STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

STAFF REPORT FOR REGULAR MEETING OF MAY 11-12, 2017
Prepared on April 5, 2017

ITEM NUMBER:	**9**
SUBJECT:	**City of Santa Barbara Presentation - Subsurface Intake Technologies and Potable Reuse Feasibility Studies**
STAFF CONTACT:	**Peter von Langen, 805/549-3688 or Peter.vonLangen@waterboards.ca.gov**
This Action:	**Informational**

SUMMARY

In 2015 the Central Coast Water Board amended the City's NPDES permit to allow operation of the City's desalination facility. The amended NPDES permit requires the City to use screens to reduce impingement and entrainment caused by the open ocean intake system, to fund a restoration project, and to evaluate the feasibility of subsurface intake and potable reuse options. As required by the amended permit, the City is providing this update on subsurface intake and potable reuse options evaluated through its work studies.

DISCUSSION

Background

The City owns and operates the Charles E. Meyer Desalination Facility, which is located adjacent to the City's El Estero Wastewater Treatment Plant (WWTP). The desalination facility was placed in standby mode in 1996 and had not been used since that time. Because of the extreme drought, the City has been working to place the desalination facility back into production to address the significant water shortage. On January 29, 2015, the Central Coast Water Board amended the City's NPDES permit to allow operation of the desalination facility. In adopting the amended NPDES permit, the Water Board found that the desalination facility was an "existing" facility per the State Water Board's Ocean Plan.

The "existing" facility designation, versus a "new" facility designation, is important because it determines design requirements. The existing desalination facility uses an open ocean intake system. Open ocean intake systems cause mortality of marine life through entrainment and impingement of organisms. Per the Ocean Plan, "new" facilities may be required to use more modern subsurface intake systems, which eliminate entrainment and impingement. Since this desalination facility is an existing system, the City is not required to install a more modern subsurface intake system. However, although the 2015 NPDES permit amendment designated the desalination facility as existing, the amendment also included additional requirements, including requiring the City to use screens to reduce impingement and entrainment caused by the open ocean intake system, to fund a restoration project, and to evaluate the feasibility of subsurface intake and potable reuse options.

Specifically, Provision VI.C.6.c.iii of the NPDES permit requires the City to submit a feasibility study work plan, analyzing “a range of alternatives, including subsurface intake and potable reuse options,” by August 31, 2015. As discussed at the January 27, 2017 Central Coast Water Board meeting, Water Board staff approved the City’s plan to evaluate such options on October 20, 2015. The permit amendment also required the City to report the results of these analyses and the Discharger’s intended implementation actions to the Central Coast Water Board, by June 30, 2017. The presentation by the City to the Central Coast Water Board satisfies the final requirement added to the amended permit.

Work Studies for Subsurface Intake Technologies and Potable Reuse Options

The City evaluated subsurface intake technology alternatives and project sites as well as potable reuse alternatives. As part of this staff report the City has provided abbreviated executive summaries of the Subsurface Intake Feasibility Study (see Attachment 1) and the Potable Reuse Feasibility Study (see Attachment 2). As discussed in the attachments, the work plans and work studies were reviewed through a public process with a technical advisory panel administered by the National Water Research Institute. Further information regarding the public process and the full detailed work studies for subsurface intake technologies and potable reuse options are available at the following link: http://www.nwri-usa.org/santa-barbara-panel.htm

The City evaluated six different subsurface intake technology alternatives; for each of these intake technologies the City considered potential project sites (East Beach, West Beach, Leadbetter Beach) based on their proximity to the City's desalination plant and the existing intake pipeline and the availability of existing geotechnical data. The work study describes how all six subsurface intake alternatives went through technical evaluation to determine the maximum yields achievable at each project site. The City also evaluated several scenarios for direct and indirect potable reuse in the potable reuse feasibility workplan and study. Several of the scenarios incorporate the desalination facility reverse osmosis technology for further treatment of El Estero WWTP effluent.

