FINAL SUMMARY REPORT
DOHENY OCEAN DESALINATION PROJECT
PHASE 3 INVESTIGATION

Extended Pumping and Pilot Plant Test
Regional Watershed and Groundwater Modeling
Full Scale Project Conceptual Assessment

PREPARED BY

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

JANUARY 2014

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

South Coast Water District

LAGUNA BEACH COUNTY WATER DISTRICT

Moulton Niguel Water

CITY OF SAN CLEMENTE CALIFORNIA

CITY OF SAN JUAN CAPISTRANO CALIFORNIA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

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GLOSSARY

AFY	acre-feet per year.
Alluvial/Alluvium	A geologic term describing beds of sand, gravel, silt, and clay deposited by flowing water through which groundwater can readily flow.
Aquifer	A geologic formation or group of formations which store, transmit, and yield significant quantities of water to wells and springs.
Anoxic	A common condition in older natural groundwater where the water is completely devoid of any dissolved oxygen.
ARB	California Air Resources Board
California Ocean Plan	The water quality control plan for the ocean that is established and periodically updated by the State Water Resources Control Board. The plan sets out the standards under which wastewater discharge permits are based upon.
dFe/dMn	Reduced, divalent iron and manganese occur in the dissolved form, primarily as hydroxides in anoxic waters.
D.O.	**D**issolved oxygen
Drawdown	The change in hydraulic head or water level relative to a background condition.
Dual Rotary Drill Rig	A water well drilling rig that combines the ability to drill and construct an outer casing to protect the open hole without the use of drilling muds.
DWR	California Department of Water Resources
Evapotranspiration	The combined loss of water from a given area by evaporation from the land and transpiration from plants.
Fault	A fracture in the earth's crust, with displacement of one side of the fracture with respect to the other. Faults may be impervious to the flow of water due to the grinding of adjacent formation materials into very fine sediments.
Fe/Mn	Iron and manganese
gpm	gallons per minute
Groundwater	Water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.
He/Tr	Helium and Tritium isotopes

LBCWD	Laguna Beach County Water District
MET	Metropolitan Water District of Southern California
MGD	million gallons per day
mg/l	milligrams per liter
MNWD	Moulton Niguel Water District
MWDOC	Municipal Water District of Orange County
Natural Isotope Tracer	Naturally occurring radioactive isotopes provide information about a groundwater's age, which refers to the last time the water was in contact with the atmosphere. They can be used to evaluate the sources of pumped groundwater over time.
NTU	nephelometric turbidity units, a measurement of turbidity and clarity of water.
O&M	Operation and maintenance
OTE	Operations, testing and evaluation
R & R	Repair and Rehabilitation
Ranney or Radial Well	A horizontal well built from a central large shaft with radial intakes horizontally pushed out into the formation, usually spaced equidistantly around the circumference of the shaft. These types of wells allow water to be drawn from the lower portion of river or stream channels to maintain yield during dry periods.
RO	Reverse Osmosis. A treatment process that uses high pressure to force water through very fine membranes.
SDCWA	San Diego County Water Authority
SDG&E	San Diego Gas & Electric
SCWD	South Coast Water District
SDI	Silt Density Index, a measure of the suspended solids in water commonly used to measure the clogging potential of feedwater to reverse osmosis membrane systems.
SJBA	San Juan Basin Authority
Slant Well	A water supply well-constructed at a relatively flat angle.

SOCOD	South Orange Coastal Ocean Desalination Project. Former name of the Doheny Ocean Desalination Project.
SOCWA	South Orange County Wastewater Authority
SWP	State Water Project
TDS	Total Dissolved Solids
UCI	University of California Irvine
UF	Ultra Filtration
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WHOI	Woods Hole Oceanographic Institute
µ	Micron

A. Project Information

1. Type: Ocean Desalination Feasibility Investigation
2. Title: Phase 3 Doheny Ocean Desalination Project – Extended Pumping and Pilot Plant Test, Regional Watershed and Groundwater Modeling, and Full Scale Project Conceptual Assessment
3. Start Date: January 11, 2008
4. End Date: December 31, 2013
5. Grant and Funding Information:
    a. California Department of Water Resources, Prop 50 Grant Agreement No. 4600007435 for $1,500,000.
    b. U.S. Environmental Protection Agency, STAG Grant Agreement No. XP-00T40501-0, for $848,000.
    c. U.S. Bureau of Reclamation, WaterSmart Grant R10AP35290 for $499,000
    d. Project Participants (South Coast Water District, City of San Clemente, City of San Juan Capistrano, Moulton Niguel Water District) Local Funding totaling $3,300,000.
6. Grantee and Managing Agency: Municipal Water District of Orange County
7. Contact: Mr. Karl W. Seckel, PE, Program Manager; Mr. Richard B. Bell, PE, Project Manager and Principal Engineer
8. Phase 3 Total Project Cost: $6,147,000.

B. Executive Summary

The Municipal Water District of Orange County (MWDOC) in partnership with five participating agencies, investigated the feasibility of slant wells to extract ocean water for the planned Doheny Ocean Desalination Project (aka Dana Point and South Orange Coastal Ocean Desalination (SOCOD) Project). The Phase 3 Extended Pumping and Pilot Plant Test, Regional Watershed and Groundwater Modeling and Full Scale Project Conceptual Assessment work were initiated in January 2008. The five participating agencies provided technical review and elected official decision-maker direction through a project governing committee structure. MWDOC provided overall project management, project development and permitting, technical support work, and staffed the committee.

Project Location and Development of the Doheny Ocean Desalination Project

The Phase 3 test facilities are located in Doheny State Beach in Dana Point, California. The test facilities consisted of the Test Slant Well, submersible pump, control vault, two monitoring wells, conveyance lines, the Mobile Test Facility, electrical service, and a temporary diffuser for discharge to the surf zone.

The full scale project would produce 15 MGD of drinking water (95% operational load factor = 15,961 AFY) and would be situated on a nearby 5-acre parcel being reserved for the project by South Coast Water District. The project site is crossed by the two regional imported supply pipelines and the adjacent San Juan Creek Ocean Outfall has sufficient brine disposal capacity. The major technical issue for the project was to determine the most cost-effective method to produce ocean water.

