corresponding increase in well yield and basin yield is approximately 6,700 to 9,000 AFY, with an average of 8,500 AFY (Table 7). The results do not vary significantly between drought and non-drought periods because the recycled water recharge and recovery pumping dominate the water balance of the basins. Approximately 9 percent of the simulated recharge (with increased pumping) was via surface application with tertiary treated recycled water and 91 percent via subsurface application with FAT recycled water\(^9\). As discussed above, if TOC thresholds for surface recharge with tertiary treated recycled water are not met and dilution cannot be demonstrated via mixing with groundwater or surface water, the City would be

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\(^9\) As discussed in Section 4.1.1.12, surface recharge sites were prioritized over injection sites because surface recharge can be accomplished more cost effectively due to the lower treatment requirements (tertiary treatment vs fully advanced treatment [FAT]).
required to blend the tertiary treated recycled with potable water or FAT water, thereby reducing the effective yield of surface recharge with tertiary treated recycled water project by up to 80 percent. If this were the case, the yield of the overall alternative would be reduced to approximately 7,900 AFY. As discussed above, if elevated TOC concentrations were an issue, the City could use FAT water for surface application, but would be faced with higher treatment costs and less available water (i.e., the volume lost to reverse osmosis concentrate).

Table 6. IPR Alternative 1 Recharge Volumes with Increased Pumping (Not Adjusted for Potential Negative Effects)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
</tr>
<tr>
<td>1987</td>
<td>322</td>
<td>4,490</td>
<td>4,812</td>
</tr>
<tr>
<td>1988</td>
<td>331</td>
<td>4,490</td>
<td>4,821</td>
</tr>
<tr>
<td>1989</td>
<td>356</td>
<td>4,490</td>
<td>4,845</td>
</tr>
<tr>
<td>1990</td>
<td>354</td>
<td>4,490</td>
<td>4,843</td>
</tr>
<tr>
<td>1991</td>
<td>301</td>
<td>4,490</td>
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<td>279</td>
<td>4,650</td>
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</tr>
<tr>
<td>1993</td>
<td>176</td>
<td>4,490</td>
<td>4,665</td>
</tr>
<tr>
<td>1994</td>
<td>297</td>
<td>4,785</td>
<td>5,082</td>
</tr>
<tr>
<td>1995</td>
<td>186</td>
<td>5,437</td>
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<td>1996</td>
<td>271</td>
<td>5,585</td>
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<td>1998</td>
<td>188</td>
<td>5,585</td>
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<td>5,585</td>
<td>5,930</td>
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<td>2000</td>
<td>294</td>
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<tr>
<td>2001</td>
<td>243</td>
<td>5,585</td>
<td>5,828</td>
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<td>2002</td>
<td>347</td>
<td>5,585</td>
<td>5,932</td>
</tr>
<tr>
<td>2003</td>
<td>334</td>
<td>5,585</td>
<td>5,919</td>
</tr>
</tbody>
</table>

All values reported in acre-feet
Table 7. IPR Alternative 1 Pumping/Basin Yield Increase (Not Adjusted for Potential Negative Effects)

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit I Pumping Increase</th>
<th>Foothill Pumping Increase</th>
<th>Total Pumping Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing City Wells</td>
<td>New Recovery Wells</td>
<td>Total</td>
</tr>
<tr>
<td>1987</td>
<td>3,314</td>
<td>2,111</td>
<td>5,425</td>
</tr>
<tr>
<td>1988</td>
<td>3,411</td>
<td>2,111</td>
<td>5,522</td>
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<td>1989</td>
<td>2,279</td>
<td>2,111</td>
<td>4,390</td>
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<td>1,889</td>
<td>2,111</td>
<td>4,000</td>
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<td>3,680</td>
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<td>5,723</td>
</tr>
<tr>
<td>2001</td>
<td>3,703</td>
<td>2,111</td>
<td>5,814</td>
</tr>
<tr>
<td>2002</td>
<td>3,440</td>
<td>2,111</td>
<td>5,551</td>
</tr>
<tr>
<td>2003</td>
<td>3,458</td>
<td>2,111</td>
<td>5,569</td>
</tr>
</tbody>
</table>

All values reported in acre-feet

Min 6,749
Ave 8,514
Max 8,953

4.2.2 Impacts to Local Groundwater Supplies and Existing Water Users

Title 22 of the California Code of regulations requires that there be adequate residence time of the IPR source water in an aquifer prior to any IPR water reaching the nearest well. The allowable residence time must be no less than 2 months for FAT water, but may range from 2 to 6 months depending on the advanced treatment technology being used, the actual water quality benefits of aquifer storage determined during pilot testing, and the accuracy of the method used to estimate residence time. Similarly, the allowable residence time must be no less than 12 months for tertiary-treated recycled water recharged at the surface (surface application). Residence time is defined as the travel time between the recharge site and the nearest potable water supply well.