At today’s meeting, the City will present the results of the studies and its intended actions. As summarized in Attachments 1 and 2, the City will discuss the technically feasible maximum yield from a variety of subsurface intake and potable reuse alternatives. Although it is the City’s choice whether to implement alternatives, the City will discuss whether the alternatives could, independently or combined, potentially replace the screened intake at the desalination facility. The City has stated that it will revisit water supply alternatives, including desalination and potable reuse, when decisions on future water needs (e.g., Lake Cachuma allocations) are known. The City has stated that the alternatives considered in these work studies will also support a future update to the City's 2011 Long-Term Water Supply Plan. The City is also waiting on State Water Board development of permitting conditions for direct potable reuse before deciding whether to proceed further with these technologies. In the meantime the City has upgraded its non-potable waste water recycling facility and capacity at the El Estero WWTP and is working on a $30 million treatment upgrade to the WWTP that could increase future recycling capability.

This item follows up on information provided at the January 26-27, 2017 Central Coast Water Board meeting held in Santa Barbara, which included a tour of the El Estero WWTP and recycling facility and an update on the status of the City’s desalination facility. For more background information regarding the status of the desalination facility, water treatment and recycling by the City, and work plan approval, please see items 1 and 16 at the following link to that meeting:

http://www.waterboards.ca.gov/centralcoast/board_info/agendas/2017/january/Agenda/agenda_jan_17.htm

CONCLUSION

On October 20, 2015, Water Board staff approved the City's plan to evaluate alternatives to its open ocean intake based on the desalination facility's permitted operational capacity. Since then the City of Santa Barbara has continued to work toward making its desalination facility operational and is now producing desalinated water. The City has completed its work studies for subsurface intake technologies and potable reuse options and is providing this progress update on these alternative studies as required by the January 29, 2015 amendment to the El Estero NPDES permit.

ATTACHMENTS

1. City's Abbreviated Executive Summary for the Subsurface Intake Feasibility Study
2. City's Abbreviated Executive Summary for the Potable Reuse Feasibility Study

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SUBSURFACE INTAKE FEASIBILITY STUDY

The City of Santa Barbara's desalination plant is supplied with seawater through a screened open ocean intake and is permitted for 10,000 acre-feet per year (AFY) of finished water. According to the City's Long-Term Water Supply Plan, seawater desalination is a water supply used during and immediately after periods of extended drought. In 2014, the City of Santa Barbara initiated a study to meet requirements set forth by City Council and the Regional Water Quality Control Board to evaluate the feasibility, cost, and timeline of converting the offshore screened open ocean intake facility into a subsurface desalination intake (SSI). To do this, the water supply must provide 15,898 gallons per minute (gpm) of seawater. This executive summary summarizes the findings of this study.

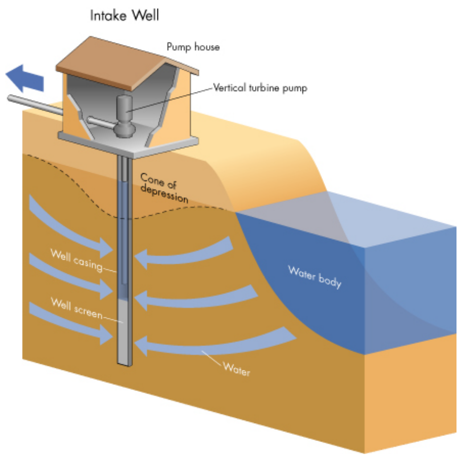
For this study, the following six SSI technologies were considered; each of these technologies is presented in Figure 1.

1) Vertical wells.
2) Lateral beach wells (i.e., onshore infiltration galleries).
3) Horizontal collector wells (i.e., Ranney Wells, Radial Collector Wells).
4) Slant wells.
5) Subsurface infiltration galleries (SIG) located offshore.
6) Horizontal directionally drilled (HDD) wells (i.e., Neodren).