Figure 1A - Schematic of Test Slant Well

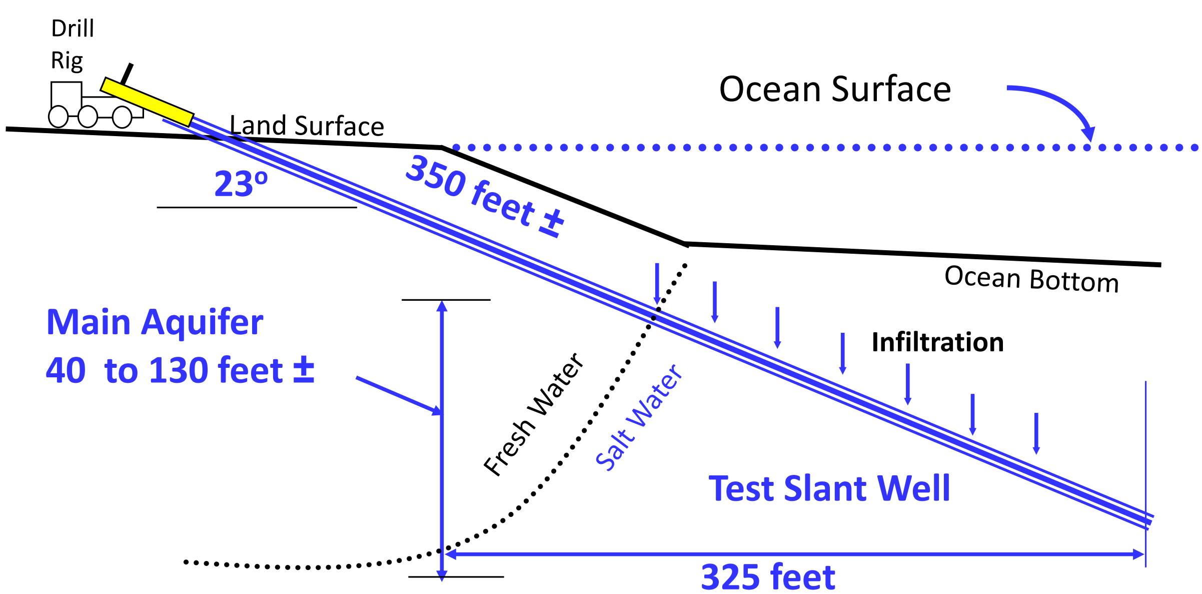


Figure 1B - Schematic of Doheny Desal Project Layout

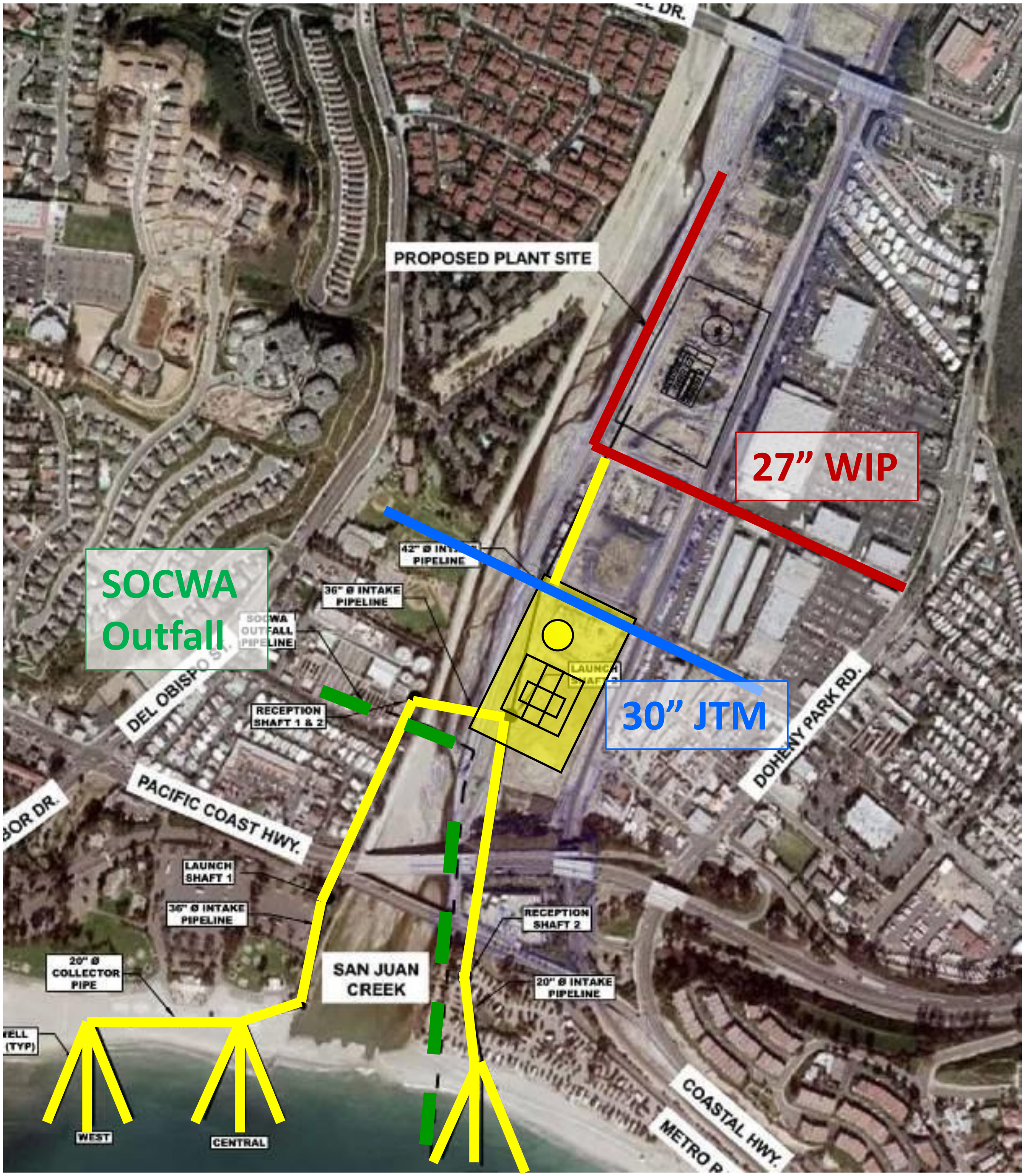


Figure 2 - Schematic of Test Facility

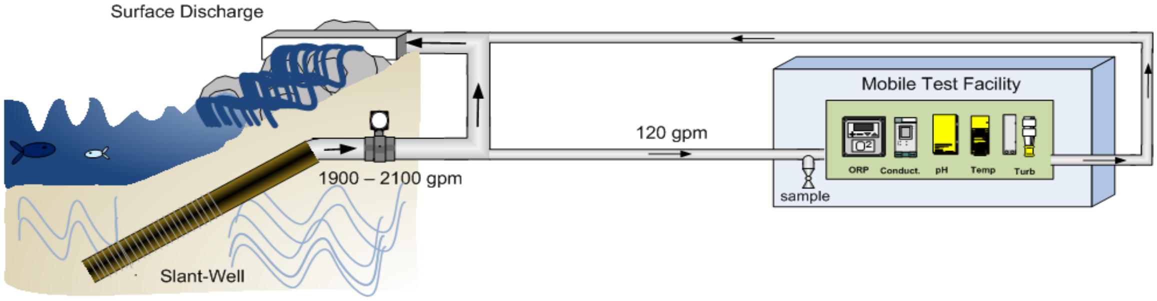
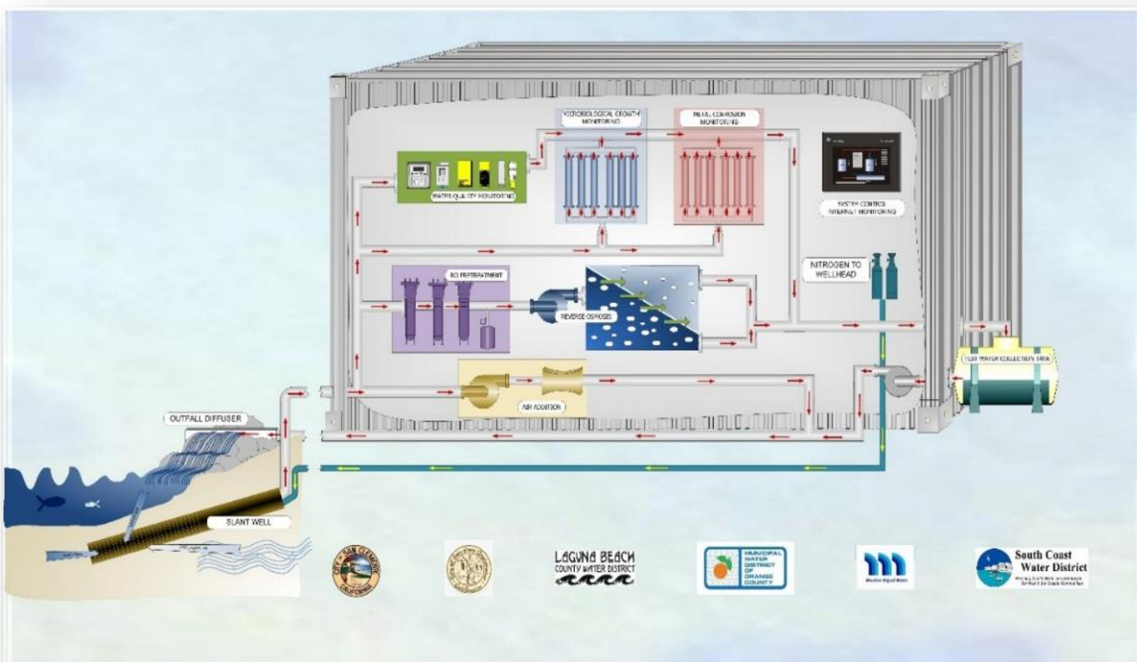


Figure 3 - Layout of Test Facilities

In 2003/04, MWDOC undertook preliminary studies to assess alternative approaches to produce ocean water in the vicinity where San Juan Creek discharges to the ocean in Dana Point. Options included a conventional open intake, a subsurface infiltration gallery, and various types of beach wells. A flat continental shelf in this location would require that a conventional open intake be situated about 7,000 feet offshore to provide sufficient depth for protection of the intake. Due to the

Figure 4 - Mobile Test Facility (MTF)



expected high cost and difficult permitting for an open intake system and based on early discussions with the California Coastal Commission staff, a decision was made to investigate the feasibility of constructing a subsurface intake system using a horizontal or angled well construction method. Infiltration galleries were deemed infeasible due to high costs, ocean floor impacts, clogging, decreasing yields and maintenance challenges. Radial wells (aka Ranney Wells) were deemed infeasible due to high costs, a long construction period that would exceed the 8-month off-season construction window allowed by State Parks, limitations on the ability to gravel pack the laterals, and the limitation to extend the laterals at significance distance out under the ocean.

To investigate the feasibility of a subsurface slant well intake, a phased hydrogeology and subsurface well technology investigation was undertaken. In 2004/05, four exploratory boreholes were drilled along the beach to a depth of 188 feet below the ground surface. The boreholes encountered highly permeable alluvium throughout their depth. In 2005/06, after a thorough review of several technologies it was determined that the most cost-effective approach for this location was the use of slant beach wells constructed with a dual rotary drill rig from the beach out under the ocean. A test slant well was deemed necessary to evaluate the aquifer response, water quality, and aquifer filtration. Groundwater modeling was also necessary to evaluate the impacts of the project draw on the groundwater basin associated with San Juan Creek and to determine the potential capacity of a slant beach wellfield.