Potable supply well locations are included in the groundwater model and recycled water travel times to these wells were calculated using particle tracking methods with the groundwater flow model. Travel times were calculated during periods with the steepest hydraulic gradients, as determined by inspection of the modeling results by USGS.
Because residence time requirements were built into the IPR Alternative No. 1 modeling constraints, they were met in all cases, with one exception. The exception is that a few of the travel times calculated for surface application of tertiary treated recycled water were slightly less than the required 12 month residence time. However, as noted in Section 4.1.1.2, the model does not simulate the sediments overlying the UPZ. As such, surface recharge was introduced directly into the UPZ within the model and, therefore, the vertical travel time through the vadose zone and sediments above the UPZ is not reflected in the particle tracking calculations. If this additional travel time was included the residence time would very likely be met.

4.2.3 Impacts to Sensitive Habitats

Potential impacts to sensitive habitats resulting from IPR activities could occur at surface application locations. Impacts to sensitive habitats resulting from injection into deeper confined aquifers would be less likely to occur, however, additional work, as described in Section 4.2.4 would be required to evaluate the degree of potential impacts. Potential impacts to sensitive habitats from IPR surface application activities could include:

- Increased groundwater levels near the recharge site where there is vegetation that is sensitive to saturated conditions (e.g., oak trees).
- Increased surface water flow and increased groundwater levels that contribute to establishment of riparian or wetland vegetation that may require preservation as habitat and/or generation of nuisance plant species.
- Changes in water quality (including increased temperature) in existing stream and riparian areas.

The County of Santa Barbara has classified sections of riparian corridor within the study area along Atascadero Creek, Cieneguitas Creek, Arroyo Burro, and Mission Creek as sensitive habitat (Figure 7a and 7b) (County of Santa Barbara, 2015). The zones classified as sensitive habitat on each of these creeks are at least partially coincident with proposed surface recharge reaches. The length of proposed surface recharge reach coincident with sensitive habitat along each creek is summarized in Table 8. The proposed surface recharge activities would create perennial wetted conditions along the creek reaches where recharge is applied and would raise the alluvial aquifer water table both adjacent to the recharge reach and downgradient. Following storms, the wetted length of the creeks would likely take longer than normal to retreat due to the high water table conditions maintained by proposed surface recharge activities. The higher water table conditions would likely create habitat for phreatophytic vegetation in the areas adjacent to proposed recharge reaches and downstream. The newly created habitat would then potentially need to be preserved. Conversely, the higher water table conditions may adversely affect existing vegetation that is sensitive to saturated conditions, such as oak trees. Additional work is needed to quantify the alluvial aquifer water table response to the proposed surface recharge activities and to evaluate potential changes in water quality (including temperature) in existing riparian areas.

---

10 Phreatophytes are plants that depend upon groundwater that lies within reach of their roots for their water supply.
Table 8. Proposed Recharge Reaches Coincident with Existing Sensitive Habitat

<table>
<thead>
<tr>
<th>Creek Name</th>
<th>Length of Proposed Recharge Reach Coincident with Sensitive Habitat¹ (feet)</th>
<th>Percent of Proposed Recharge Reach Coincident with Sensitive Habitat¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atascadero Creek</td>
<td>1,400</td>
<td>74%</td>
</tr>
<tr>
<td>Cieneguitas Creek</td>
<td>1,150</td>
<td>100%</td>
</tr>
<tr>
<td>Arroyo Burro</td>
<td>1,000</td>
<td>100%</td>
</tr>
<tr>
<td>San Roque Creek</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Mission Creek</td>
<td>300</td>
<td>6%</td>
</tr>
</tbody>
</table>

Notes:
¹ Sensitive habitat zones defined by the County of Santa Barbara
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FIGURE 7a
Sensitive Habitat Zones in Atascadero Creek, Cieneguitas Creek and Arroyo Burro
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
- Stream Recharge Reach
- Sensitive Habitat Zone
- All Other Features
- Study Area
- Major Roads
- Streams and Creeks
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4.2.4 Potential Capture or Mobilization of Known Groundwater Contamination

The Shallow Zone that underlies the City in Storage Unit I is about 100 to 200 feet thick in the downtown area and extends toward and beneath the shoreline. The Shallow Zone thins to the northwest in Storage Unit I, toward the Mission Ridge Fault. In the Foothill basin, the shallow alluvium varies in thickness from 100 to 400 feet, with the area of greatest thickness occurring just north of the Mission Ridge Fault and generally thinning toward the northern edge of the Foothill basin. Groundwater quality in this Storage Unit I Shallow Zone and Foothill Basin alluvium has been impacted by a number of sources of contamination, which are regulated by the Regional Water Quality Control Board and other regulatory agencies. It is possible that surface or subsurface application activities could mobilize or affect the movement of contaminants in the subsurface. This potential was evaluated by:

1. Preparing a contaminant source inventory for the area within 1 mile of each potential groundwater replenishment site and IPR recovery well, using the California State Water Resources Control Board (SWRCB) GeoTracker database.

2. Identifying known and documented sources of groundwater contamination that have the potential, due to proximity and mobility characteristics, to be affected by recycled water recharge and recovery activities (Shallow Zone or deeper producing zones).