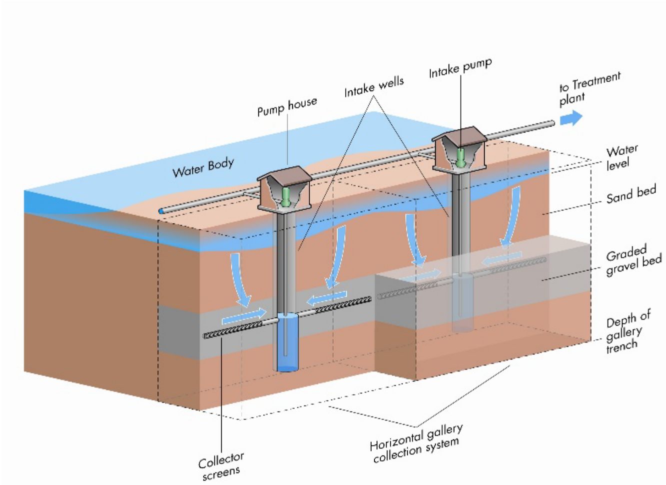
The study included a technical advisory panel (TAP) to provide an independent, third part review of the feasibility evaluation at key intervals throughout the project duration. The TAP had the following three objectives: 1). Provide timely review of project work products by subject matter experts to advise and guide the study; 2). Facilitate input from project stakeholders that can be used to inform the City's comparison of alternatives; and 3). Create a record of the review and stakeholder process to be included as an appendix to the feasibility study report. The City retained the services of the National Water Research Institute (NWRI) to administer the TAP, including soliciting public comments and providing complete documentation of the technical review and comment process on the project website.

To evaluate these technologies, several criteria were established based on geotechnical, hydrogeologic, and oceanographic factors as well as the presence of sensitive habitats and any design and construction constraints. Technologies were then classified as "not feasible," "potentially feasible but does not meet current study goals," or "potentially feasible." Only "potentially feasible" technologies would be evaluated further for their social, environmental, and economic feasibility.

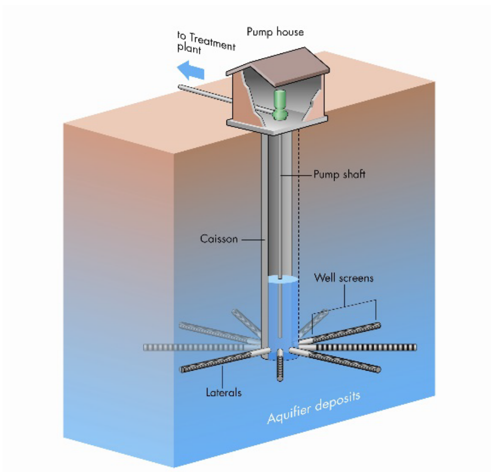
Figure 2 presents a summary of the potential water yield from each of the SSI alternatives. For the initial screening analysis, conceptual designs were developed for technologies that met basis of design requirements established in the study. For example, a conceptual design was not developed for constructing a SIG because it was not feasible at any project site due to the presence of geologic faults and its inability to protect against filter bed erosion. Technologies that did not meet the study goals (e.g., able to produce 15,898 gpm) still had conceptual designs developed based on the greatest production capacity that could be obtained given the hydrogeological or land area restrictions.



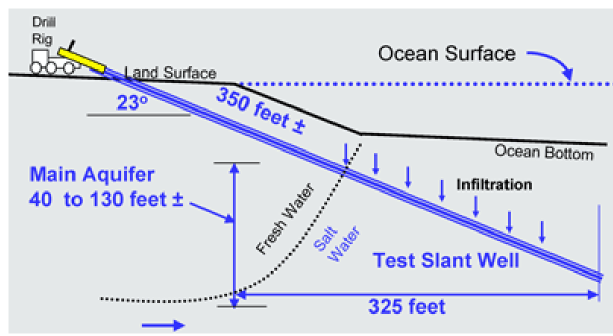
Vertical Wells



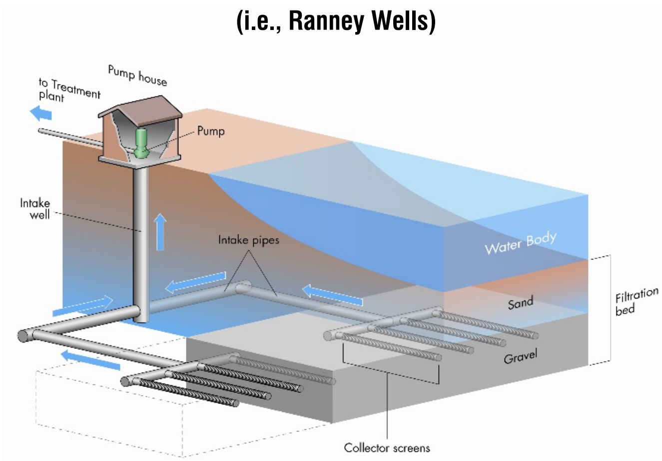
Lateral Beach Wells
(Onshore Infiltration Galleries)