In 2005/06 with grant funding support from the California Department of Water Resources, U.S. EPA and U.S. Bureau of Reclamation and MWDOC, a demonstration Test Slant Well was permitted, designed and constructed and a short-term aquifer pumping test was performed. Initial groundwater modeling indicated a full scale slant wellfield could produce about 30 million gallons per day at acceptable drawdowns to wells in the local vicinity. The results from this demonstration well were encouraging and it was then determined that an extended pumping and pilot plant test was necessary.

Phase 3 Extended Pumping and Pilot Plant Test – AN OVERVIEW

The extended pumping and pilot plant test required the installation of a submersible pump, vault with control valves, a diffuser for surf zone discharge of the pumped water, conveyance lines to and from a mobile test facility, and electrical service. MWDOC conducted the planning, environmental documentation and permitting with the assistance of consultants. The mobile test facility was designed by Dr. Mark Williams and the submersible pump was designed by Bayard Bosserman under contracts to MWDOC. The Mobile Test Facility was procured from Intuitech and the submersible pump was procured from INDAR. The remainder of the test facility infrastructure was designed by Carollo Engineers and awarded to and constructed by SCW Contractors. This work was conducted in 2008 to 2010.

Separation Processes (SPI) was the contractor selected for the extended pumping and pilot plant Operations, Testing and Evaluation (OTE) work. They were awarded the work through a competitive proposal/interview process that consisted of staff from the participating agencies and outside experts. The OTE work consisted of pumping the test slant well for a period over 21 months to evaluate the performance of the pump, well and aquifer and to determine water quality produced from the marine aquifer, filtration performance of the aquifer, and corrosion and microbial fouling potential. In addition, the work included iron/manganese pretreatment pilot tests.