3. Using the results from the numerical modeling assessment to assess whether changes in groundwater gradients due IPR related groundwater replenishment and recovery operations may cause mobilization of contaminants in the unsaturated zone, movement of known sources of contamination, or impacts to existing City production wells.

4. In relative terms, describing the relative risk (high, medium, or low) of capturing or mobilizing known sources of contamination.

5. Identifying the need for a geochemical mixing analysis that can determine whether dissolution of naturally-occurring minerals in the aquifer sediments or precipitation of porosity-reducing constituents could occur.

The California State Water Resources Control Board’s (SWRCB) GeoTracker database was used to identify contaminated sites located within one mile of each potential groundwater replenishment site and recovery well. A total of 355 sites were identified, of which 52 sites are listed as ‘Open’ and ‘Active’, while the remainder are designated as ‘Case Closed,’ ‘Eligible for Closure,’ or ‘Inactive.’ The ‘Open’ sites had status designations of ‘Site Assessment’ or ‘Verification Monitoring’ and include contamination from heavy metals, cyanide, gasoline, diesel, waste oil, solvents, polynuclear aromatic hydrocarbons (PAH), and total petroleum hydrocarbons (TPH). The 52 open sites include 14 sites that have not impacted groundwater (contamination reported in near-surface soil only), leaving 38 open sites with reported groundwater contamination in the Shallow Zone. A summary of these 38 ‘Open’ sites and their respective constituents of concern (COC) is provided in Appendix F-1 and the locations of all contaminated sites are shown on Figure 8. Groundwater contamination sites potentially affected by proposed surface water recharge and IPR wells and soil contamination sites potentially affected by rising groundwater levels in the Shallow Zone are discussed below.
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FIGURE 8
Contaminated Sites within 1 Mile of IPR Facilities
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
△ Active GeoTracker Sites - GW
▲ Active GeoTracker Sites - GW Located within 1,500 feet of IPR Wall
● Active GeoTracker Sites - Soil
§ Active GeoTracker Sites - Soil Located within 1,500 feet of IPR Injection Well
● Inactive GeoTracker Sites
● IPR Injection Wells
● IPR Recovery Wells
● Stream Recharge Reach
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 1, 2016
Data Sources: SWRCB, Santa Barbara County, USGS, ESRI; air photos taken on June 1, 2014 by the USDA
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4.2.4.1 Groundwater Contamination Sites Potentially Affected by Proposed Surface Recharge Reaches

There is only one open alluvial groundwater contamination site located in the northern portion of the Foothill basin, where the proposed surface recharge reaches are located. The site (ID# T0608300183) is located approximately 300 feet from the proposed surface recharge reach in Atascadero Creek, near the intersection of Foothill Road and Highway 154 (Figure 8). This site is listed as an old Mobil Oil gas station that is currently in ‘Verification Monitoring’ status. According to GeoTracker, the site has been considered for closure, but as of May 2015 there remained several impediments to closure, including discovery of free product in a site monitoring well and the groundwater contaminant plume remains greater than 250 feet in length with benzene concentrations greater than 3,000 micrograms per liter (µg/L). The site is currently in redevelopment. Upon completion, new monitoring wells will be installed to assess the plume and possible need for targeted remediation (SWRCB, 2016a). Due to the close proximity to the proposed recharge reach in Atascadero Creek and the moderate to high mobility of gasoline derivative contaminants in groundwater there is a medium risk of contaminant mobilization from this site.

In Storage Unit I there is one open Shallow Zone groundwater contamination site located in close proximity to the proposed surface recharge reaches in Mission Creek. The site (ID# T10000000578) is located adjacent to Mission Creek, at the intersection of De La Vina Street and Vernon Road (Figure 8). This site is listed as the former Regal Cleaners (dry cleaners) that is currently in ‘Assessment & Interim Remedial Action’ status. According to GeoTracker, the contamination at the site resulted from a release of tetrachloroethylene (PCE) to soil and groundwater beneath the site and contamination may now extend downgradient, across Mission Creek to the south. Depth to groundwater is approximately 70 feet below ground surface (bgs) at the site. The maximum PCE concentration detected at the site is 1,600 µg/L. The responsible parties have proposed to clean up the subsurface using soil vapor extraction (SVE), as documented in the February 2016 Remedial Action Workplan11 (CCRWQCB, 2016). This site is also located within 1,500 feet of three proposed IPR injection wells (Figure 8). Due to the close proximity of PCE contaminated soils to the proposed recharge reach in Mission Creek and the moderate mobility of PCE in groundwater there is a high risk of contaminant mobilization from proposed IPR surface recharge.

4.2.4.2 Groundwater Contamination Sites Potentially Affected by Proposed IPR Wells

Because the IPR injection and recovery wells would be completed in the primary water producing zones of the UPZ, MZ, and LPZ beneath the confining layer at the top of the Santa Barbara Formation, the proposed IPR operations likely will not significantly alter groundwater flow in the overlying Shallow Zone in Storage Unit I and alluvium in Foothill Basin. The confining layer, which occurs in both Storage Unit I and the Foothill basin, is generally 20 to 100 feet thick and has an estimated vertical hydraulic conductivity of 0.03 foot/day (Freckleton, 1989). Changes to groundwater levels or flow directions above the confining layer and potential for contaminant mobilization as a result of proposed injection would be muted by this confining layer. The USGS groundwater model does not simulate shallow

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groundwater levels, therefore, it does not directly address the question of potential changes to water level and flow direction above the confining layer.