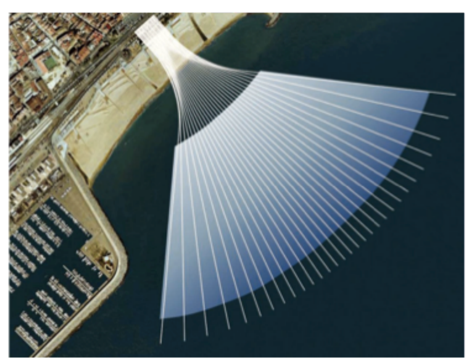
Horizontal Collector Wells
(i.e., Ranney Wells)



Slant Wells



SIG - offshore



HDD Wells
(i.e., Neodren)

Figure 1 - Subsurface Intake Technology Alternatives

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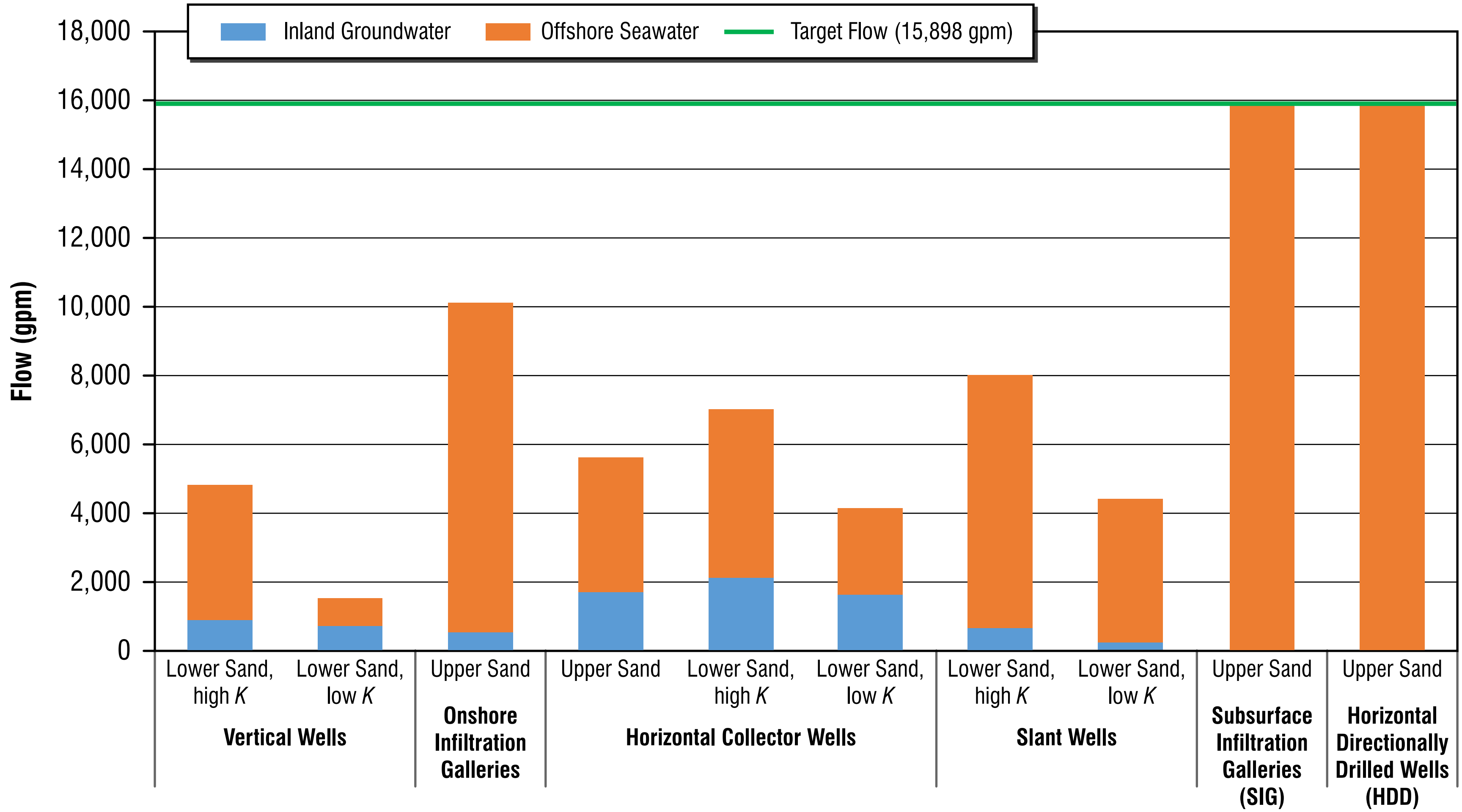