The testing work found that the pump and aquifer performed exceptionally well. The well experienced some sand clogging that was due to insufficient well development which was a result of a decision to construct the test slant well with only a 12-inch internal diameter (to reduce costs) and to utilize a high speed submersible pump that would enable a shorter test duration at high pumping rates to adequately stress the aquifer. This problem should not occur in the full scale project as proper and full development would be provided and the well would be equipped with a lower speed production pump.

Over the extended test period, the salinity increased from 2,500 mg/l to over 17,000 mg/l, which was fairly close to what was predicted by the initial variable density groundwater model. It is estimated, that under constant pumping it would have eventually reached about 32,000 mg/l when fully connected with the ocean assuming 95% ocean water at 33,700 mg/l (average of analyses during Phase 3) and 5% brackish groundwater at 2,200 mg/l. The increase in salinity showed that ocean water was slowly being pulled into the well over the test period. A major and unexpected finding was the high level of dissolved iron and manganese contained in the pocket of old marine groundwater that lies under the ocean. This water was anoxic (devoid of oxygen) and slightly acidic, and was found to be about 7,500 years old. From the groundwater modeling work, it was estimated that under full production capacity, the old marine groundwater would be mostly pumped out and replaced by ocean water within a year or so. However, further work is needed to zero in on this time estimate.

The pump out of the old pocket of marine groundwater will likely significantly reduce or potentially eliminate the need for iron/manganese pretreatment. There is also some uncertainty whether the pumped water would remain anoxic under full scale production. In all other respects, the produced water showed a very low silt density index (average around 0.5 units) and turbidity (averaged around 0.1 NTU), indicating excellent filtration by the aquifer which eliminates the need for conventional pretreatment filtration and saves costs.

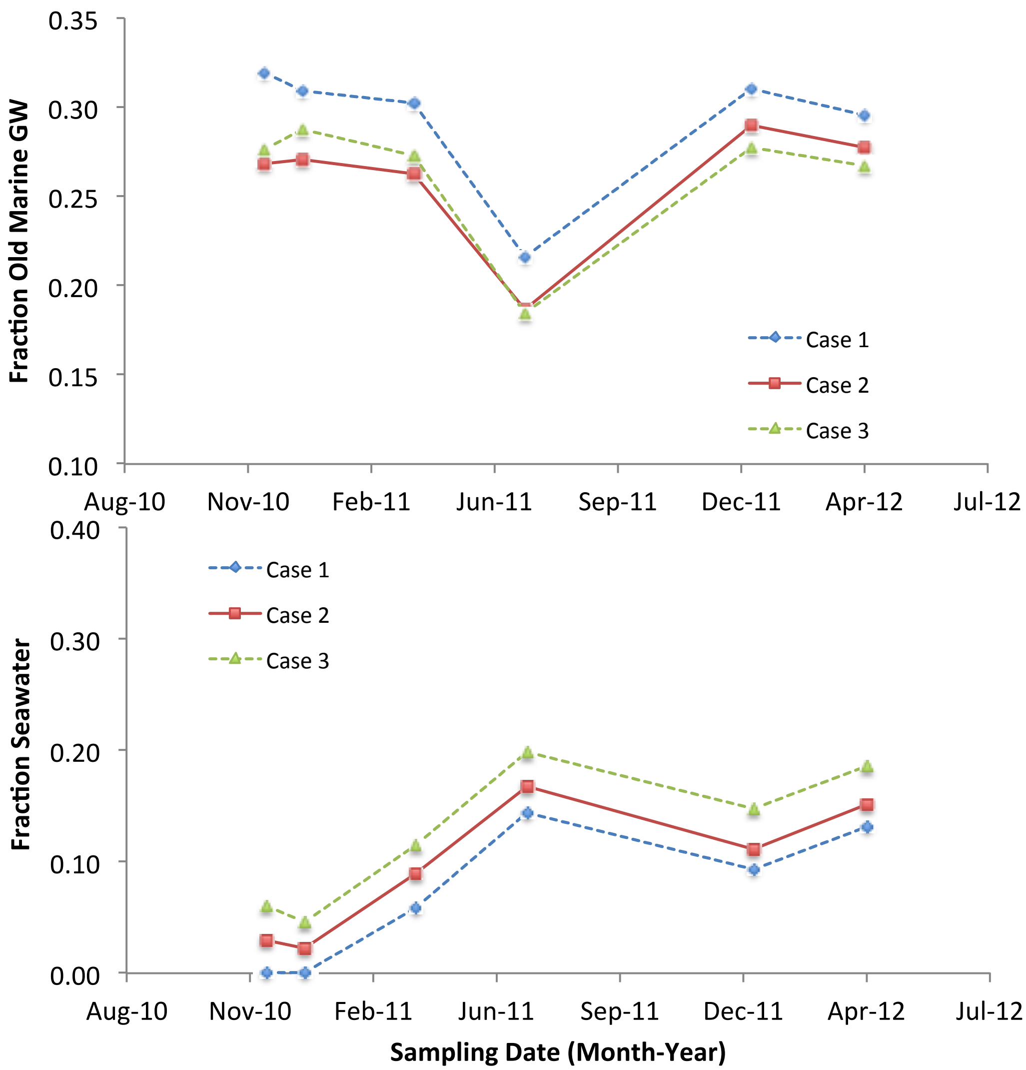
In addition, the produced water showed no presence of bacterial indicator organisms which were found to be present in high concentrations in the ocean and seasonal lagoon. Initial pump out of the brackish groundwater showed higher levels of TOC (Total Organic Carbon) which decreased with increasing production of marine groundwater and ocean water. During the initial period of pump out, a higher level of groundwater bacteria were observed which steadily decreased to extremely low levels. Biofilm growths by the end of the test were found to be less than 10 µ in thickness, a level of no concern for biofouling.

Pumped well water was run directly to the test RO units continuously for over four months. No fouling or performance deterioration was observed during the test or in the post-membrane autopsy as all the dissolved iron and manganese was easily removed as anoxic conditions were maintained throughout the test period.

A pilot plant study was conducted to test advanced iron/manganese removal pretreatment systems. The tested pretreatment processes were oxidized pressure filtration and pre-oxidized UF membrane filtration. Column tests were performed to determine the best media, oxidants, and dosages. Oxidation and sedimentation tests were also performed to evaluate approaches for use during well development to meet discharge requirements. The results showed that the oxidized advanced media filtration process provided higher levels and consistency of removal. A final decision on whether pretreatment would be required must wait until the initial period of pump out of the old pocket of marine groundwater is accomplished. It is recommended that prior to final design, that a final pilot plant test be conducted on the produced water after it has stabilized and the old pocket of marine groundwater has been pumped out.