One site in the GeoTracker database located within the 1-mile search radius has five monitoring wells completed in the UPZ as well as several monitoring wells completed in the Shallow Zone. This site is the Mission Industries/Ambassador Laundry (ID SL203061244) on East Haley Street. Comparison of water levels in the Shallow Zone to water levels in the UPZ at this site shows a persistent, strong upward hydraulic gradient between the UPZ and the Shallow Zone (URS, 2010). The existence of a persistent upward gradient between the UPZ and the Shallow Zone demonstrates the effectiveness of the confining layer. Injection of water into the UPZ would act to increase the upward gradient toward the Shallow Zone, but additional work would be needed to evaluate the degree of potential changes in water level and mobilization of contaminants in the Shallow Zone. Approaches might include comparing Shallow Zone water levels at other cleanup sites with producing zone water levels to better understand the degree of connectivity, updating the groundwater model to simulate shallow groundwater levels (using Shallow Zone water levels available from GeoTracker), or performing aquifer testing to characterize vertical connectivity.

4.2.4.2.1 Groundwater Contaminated Sites Located Near Proposed IPR Wells

This section discusses shallow groundwater contamination sites that, based on location, are estimated to have a higher likelihood of impact from proposed IPR injection and recovery wells. Of the 38 ‘Open’ contaminated sites affecting groundwater, 12 are located within 1,500 feet of the proposed IPR wells. Each of these 12 sites are discussed below and their locations can be seen on Figure 8.

The Five Points Shopping Center site (ID# SL0608378294) is listed in ‘Verification Monitoring’ status. The site contained a dry cleaning facility known as Ambassador Laundry and Cleaners, which operated at the site from 1961 to 1979. The principal and secondary constituents of concern are PCE and trichloroethylene (TCE), respectively. The site has also been affected by petroleum hydrocarbon releases from neighboring active or inactive/former service stations. PCE concentrations in groundwater remain above 50 μg/L (LFR, 2008). This site is located approximately 650 feet from a proposed IPR injection well. The site is considered to be at medium risk for contaminant mobilization from IPR injection.

The former Schauer Printing site (ID# SL0608395538) is listed in ‘Verification Monitoring’ status. The primary groundwater contaminant at this site is PCE. Only low levels of PCE are remaining in soil and shallow groundwater at this site. Although located within 600 feet of a proposed IPR injection well, the site is considered to be at low risk for contaminant mobilization.

The Santa Barbara Manufactured Gas Plant site (ID# SL203341272) is listed in ‘Remediation’ status, but actually has had all monitoring wells abandoned following completion of the five-year post-remediation monitoring period that ended in 2013 (URS, 2015). The site is located approximately 1,000 feet from a proposed IPR recovery well and is considered to be at low risk for contaminant capture.

The Dutch Maid Cleaners site (ID# SLT3S0511299) is listed in ‘Assessment & Interim Remedial Action’ status. The primary constituents of concern are PCE and gasoline derivatives. Remediation strategies used historically at the site include SVE, pump and treat, and enhanced reductive dechlorination (ERD) (DBS&A, 2012). Historical PCE concentrations detected in groundwater at the site were as high as 11,000 μg/L. The highest PCE concentrations detected in 2006 were 2,460 μg/L after the ERD program
was implemented. Significant PCE contamination remaining at the site has prompted development of a work plan for injection of potassium permanganate (CCRWQCB, 2015). This site is located approximately 650 feet from a proposed IPR injection well. The site is considered to be at high risk for contaminant mobilization from IPR injection based on the high level of remaining contamination.

The S.B. City Police Station site (ID# T0608300020) is listed in ‘Site Assessment’ status. The primary constituents of concern are gasoline derivatives. Since 1992, nine groundwater monitoring wells have been installed and monitored intermittently and active remediation systems including SVE and air sparging have been used. According to recent groundwater data, water quality objectives have been achieved, or nearly achieved, except in the source area. The site does not meet criteria for closure because the secondary source of contamination has not been removed to the extent practicable and because the contaminant plume that exceeds water quality objectives is greater than 100 feet long (SWRCB, 2016b). This site is located only about 330 feet from a proposed IPR injection well. The site is considered to be at medium to high risk for contaminant mobilization from IPR injection based on the close proximity to the proposed IPR injection well.

The Mobil Oil Station #11-KRA site (ID# T0608300587) is listed in ‘Verification Monitoring’ status, however groundwater contamination remains at the site. The primary constituents of concern are gasoline derivatives. Historical total petroleum hydrocarbons (TPH) and benzene concentrations in groundwater were as high as 30,000 µg/L and 4,700 µg/L, respectively, and free product has been recovered. Active remediation systems including SVE and air sparging have been used at the site. According to recent groundwater data, TPH and benzene concentrations in groundwater are now at 2,000 µg/L and 170 µg/L, respectively. The site being considered for closure contingent on a confirmation soil assessment (Blaes, 2015). This site is located approximately 650 feet from a proposed IPR recovery well. The site is considered to be at medium risk for contaminant capture.