NOTES:
1. Lower sand and upper sand represent the aquifer unit where the subsurface intake would be constructed.
2. *K* represents hydraulic conductivity and is representative of how easily water can pass through soil.
3. Inland groundwater is freshwater withdrawn from local, non-seawater aquifers.
4. Flow from some subsurface intakes would be a combination of freshwater and seawater as shown above.
5. SIG and HDD wells are able to produce a flow of 15,898 gpm, and are the only two alternatives that derive all of their flow from offshore sources.

Figure 2 - Water Yield From Subsurface Intake Alternatives

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Table 1 presents the results of the initial screening analysis. As the table shows, no technologies evaluated were deemed "potentially feasible" given the study objectives.

Of the technologies evaluated, only SIG and HDD wells met the requirement of adequate capacity within the City-owned beachfront. These technologies also only derive flow from offshore sources and do not affect onshore groundwater resources. In contrast, the other technologies evaluated can only produce between 9 and 64 percent of the required flow and may affect inland groundwater.

However, SIG failed technical feasibility screening in several categories, including the inability to mitigate and protect against seismic hazards and erosion. HDD wells did pass all initial screening criteria, but they ultimately failed because they lacked prior successful precedent in a similar application. With time, HDD well technology is likely to improve and may become more reliable. At present, though, the City cannot have its water supply depend on an unproven or unreliable technology.

Although no SSI alternative passed the initial screening analysis, the information developed and presented in the report will be used to inform future studies.

Table 1 Subsurface Desalination Intake Initial Screening Results

Initial Screening Criteria		Subsurface Intake Alternative					
		Vertical Beach Wells	Onshore Infiltration Gallery	Radial Collector Wells	Slant Wells	Subsurface Infiltration Galleries	HDD Wells
Geotechnical Hazards							
1	*Seismic Hazard*						
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	PF	PF	PF	PF	NF	PF
Hydrogeological Factors							
2	*Impact on existing freshwater aquifers, local water supplies, or existing water users*						
a.	Volume of groundwater in storage is reduced due to subsurface intake pumping, impacting drought supply and requiring additional desalination to make up for loss of groundwater.	PF	PF	PF	PF	PF	PF
b.	Operation of subsurface intake causes salt water intrusion into groundwater aquifers.	PF	PF	PF	PF	PF	PF
3	*Impact to sensitive habitats such as marshlands, drainage areas, etc.*						
a.	Operation of subsurface intake drains surface water from sensitive habitat areas or adversely changes water quality.	PF*	PF*	PF*	PF*	PF	PF
4	*Insufficient length of beach available for replacing full yield derived from existing open ocean intake*						
a.	Small individual facility yield, large number of facilities required, and minimum spacing between facilities requires more shoreline than is available.	PF*	PF*	PF*	PF*	PF	PF
Benthic Topography							
5	*Land type makes intake construction infeasible.*						
a.	Depth to bedrock too shallow (i.e., less than 40-feet deep); rocky coastline; cliffs	PF	PF	PF	PF	PF	PF
Oceanographic Factors							
6	*Erosion, sediment deposition, sea level rise, or tsunami hazards*						
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.	PF (5)	PF (4) (5)	PF (5)	PF (5)	NF (5)	PF (5)