To determine how much ocean water was being recharged into the aquifer and pumped, natural isotope testing and analyses were conducted throughout the test. This work utilized a multiple tracer approach to quantify the groundwater source captured by the slant well intake. Tracers included natural isotopes of radium, helium, tritium and radiocarbon. Three iterations of a mixing model that utilized the multiple tracer dataset were performed. The model runs suggested ocean water recharge capture was 14-20% by the end of the test with the remainder being a mixture of old marine and brackish groundwater. At the beginning of the test the capture was 0-6%. The 6% range in the model estimates can be narrowed by sampling of the old marine groundwater (see Figure 5).

Figure 5 - Natural Isotope Model - Slant Well Source Production



If the pumping test were to have continued, the old marine groundwater would have been most likely fully pumped out of the offshore formation and replaced by ocean water. Under steady state pumping conditions, there is a high probability that the pumped water would contain very low levels of dissolved iron/manganese. This would result from a combination of the infiltration and plug flow movement of the oxic and slightly alkaline ocean water into and through the aquifer that is reduced to either slightly oxic or anoxic groundwater as a result of microbial activity that consumes dissolved oxygen depending on the amount of available organic carbon. Furthermore, given the observed levels of dissolved Fe and Mn in the old marine groundwater, it is unlikely that their in-situ precipitation from any boundary mixing of oxygenated seawater recharge flows would have a measurable impact on the aquifer permeability at the expected Fe and Mn concentrations, especially under the plug flow conditions that would largely occur. Further, the accumulation of Fe (and Mn) oxides is likely present within the upper shallow aquifer where there is a likely redox boundary where iron precipitation would occur under groundwater ocean discharge conditions. With pumping, ocean water would flow down into the aquifer.

There are two likely locations for precipitation: (1) in the shallow zone of the terrestrial-marine groundwater interface before the water discharges into the ocean and (2) in the shallow sediments on the ocean side of the ocean water interface, where wave and tide driven pore water exchange drive high pH and oxygen rich groundwater into the aquifer. Altogether, under steady-state pumping conditions, this zone would likely contribute little iron to the ocean water that would infiltrate and move through the aquifer to the wellfield. The presence of organic carbon and aerobic bacteria in the shallow seafloor sediments utilizes the oxygen in the ocean water rendering it anoxic, as demonstrated over the extended pumping test. Further evaluation of the organic carbon content in the shallow sediments and sources should be evaluated to determine if the anoxic condition of the recharged ocean water would be maintained over the long run.

Initial Pump Out and Disposal of Old Marine Groundwater

The alluvial channel within the continental shelf offshore of San Juan Creek was submerged by the ocean following the end of the last ice age. Under current conditions, subsurface outflows from San Juan Creek discharge out under and up into the ocean within the area shoreward of the saltwater interface. On the ocean side of this interface, the ocean filled alluvium groundwater has remained isolated since its inundation about 7,500 years ago. We have termed this “older” ocean groundwater as “old marine groundwater”.

Testing found that the old marine groundwater is slightly acidic, anoxic and enriched with reduced, divalent, dissolved iron and manganese. Dissolved iron and manganese concentrations increased by the end of the test to a peak of about 11 mg/l and 5 mg/l, respectively. Their concentrations in the old marine groundwater may range from 11 mg/l to as high as 30 mg/l, but the current range is inconclusive due to a lack of offshore aquifer water quality and microbial community conditions.

Water quality and isotope testing provided data to estimate the relative mix by source of the pumped groundwater over the test period. Based on the natural isotope data/model, the pumped water was first mostly brackish groundwater which then steadily decreased as ocean water steadily increased from zero to about 17%, and old marine groundwater. The fraction of old marine groundwater started out at zero, reached an apparent maximum of about 29% before decreasing and in time would have been fully replaced by replaced by recharged “young” ocean water. See Figure 6 for an illustration of how the change in source water would occur over time. Under the full production rate of 30 mgd ocean water recharge would be greatly accelerated from what was observed under the Phase 3 test of 3 mgd.

As illustrated, the source of water being pumped out will continually change in make up until it reaches a steady state condition. For the full scale project, initial modeling suggested that under steady state conditions the extracted well water would reach about 5% brackish groundwater and about 95% ocean water ("young" marine groundwater).

The Phase 3 test data is planned to be utilized in the calibration of a fine grid coastal groundwater flow, variable density, and geochemical model. The fine grid model will help to better predict pumped water quality over time and by source, to evaluate drawdown effects, and seawater intrusion and controls.

Under the full scale project, during the period of initial pumping when the pocket of old marine groundwater is being pumped out and replaced by "young" ocean water, there are two major questions:

(1) How long will it take to pump out the pocket of old marine groundwater?

(2) What is the best approach for handling the old marine groundwater?