The ExxonMobil Oil Corp ss#18-KFK site (ID# T0608300588) is listed in ‘Remediation’ status. The primary constituents of concern are gasoline derivatives and waste oil. Remediation strategies used historically at the site include soil excavation, SVE, air sparging, and vapor barrier Installation. The site is currently undergoing redevelopment and remaining contamination levels detected in groundwater are low (SBPHD, 2015). This site is located approximately 1,000 feet from a proposed IPR injection well. The site is considered to be at low risk for contaminant mobilization from IPR injection.

The Porter Auction Company site (ID# T0608300695) is listed in ‘Remediation’ status. The primary constituents of concern are gasoline derivatives. Remediation strategies used historically at the site include soil excavation, free product removal, pump and treat, SVE, and dual phase extraction (DPE). According to recent groundwater data, benzene and MTBE concentrations detected in groundwater remain above 30,000 µg/L and 700 µg/L, respectively (Reynolds, 2015) and the contaminant plume is still greater than 100 feet long (SWRCB 2013). Although located almost 1,500 feet down gradient from the nearest proposed IPR injection well, the site is considered to be at medium risk for contaminant mobilization based on the high level of remaining contamination.

The Former Chevron Station site (ID# T0608368725) is listed in ‘Site Assessment’ status. The primary constituents of concern are gasoline derivatives. Remediation strategies used historically at the site include soil excavation and free product removal. In addition, a multiple phase extraction (MPE) remediation system has been the subject of a pilot study. As of June 2015, benzene and TPH concentrations in groundwater were detected at 6,600 µg/L and 30,000 µg/L, respectively. Free product
has been recovered as recently as late 2015. Continued remedial efforts are needed at the site, but the planned MPE remediation system has not been installed yet due to outstanding site access agreement (SBPHD, 2016). Although located almost 1,500 feet down gradient from the nearest proposed IPR injection well, the site is considered to be at medium risk for contaminant mobilization based on the high level of remaining contamination.

The Mobil Oil #11-EP9 site (ID# T0608386520) is listed in ‘Remediation’ status, however recent groundwater quality data suggests that the site could be considered for closure. The primary constituents of concern are gasoline derivatives. Remediation strategies used historically at the site include soil excavation and SVE. According to recent groundwater quality data all TPH and BTEX analyses are below detection levels as of mid-2015. Although located only about 400 feet from a proposed IPR recovery well, the site is considered to be at low risk for contaminant capture.

The former Regal Cleaners site (ID# T10000000578) is discussed in detail above in Section 4.2.4.1. The high risk of contaminant mobilization from this site is primarily due to proposed IPR surface recharge in Mission Creek. However, this site is also located within 1,500 feet of three proposed IPR injection wells (Figure 8) and therefore is also considered at risk for contaminant mobilization from IPR injection activities.

The Former Shell Station site (ID# T10000002779) is listed in ‘Assessment & Interim Remedial Action’ status. The primary constituents of concern are gasoline derivatives. A DPE remediation system has been used at the site. Continued remediation is required at this site. TPH and benzene concentrations in groundwater were detected at 10,000 μg/L and 7,100 μg/L, respectively during the first quarter 2016. The site is located approximately 700 feet from a proposed IPR injection well. The site is considered at high risk for contaminant mobilization from IPR injection based on the high level of remaining contamination.

4.2.4.3 Soil Contamination Sites Potentially Affected by Proposed IPR Wells

There are 13 contaminated sites in Storage Unit I with affected soils, but without direct impact to groundwater (Figure 8 and Appendix F-2). Two of these sites (ID#s SLT3S0381291 and T10000005625) are located within 1,500 feet of a proposed IPR injection well and are discussed here in regards to potential contaminant mobilization due to the potential for rising groundwater levels in the Shallow Zone resulting from groundwater replenishment. The extent of soil contamination at these sites is less than 10 feet bgs and groundwater levels in the Shallow Zone at or near these two sites is typically more than 45 feet bgs (GeoTracker, 2016). Pre-development groundwater levels at these sites are estimated to be about 30 feet bgs (USGS, in press). Modeling indicates that the proposed IPR injection would not raise UPZ water levels above pre-development levels. Therefore, these sites are considered to be at low risk for contaminant mobilization in groundwater due to rising groundwater levels in the Shallow Zone.
4.2.5 Geologic Hazards

Geologic hazards, including liquefaction, slope failure, and high groundwater have the potential to be created or exacerbated due to proposed IPR activities. The Santa Barbara General Plan (City of Santa Barbara, 2011) provides baseline conditions for each of these three geologic hazards. Locations of the proposed IPR recharge facilities relative to the 2011 mapped hazard areas and descriptions of how hazard levels might be affected by proposed IPR activities is presented below.