Initial Screening Criteria		Subsurface Intake Alternative: Vertical Beach Wells	Onshore Infiltration Gallery	Radial Collector Wells	Slant Wells	Subsurface Infiltration Galleries	HDD Wells
Presence of Sensitive Habitats							
7	*Proximity to marine protected areas*						
a.	Location would require construction within a marine protected area.	PF	PF	PF	PF	PF	PF
Design and Construction Constraints							
8	*Adequate Capacity*						
a.	Subsurface material lacks adequate transmissivity to meet target yield of at least 15,898 gpm (i.e., build-out intake capacity necessary to produce 10,000 AFY).	PF*	PF*	PF*	PF*	PF	PF
9	*Lack of adequate linear beach front for technical feasibility*						
a.	Length of beachfront available is not sufficient for construction of the required number of wells of all or portion of intake to meet target yield.	PF*	PF*	PF*	PF*	PF	PF
10	*Lack of adequate land for required on-shore facilities*						
a.	Surface area needed for on-shore footprint (i.e., pump house) of an intake unit is greater than the available onshore area.	PF	PF	PF	PF	PF	PF
b.	Requires condemnation of property for new on-shore intake pumping facilities.	PF	PF	PF	PF	PF	PF
11	*Lack of adequate land for required on-shore construction staging*						
a.	The amount of land available to stage construction does not meet need.	PF	PF	PF	PF	PF	PF
12	*Precedent for subsurface intake technology*						
a.	Intake technology has not been used before in a similar seawater or fresh water application at a similar scale.	PF	PF	PF	PF	PF	PF
Passes Initial Screening? Yes (Y) or No (N)		N	N	N	N	N	N

Notes:

(1) NF = Not Feasible

(2) PF = Potentially Feasible

(3) PF* = Potentially Feasible, but does not meet current study goals

(4) Potentially feasible at Leadbetter and West Beach only. Sediment transport conditions at East Beach make the implementation of an onshore infiltration gallery infeasible (refer to Section 3.4.2).

(5) Refer to Section 3.4. Beach facilities would be susceptible to inundation and erosion as a result of tsunami and would also be increasingly impacted by seawater rise over the 20 year project life. Electrical buildings and wet wells will need to be constructed in a manner that provides flood protection.

Abbreviated Executive Summary

POTABLE REUSE FEASIBILITY STUDY

In 2014, the City of Santa Barbara (City) initiated a potable reuse feasibility study to meet requirements set forth by City Council and the Regional Water Quality Control Board. The study explored alternatives for replacing its desalination plant's permitted capacity of 10,000 acre-feet per year (AFY) with potable reuse or supplying 11,400 AFY of potable reuse for alternatives affecting the City's planned 1,400 AFY of non-potable reuse (NPR). Alternatives involved using indirect or direct potable reuse, both of which are described below.

1) Indirect potable reuse (IPR): Advanced treated water is introduced into a groundwater aquifer and is then withdrawn for potable purposes.
2) Direct potable reuse (DPR): Advanced treated water is used to augment raw surface water supplies and is then re-treated as a surface water before being distributed for potable purposes.

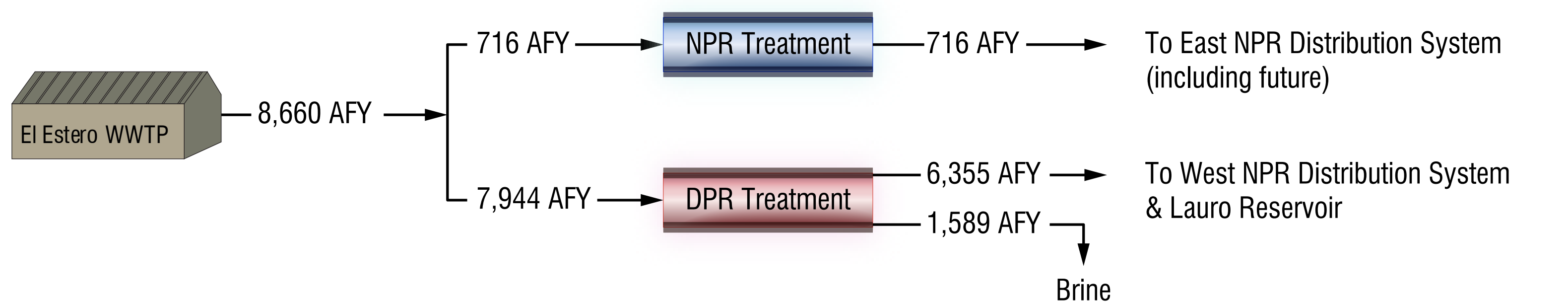
To evaluate these alternatives, several criteria were established based on geotechnical, hydrogeological, and oceanographic factors as well as the presence of sensitive habitats and any design and construction constraints. Alternatives were then classified as "not feasible," "potentially feasible but does not meet current study goals," or "potentially feasible." Only "potentially feasible" alternatives would be evaluated further for their social, environmental, and economic feasibility.