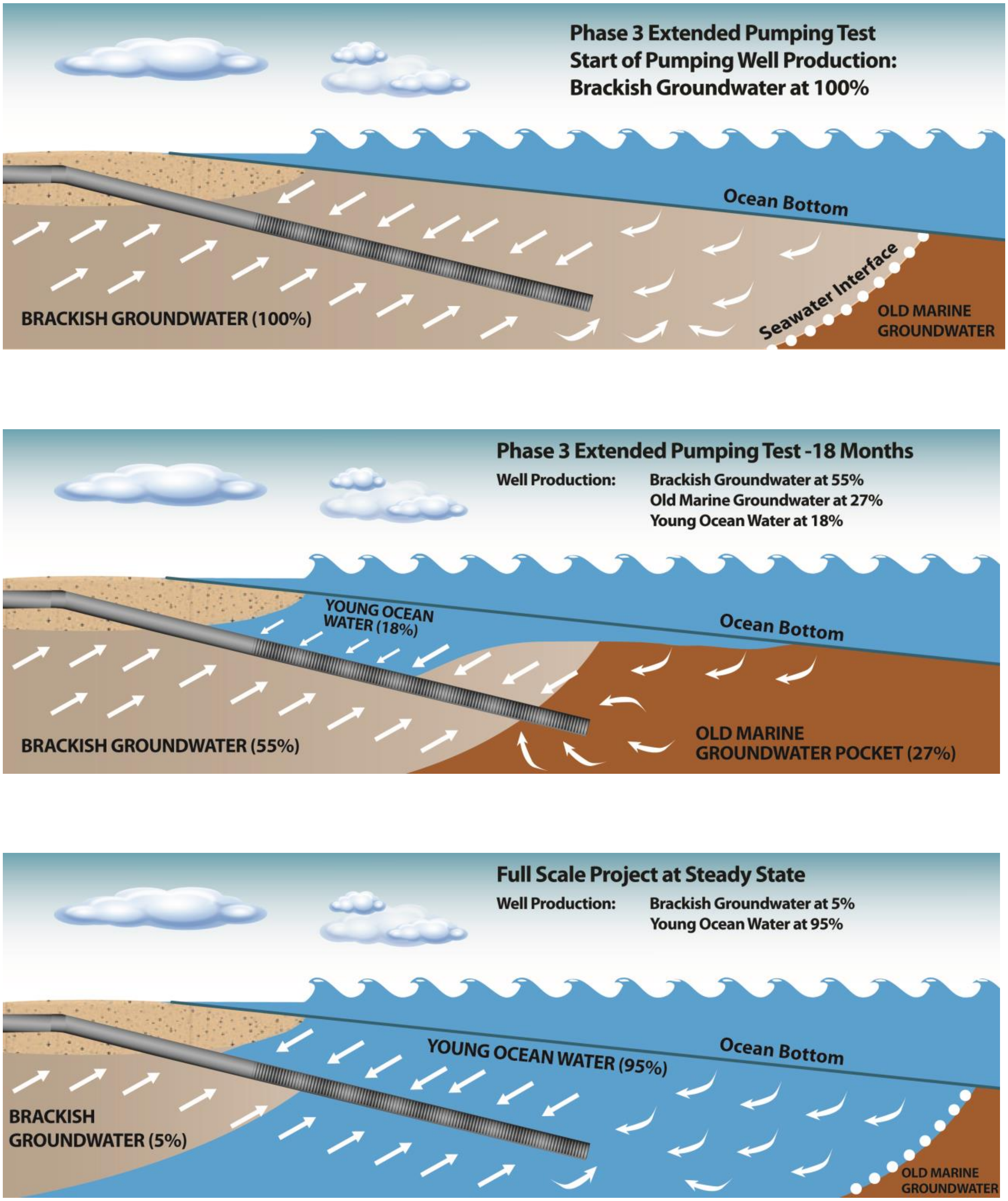
We see two basic approaches for construction of the full scale 30 mgd slant well intake capacity project: (1) include in the desalination plant an iron/manganese pretreatment unit (capital cost estimated at $50 million), or (2) pump out the old pocket of marine groundwater before completing the design and construction of the desalination plant, since it is expected that levels will drop significantly under steady state conditions to levels which will either significantly reduce or avoid the need for Fe/Mn removal.

In addressing the first approach, Arcadis (Malcolm Pirnie) assumed that the steady state iron concentration would remain constant at 6 mg/l and developed capital and O&M cost opinions for handling this amount of dissolved iron. This approach assumes a constant high level of iron/manganese throughout the project life. This is unlikely the case.

It should be noted that during the Phase 3 test, the iron concentration in the pumped water reached 11 mg/l and was fairly constant for several months. However, when considering the full scale project slant well intake production rate of 30 mgd, based on initial modeling, it would be expected that the old marine groundwater would be pumped out in about one year, reducing the concentration of iron/manganese in the feedwater to very low levels. As previously noted, the fine grid, variable density, geochemical model will aid in better understanding the old marine groundwater pump out time as well as aiding in understanding changes in water quality during the pump out period and what might be expected under steady state conditions.

For the second approach to be feasible, we need to better know how long it will take to pump out the old marine groundwater until it is fully replaced with "young" ocean water and reaches steady state conditions. During the Phase 3 test, the iron levels increased steadily and then stayed relatively constant after reaching about 10 mg/l after 8 months of pumping and then slightly increased to 11 mg/l near the end of the test; the increasing amount of "young" ocean water and the slightly decreasing fraction of old marine groundwater kept the iron concentrations relatively flat over the last year of the test. The isotope data showed a slightly decreasing fraction of old marine groundwater being pumped over the test, as the "young" ocean water recharged the marine aquifer area where brackish groundwater had discharged out under the ocean. The location of the seawater interface was previously estimated at about 1,100 feet offshore under 2005 wet hydrologic conditions and lower basin pumping. For comparison, it is worth noting that the estimated volume of the brackish water from the shoreline to the saltwater interface was about 1200 AF (at a specific yield of 10 percent) under 2005 conditions and over the Phase 3 test the pumped volume of brackish water was estimated at about 3,600 AF out of a total volume of 5,286 AF by a salinity model that used actual test data (see Figure 6).

Figure 6 - Illustration of Slant Well Source Water Production vs. Time



Modeling will be required to evaluate the change in fraction of source water reaching the full scale project wells as a function of pumping rate and duration. Based on the earlier Phase 2 modeling, it had been roughly estimated that the old marine groundwater could be fully pumped out within about a year or so at the much higher 30 mgd production rate. The fine grid model will improve this estimate. At steady state after pump out of the old marine groundwater, the wells were predicted to produce about 95% “young” ocean water and 5% brackish groundwater.

The blended concentration at steady state is expected to be low from the large dilution of the “young” ocean water component. The iron/manganese concentrations at steady state are largely dependent on the concentration of iron/manganese in the brackish groundwater reaching the wells and if there is any trace amount of old marine groundwater remaining. Ocean water in the vicinity of the project is fully oxidized and would be expected to have a very low level of iron/manganese (levels are higher near the shoreline and decrease offshore away from San Juan Creek). As the ocean water is recharged into the aquifer, it is anticipated that the ocean water will pick up some dissolved Fe. Under steady state conditions, the produced water is expected to have a dissolved iron concentration around 0.10 mg/l assuming brackish groundwater iron at 2.0 mg/l. At this low total iron concentration the RO membrane should not have a problem removing any oxidized portion of the dissolved iron/manganese in the produced water. However, some chemical conditioning may be required to minimize cleaning. If higher concentrations occur, higher oxidized media filtration rates than assumed by the Arcasdis cost estimate could be used to remove iron/manganese at much lower capital and O&M cost.

If an injection barrier is found to be necessary to reduce drawdown impacts, in time both the injected and slant wellfield produced water would likely be largely free of dissolved iron/manganese.

Further fine grid flow, variable density and geochemical modeling is necessary to provide a better estimate of the pump out time, to estimate produced water quality over time, and to estimate pumped water quality under typical or steady state conditions. Offshore hydrogeology borehole lithology and water quality data and geophysical surveys for alluvial channel structural data will be necessary to fine tune these estimates during the project design, but are expensive to obtain. With operational data, the best method of handling the old marine groundwater iron/manganese loads can then be determined.