4.2.5.1 Liquefaction

Liquefaction is a temporary loss of soil strength that can occur during moderate to large earthquakes. Three conditions must be present for liquefaction to occur: affected soils must be composed of granular materials such as sand or silt; the soil must be saturated by groundwater; and the soil must be relatively loose or cohesionless. Of these three conditions, saturation by groundwater is the condition that can change over time. An increase in groundwater levels in the Shallow Zone could increase the occurrence and severity of liquefaction. In general, liquefaction risk is considered to be low when groundwater levels are greater than 60 feet bgs (City of Santa Barbara, 2011). The baseline liquefaction hazard map from the Santa Barbara General Plan is shown in Figure 9.

Groundwater replenishment via the proposed surface recharge reaches in Foothill Basin and Storage Unit I would result in rising water levels in the Shallow Zone/alluvium adjacent to the creek. These rising water levels could increase the liquefaction hazard level, especially if water levels rise to above 60 feet bgs. The groundwater model indicates that head levels in the UPZ would increase as a result of IPR injection. By model year 2004, the UPZ head levels approach pre-development conditions and indicate an increase in overall area where the potentiometric surface in the UPZ is 60 feet or less bgs (Figure 10). As stated in Section 4.2.4.2, changes to groundwater levels in the Shallow Zone/alluvium resulting from increased head in the UPZ would be muted by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases in liquefaction hazard in response to injection in the underlying producing zones. Localized increases in liquefaction hazard adjacent to the surface recharge reaches should be expected. Areas where groundwater levels in the Shallow Zone/alluvium are 60 feet or less bgs are likely to increase due to IPR injection in deeper productive zones, but the magnitude of water table response in the Shallow Zone/alluvium requires further evaluation.

4.2.5.2 Slope Failure

Slope failures occur when the weight of the material that comprises a slope plus the weight of the objects placed on the slope (driving forces) exceed the shear strength of the slope material (resisting forces). The potential for slope movement to occur is dependent on many factors, including, but not limited to: the height and angle of the slope, the orientation of the bedding planes in the underlying geologic formation(s), and the amount of water contained in the slope material. The addition of water to a slope increases the likelihood for failure due to the added weight of the water, reduction in cohesive forces between grains, and lubrication effect on slip planes, if any, within the slope materials (City of Santa Barbara, 2011). The City has defined hazard areas as follows:

- Hazard Area 1 – Very Low Landslide Potential

12 Pre-development conditions were determined for 1929 by USGS using the groundwater model.
The study area falls mostly within hazard areas 1 and 2, but also contains minor portions of hazard areas 3 and 4 in the northern sections of Storage Unit I and Foothill Basin. There are four proposed IPR injection wells located within hazard areas 3 or 4 in Storage Unit I and two in Foothill Basin. In addition, the surface recharge reaches on Cieneguitas Creek, Arroyo Burro, and Mission Creek fall, at least partially, within hazard areas 3 or 4 (Figure 11). It is possible that groundwater replenishment at these locations could increase the likelihood for slope failure. Surface recharge in the creeks would result in rising water levels in the Shallow Zone, which could directly impact adjacent slope stability. As stated in Section 4.2.4.2, changes to groundwater levels in the Shallow Zone resulting from injection would be muted by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases in slope failure hazard in response to injection in the underlying producing zones.

4.2.5.3 High Groundwater

High groundwater or near-surface groundwater is a hazard that can have adverse effect on building construction, roads, storage tank installation, utilities, and other projects with structural elements that penetrate the subsurface. The major issues that can result from high groundwater are moisture intrusion and buoyancy forces that can potentially cause structural offsets. In general, groundwater within 15 feet of the ground surface can create a nuisance and can require special structure design to address buoyancy and moisture intrusion (City of Santa Barbara, 2011). The baseline high groundwater hazard map from the Santa Barbara General Plan is shown in Figure 10.

Groundwater replenishment via the proposed surface recharge reaches in Foothill Basin and Storage Unit I would result in rising groundwater levels in the Shallow Zone/alluvium adjacent to the creeks where surface application is performed. These rising water levels could increase the high groundwater hazard level, especially if water levels reach levels above 15 feet bgs. The groundwater model indicates that the area in which UPZ head levels would be within 15 feet of the ground surface is approximately the same as the ‘Potentially Shallow Groundwater’ area defined in the baseline high groundwater hazard map (Figure 12), except for in the western Foothill Basin (Figure 13) where an additional area of high groundwater hazard is suggested by the model. As stated in Section 4.2.4.2, changes to groundwater levels in the alluvium resulting from increased head in the UPZ would be muted by the confining layer at the top of the Santa Barbara Formation. Additional work would be needed to determine the degree of potential increases to the high groundwater hazard in western Foothill Basin caused by IPR activities. Localized increases to the high groundwater hazard immediately adjacent to the surface recharge reaches should be expected. Areas of high groundwater in the alluvium of the western Foothill Basin are likely to increase due to IPR activities and ponding north of the Mission Fault, but the magnitude of water table response in the alluvium requires further evaluation.

4.2.5.4 Summary of Geologic Hazards on IPR Potential Yield

In consideration of the potential risks associated with surface recharge activities from liquefaction, slope failure and high groundwater, the benefits of surface recharge (annual average storage of 740 AFY) are
considered too low. For this screening level analysis therefore, surface recharge is removed as a method of re-using recycled water (whether tertiary-treated or FAT).