The study included a technical advisory panel (TAP) to provide an independent, third part review of the feasibility evaluation at key intervals throughout the project duration. The TAP had the following three objectives: 1). Provide timely review of project work products by subject matter experts to advise and guide the study; 2). Facilitate input from project stakeholders that can be used to inform the City's comparison of alternatives; and 3). Create a record of the review and stakeholder process to be included as an appendix to the feasibility study report. The City retained the services of the National Water Research Institute (NWRI) to administer the TAP, including soliciting public comments and providing complete documentation of the technical review and comment process on the project website.

As presented in Figure 1, six alternatives (Alternatives 1A, 1B, 2A, 2B, 3A, and 3B) were identified for evaluation, all involving combinations of NPR, IPR, DPR, along with siting and layout of an advanced water treatment facility (AWTF). The maximum potential yield of potable reuse water that is technically feasible was identified for each alternative and is summarized in Table 1.

ALTERNATIVE NUMBER	FLOW DIAGRAM	DESCRIPTION NOTES

1A

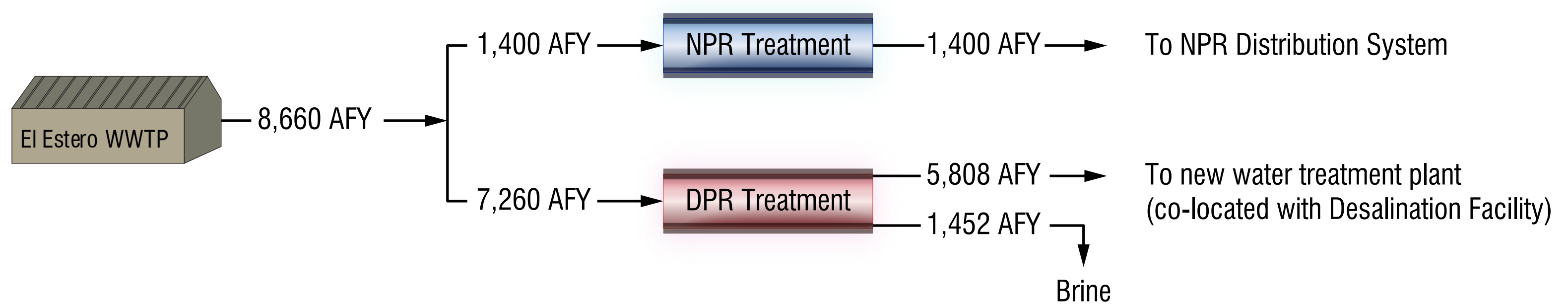


Maximize NPR treatment & use Lauro Reservoir
- Only tertiary treated flow going east.
- DPR treat all flows going west.
- DPR treated flow sent to Lauro Reservoir.
- Alternative maximizes NPR treated flow.

1B

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

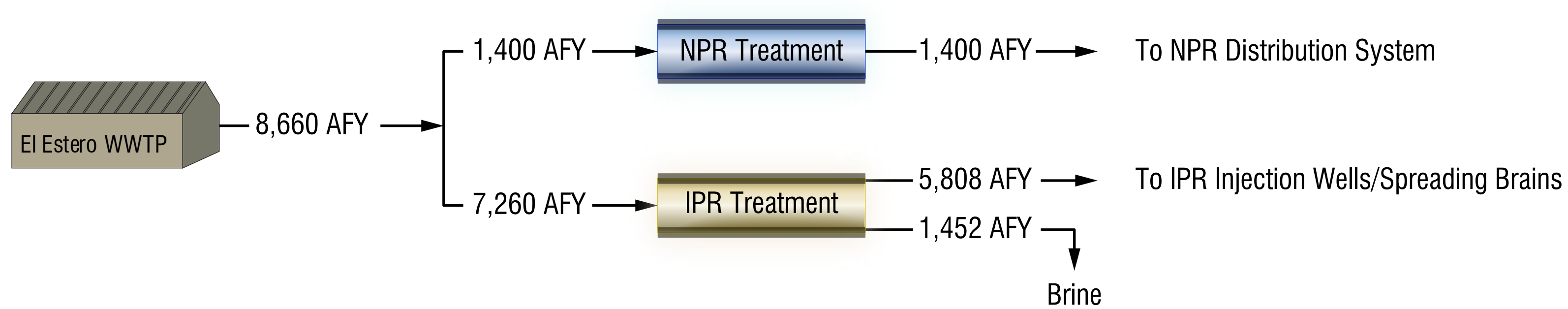


Maximize NPR treatment & use new WTP
- NPR system remains in place as is.
- Remaining flow is sent to DPR facility, and retreated at new WTP co-located with Desalination Facility.