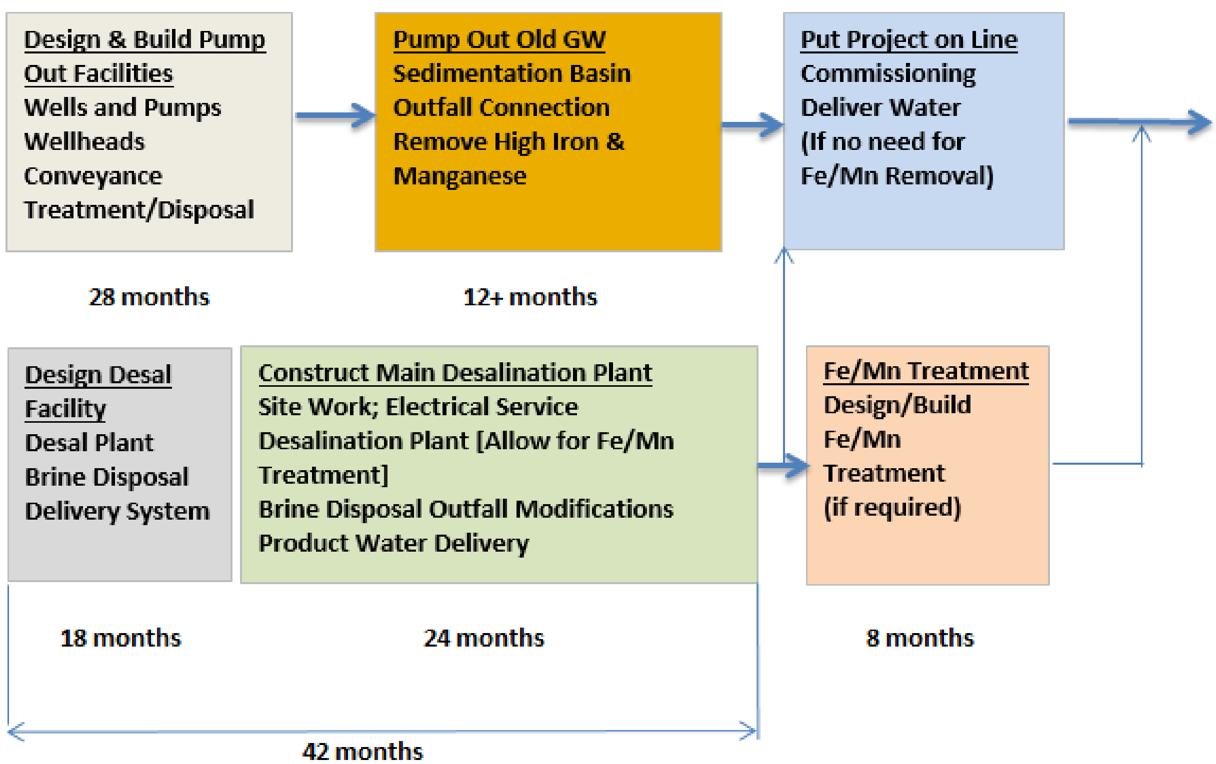
Assuming that the old marine groundwater can be pumped out in about a year or so under full scale production at 30 mgd, the second approach would be preferred. This approach would require that the project be constructed in two stages: (1) wellfield, conveyance and disposal system constructed and operated to pump out the old marine groundwater, complete pilot plant testing to finalize feedwater quality for treatment process design, and (2) complete construction of the remainder of the project. This may be necessary in any event due to the unknown steady state pumped water quality.

During the initial period of pump out of the old marine groundwater, it would be necessary to install a system to remove iron/manganese to levels that can meet discharge requirements through the SOCWA ocean outfall. The current NPDES permit does not have an iron/manganese numerical discharge limitation, but does have limits on settleable solids and turbidity, which would be impacted by the discharge of oxidized iron/manganese. This operation would require permitting through SOCWA and under its NPDES discharge permit.

To meet discharge requirements, iron/manganese will need to be reduced to acceptable levels in a cost-effective manner. During the Phase 3 iron/manganese pilot plant testing work, data were obtained on the effectiveness of oxidizing soluble iron/manganese followed by sedimentation to reduce the iron/manganese load. It was found that chlorine addition was necessary to provide effective oxidation followed by sedimentation at 15 minutes detention, which nearly fully removed all the iron and manganese. The cost for this short-term operation, for one year would include the costs for outfall use, slant well pumping energy, outfall O&M, ocean monitoring, and treatment equipment with chemicals and O&M. The cost for one year of operation is estimated around $4.5 Million. If a longer period is required, a second year is estimated to cost about $3.5 M. Compared to the cost of installing a full scale iron/manganese removal plant at $50 Million, the two stage approach is warranted.

Figure 7 "Full Scale Project Design and Construction Staged Implementation" illustrates the sequence for the major design and construction activities for the full scale project following the recommended approach to pump out the old marine groundwater prior to a decision on Fe/Mn treatment.