Additionally, the soil and/or groundwater contamination sites identified in Sections 4.2.4.2 and 4.2.4.3 also present potential challenges to siting IPR injection or recovery wells. The bulk of these sites only impact the Shallow Zone soil and/or groundwater. Only one site, Mission Industries/Ambassador Laundry (ID# SL203061244), has documented contamination in the UPZ. It is unlikely that elevated water levels in the confined UPZ and LPZ aquifers would affect Shallow Zone water levels because of the significant permeability barrier constituted by the confining layer above the UPZ. If IPR planning is carried forward into a more detailed design, permitting and planning phase, all of the proposed sites would undergo more rigorous consideration. Based upon the hydrogeologic considerations used in this preliminary injection and recovery well site selection, alternative sites could likely be identified if issues such as potential risk to existing contaminated sites are identified.

Based upon these considerations, the following table (Table 9) is provided that identifies the more likely maximum yield of an IPR operation in Santa Barbara.

**Table 9. Final IPR Alternative 1 Pumping/Basin Yield Increase (Adjusted for Potential Negative Effects)**

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Storage Unit 1</th>
<th>Foothill Basin</th>
<th>Total RW Recharge Both Basins</th>
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<tr>
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<td>Surface Percolation</td>
<td>Injection</td>
<td>Total RW Recharge</td>
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<tr>
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</tr>
<tr>
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<td>4,490</td>
</tr>
<tr>
<td>1989</td>
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<td>4,490</td>
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<td>0</td>
<td>5,585</td>
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Notes:
- All values reported in acre-feet
- RW = recycled water

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Ave</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total RW Recharge Both Basins</td>
<td>7,118</td>
<td>7,715</td>
<td>8,213</td>
</tr>
</tbody>
</table>
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FIGURE 9
Baseline Potential Liquefaction Hazard Zones
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells
- Liquefaction Potential (Santa Barbara General Plan, 2011)
  - High
  - Moderate
  - All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads
- Streams and Creeks

Date: June 3, 2016
Data Source: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
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FIGURE 10
Groundwater Model Predicted Areas of UPZ Heads Less Than 60 Feet Below Ground Surface

Hydrogeologic Analysis of Indirect Potable Reuse Alternatives Santa Barbara Desalination Project

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells
- Groundwater Model Predicted Areas of UPZ Heads Less Than 60 Feet Below Ground Surface
- Liquefaction Potential (Santa Barbara General Plan, 2011)
- High
- Moderate
- All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads
- Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
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FIGURE 11
Slope Failure Hazard Areas Relative to Proposed IPR Facilities
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
Stream Recharge Reach
Injection Wells
IPR Recovery Wells
Relative Landslide Potential Areas
(Santa Barbara General Plan, 2011)
High
Moderate
Low
Very Low
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads
Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA

Pacific Ocean
SanAntonio Creek
Arroyo Burro
Cieneguitas Creek
Atascadero Creek
Sycamore Creek
San Roque Creek
Mission Creek

0 1,500 3,000 4,500 Feet

Source: GI Solutions, Inc. - MapAdapt, Inc.
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FIGURE 12
Baseline High Groundwater Hazard Zones
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells

Groundwater Hazard Zones
(Santa Barbara General Plan, 2011)
- Potentially Shallow Groundwater
- Moderately Shallow Groundwater
- Deep Groundwater

All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads
- Streams and Creeks

Date: June 3, 2016
Data Source: City of Santa Barbara, Santa Barbara County, U.S. Geological Survey, Air photo taken June 1, 2014 by USDA
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FIGURE 13
Groundwater Model Predicted Areas of UPZ Heads Less Than 15 Feet Below Ground Surface

Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
- Stream Recharge Reach
- Injection Wells
- IPR Recovery Wells
- Groundwater Model Predicted Areas of UPZ Heads Less Than 15 Feet Below Ground Surface
- Groundwater Hazard Zones (Santa Barbara General Plan, 2011)
  - Potentially Shallow Groundwater
  - Moderately Shallow Groundwater
  - Deep Groundwater
- All Other Features
  - Study Area
  - Santa Barbara City Limits
  - Highway 101
  - Major Roads
  - Streams and Creeks

Date: June 3, 2016
Data Sources: City of Santa Barbara, Santa Barbara County, USGS, ESRI, Air photo taken on June 1, 2014 by the USDA
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4.3 Hydrogeologic Evaluation Results for IPR Alternative No. 2

The following section summarizes the results of the hydrogeologic evaluations of the seawater intrusion barrier concept.

4.3.1 Groundwater Replenishment Rates, Available Groundwater Storage, and Basin and Well Yield Increases

The ability of a seawater intrusion barrier to collectively accept, store, and ultimately facilitate production of up to 10,000 AFY (or 11,400 AFY) of IPR water is an important technical feasibility consideration. The ability to replenish groundwater via a seawater intrusion barrier with recycled water, store recycled water, and increase basin and well yields by transmitting the recycled water through the aquifers to wells are all related and are all a function of the basin hydrogeology that is simulated by the USGS groundwater flow model.