2B

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



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

Maximize IPR by minimizing NPR
- NPR system is removed, and all flow is IPR treated and sent to injection wells/spreading basins.

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

Figure 1
Final Summary of Potable Reuse Alternatives

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Table 1 Potential Maximum Yields of Alternatives

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

Note:

(1) 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.

After evaluating the six alternatives for their technical feasibility, all were deemed either "not feasible" or "potentially feasible but doesn't meet the study goals." For a breakdown of the results and the reasons for them, consult Table 2.

Because an alternative must be deemed "potentially feasible" to pass this level of screening, no alternative was selected for further analysis of social, environmental, and economic factors. However, although the alternatives did not pass initial screening, the study did give the City valuable technical information for future water supply planning studies.

The State of California 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. The City intends to 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 2 Potable Reuse Alternatives Initial Screening Results

Initial Screening Criteria		Potable Reuse Alternative					
		Alternative 1A	Alternative 1B	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B
Geotechnical Hazards							
1	*Seismic Hazard*						
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	PF	PF	PF	PF	NF	PF
Hydrogeological Factors							
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*						
a.	Insufficient travel time (e.g., < 2 months) between groundwater replenishment point and other groundwater users	PF(4)	PF(4)	PF(4)	PF(4)	PF	PF
3	*Operation of groundwater replenishment facilities (i.e., injection wells or spreading basin) adversely impacts sensitive habitats such as marshlands, drainage areas, etc.*						
a.	Operation of facility adversely changes water quality of habitat (e.g., salt water habitat becomes fresh water)	PF(4)	PF(4)	PF(4)	PF(4)	PF(6)	PF(6)
4	*Insufficient storage space*						
a.	Groundwater basin lacks adequate storage capacity to receive 10,000 AFY (or 11,400 AFY) at build-out	PF(4)	PF(4)	PF(4)	PF(4)	PF*	PF*
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.)	PF(4)	PF(4)	PF(4)	PF(4)	PF	PF
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)	PF(4)	PF(4)	PF(4)	PF(4)	PF*	PF*
Oceanographic Factors							
5	*Sea level rise or tsunami hazard*						
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	PF	PF	PF	PF	PF	PF

Initial Screening Criteria	Potable Reuse Alternative Alternative 1A	Alternative 1B	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B
Presence of Sensitive Habitats						
7 *Habitat creation*						
a. Facility creates habitat that is unsustainable (i.e., requires continued discharge by IPR or DPR facility) or adversely affects local ecosystem	PF	PF	PF	PF	PF	PF
Design and Construction Constraints						
7 *Adequate Capacity*						
a. Availability of effluent needed to produce 10,000 AFY (or 11,400 AFY) of recycled water at build-out	PF*	PF*	PF*	PF*	PF*	PF*
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	PF*	PF*	PF*	PF*	PF*	PF*
8 *Lack of adequate land required for IPR or DPR treatment facilities or groundwater replenishment facilities*						
a. Surface area needed for footprint of IPR or DPR treatment facilities or groundwater replenishment facilities is greater than what is available.	PF	PF	PF	PF	PF	PF
b. Requires condemnation of property for new injection well facilities.	PF(4)	PF(4)	PF(4)	PF(4)	PF	PF
Passes Initial Screening? Yes (Y) or No (N)	**N**	**N**	**N**	**N**	**N**	**N**
Regulations Exist in CA? Yes (Y) or No (N)[6]	**N(7)**	**N(7)**	**N(7)**	**N(7)**	**Y**	**Y**

Notes:

(1) NF = Not Feasible.
(2) PF = Potentially Feasible.
(3) PF* = Potentially Feasible, but does not meet current study goals.
(4) Potentially feasible because alternative does not include an IPR component. Thus, this initial screening criteria is not applicable.
(5) Additional study will be required to locate groundwater replenishment wells at locations that will not adversely affect sensitive areas or other users.
(6) Do standard regulations exist in the state of California currently to implement the alternative?
(7) 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.