The groundwater modeling performed for this this technical feasibility evaluation indicates that the capacity of the Storage Unit 1 producing zones to accept, store, and transmit recycled water, even with simultaneous increased in pumping inland of the barrier, is very limited in the coastal portion of the basin. The modeling results indicate that, even with increased pumping inland of the barrier, only approximately 740 AFY of recycled water recharge can be injected to form a seawater intrusion barrier before excessive head buildup occurs at the injection sites. This makes sense because the combined transmissivity of producing zones near the coast is very low (Figure 14). Because of the low transmissivity in the barrier area, individual injection well yields are low and, consequently, 24 barrier wells were needed to achieve 740 AFY of injection. Additionally, the model results indicate that the barrier would not completely prevent seawater intrusion even with 24 simulated barrier wells. Although it may be possible to create an effective seawater intrusion barrier with even more wells, the total volume of injected recycled water and associated recovered groundwater would not increase materially. Additionally, simulation of additional injection wells would have required refinement of the model grid, which is beyond the scope of this evaluation. The modeling results indicate that the IPR Alternative No. 2 is not technically feasible. Therefore, further analysis of geologic hazards, mobilization of groundwater contaminants, and possible impacts to sensitive habitats is not discussed for IPR Alternative 2.
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FIGURE 14
Groundwater Model Transmissivity
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
Combined Transmissivity of All Producing Zones (eq. ft/day)

- >10,000 - 100,000
- >1,000 - 10,000
- >100 - 1,000
- >10 - 100
- >1 - 10
- >0.1 - 1
- 0 - 0.1

All Other Features
- Study Area
- Santa Barbara City Limits
- Major Roads
- Streams and Creeks

Date: June 3, 2016
Data Sources: Santa Barbara County, USGS, ESRI
All photos taken on June 1, 2016 by the USA
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Appendix A: Groundwater Head Maps for Alternative 1B

The following maps show groundwater levels generated by the groundwater model in the UPZ, MZ, and LPZ for pre-development (1929), 1990, and 2004.
FIGURE A-1
UPZ: 1927
Hydrogeologic Analysis of
Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
UPZ: 1927 Water Level Elevation (WLE)

High: +300 feet

Low: -100 feet

WLE 10 foot Contours
All Other Features
Study Area
Santa Barbara City Limits
Highway 101
Major Roads

Date: June 3, 2016
Data Source: Santa Barbara County, USGS, ESRI
All photo taken on June 1, 2016 by the USDA
FIGURE A-2
UPZ: 1990
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
UPZ: 1990 Water Level Elevation (WLE)
High: +300 feet
Low: -100 feet

- WLE 10 foot Contours
- All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads

Date: June 3, 2018
Data Source: Santa Barbara County, USGS, ESRI
Art photo taken on June 1, 2014 by the USGS
FIGURE A-3
UPZ: 2004
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
UPZ: 2004 Water Level Elevation (WLE)
- High: +300 feet
- Low: -100 feet

WLE 10 foot Contours
All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads

Pacific Ocean

Date: June 3, 2018
Data Source: Santa Barbara County, USGS, ESRI
Arc photo taken on June 1, 2014 by the USCGS

GSI Water Solutions, Inc.
FIGURE A-4

MZ: 1927
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
MZ: 1927 Water Level Elevation (WLE)
- High: 70 feet
- Low: -100 feet

- WLE 10 foot Contours
- All Other Features
- Study Area
- Santa Barbara City Limits
- Highway 101
- Major Roads

Note: Data sources: Santa Barbara County, USGS, ESRI

Date: June 3, 2016

All data is used with permission from the City of Santa Barbara and the County of Santa Barbara.

Pacific Ocean
FIGURE A-5
MZ: 1990
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
MZ: 1990 Water Level Elevation (WLE)

- High: 70 feet
- Medium: 20 feet
- Low: -100 feet

- WLE 10 foot Contours
- All Other Features
  - Study Area
  - Santa Barbara City Limits
  - Highway 101
  - Major Roads

Pacific Ocean

Date: June 3, 2016
Data Source: Santa Barbara County, USGS, ESRI
All photos taken on June 1, 2016 by the USA
FIGURE A-6
MZ: 2004
Hydrogeologic Analysis of Indirect Potable Reuse Alternatives
Santa Barbara Desalination Project

LEGEND
MZ: 2004 Water Level Elevation (WLE)
- High: 70 feet
- Low: -100 feet

/∗ WLE 10 foot Contours
/∗ All Other Features
/∗ Study Area
/∗ Santa Barbara City Limits
/∗ Highway 101
/∗ Major Roads

Pacific Ocean

Date: June 3, 2016
Data Source: Santa Barbara County, USGS, ESRI
All photos taken on June 1, 2014 by the USA
Appendix B: Groundwater Head Difference Maps for Alternative 1B

The following maps provide comparison of groundwater levels from pre-development to simulated years 1990 and 2004 for the UPZ, MZ, and the LPZ.