Figure 7 - Full Scale Project Design and Construction Staged Implementation



Regional Watershed and Groundwater Modeling

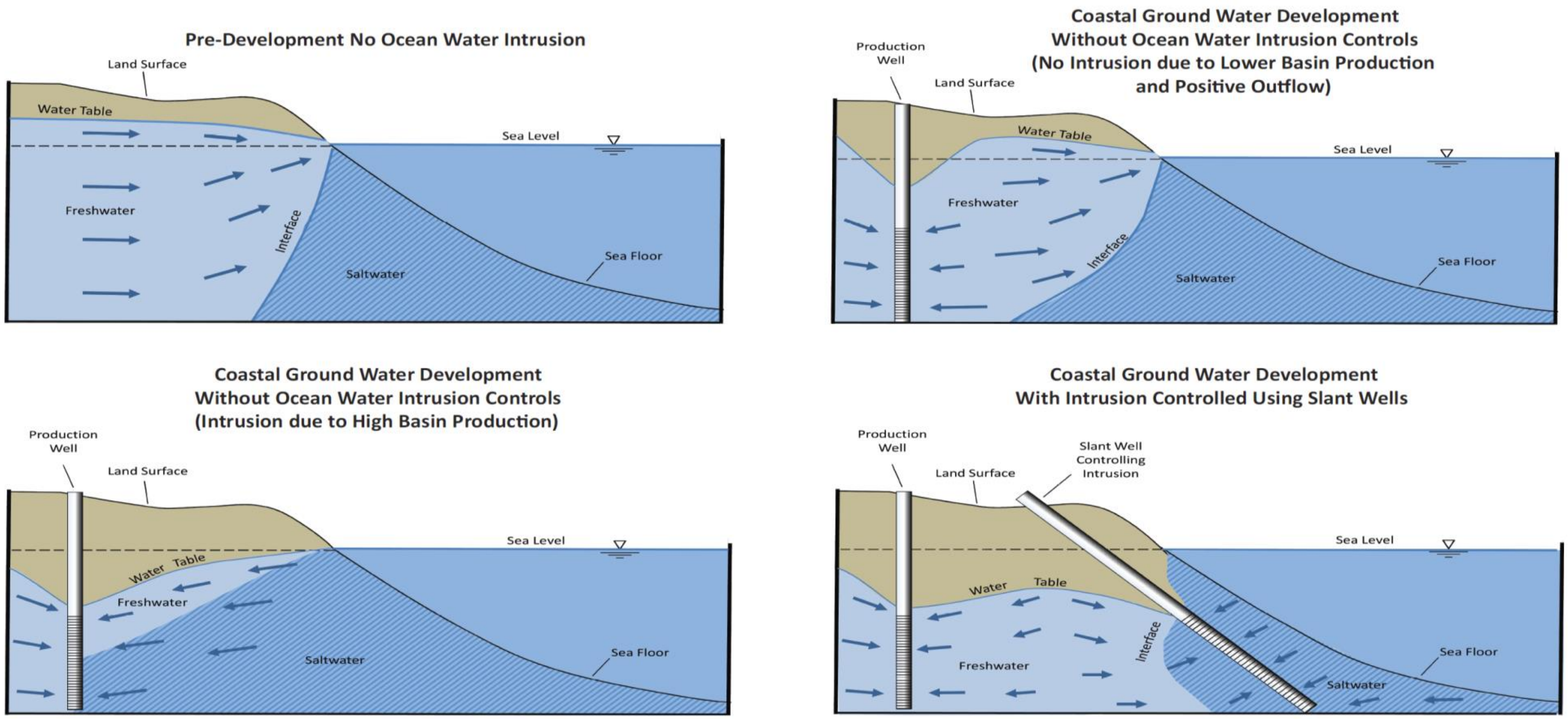
In this location, the paleo San Juan Creek alluvial channel extends out under the ocean within the continental shelf for about three miles. This paleo-channel offers a permeable connection to the ocean. The slant wells would tap into this alluvial structure to pull in filtered ocean water. Under steady state conditions, about 5% of the pumped water would be pulled in from the landward portion of the aquifer, which is brackish groundwater. Groundwater development of the Lower San Juan Basin has occurred over the last several years with the construction of two groundwater recovery desalter plants. To determine the Doheny Desal project impact on the basin and the desalter plant wells, it was necessary to develop analytical models to evaluate drawdown and groundwater take impacts on the basin.

To determine these impacts, a regional surface watershed and groundwater model was developed to determine the basin operable yield using a 64 year hydrology record (1947-2010) which included a 31 year dry period. The first tasks were to determine the basin operable yield without the ocean desalination project. This work which required nearly three years of effort, determined that the lower basin total storage capacity is about 46,000 acre-feet, about 12% less than previously estimated by DWR in 1972 and that the actual volume of water in storage in 2010 was about 30,000 af. The modeling also showed that basin yields over an extended dry and average periods would be about 8,040 AFY and 9,150 AFY, respectively, less than previously believed. Over the 64 year hydrology, it was found that basin storage levels would drop to about 25% of capacity during the long dry period and would refill relatively rapidly under average and wet periods. The model also indicated that seawater intrusion would occur over both dry and average conditions and would reach the SCWD wells in 9 to 12 years, assuming the higher production levels at the long-term sustainable yield levels, rendering them inoperable if additional desalination process treatment were not constructed. Accounting for the seawater intrusion would reduce the yields noted above by 300-400 AFY. Further work is necessary to refine these estimates.

As previously noted, about 5% of the 30 mgd slant well field production (about 1,660 AFY) would be basin brackish groundwater. In addition, the slant well field would provide seawater intrusion control through a coastal trough created from pumping. To mitigate the drawdown and take impacts on impacted producers, make-up water from the desalination project up to 1,660 AFY could be provided to them, less the amount that the basin would otherwise have to use to curtail production to avoid seawater intrusion impacts. Also, seawater intrusion control benefits that would be provided by the Doheny Desal Project should greatly reduce or fully avoid SJBA seawater intrusion control costs.

Future detailed coastal groundwater and geochemical modeling are required to fine tune drawdown impacts and to predict pumped water quality over time. This work will also evaluate physical mitigation using injection wells to create an artificial barrier by raising groundwater levels in the coastal area. This analysis will help to determine the least cost mitigation approach. Other work by the SJBA will investigate the ability to augment the groundwater supplies through stormwater conservation and recycled water and means to protect against seawater intrusion. The two monitoring wells constructed by MWDOC in Doheny State Beach should be maintained and used to monitor for seawater intrusion under upstream groundwater operations.

Figure 8 - Illustration of Seawater Intrusion and Extraction Control



Full Scale Project Conceptual Assessment

The full scale Doheny Desal Project will consist of five major components: (1) feedwater supply system, (2) power supply, (3) desalination plant, (4) brine disposal and (5) system integration. Following is a brief description of each major system component.

Feedwater Supply System. At this time, it is expected that 30 MGD of ocean water supply can be drawn from a slant beach well system consisting of nine wells constructed in three clusters of three wells each along the mouth of the paleo-channel of San Juan Creek along Doheny State Beach. The wells will be fully buried and will extend out under the ocean. Seven wells will be fully operational with two standby wells for operating flexibility and redundancy. The slant wells, wellhead vaults, submersible pumps, power supply, instrumentation cables, nitrogen feed lines, and conveyance pipelines will all be fully buried. Since the wells will be constructed on Doheny State Beach, the construction and maintenance periods are restricted to the off-peak recreational use season, September 15 to May 15.

The wells will be constructed from the beach upslope of the ordinary high water line near the back of the sandy beach, at a 23 degree angle from horizontal, fully penetrating the offshore paleo-channel alluvial deposits. The preferred construction method is Dual Rotary Drilling which avoids the need for drilling muds by advancing an outer pipe shield casing that also prevents cave ins. The well lengths will be approximately 520 feet, consisting of about 280’ of 24-inch diameter blank pump housing and 240’ of 12 to 16-inch diameter well screen. The long pump housing permits maximum drawdown and yield.

The wells will be constructed in arrays of three wells each with a single construction location and common well vault. The three vaults will be buried to a depth of about five feet below the beach. The vaults will contain the well headers, distribution pipeline, well spools for well cleaning, control valves, flow meters, check valves, isolation valves, nitrogen gas feed lines, and power and instrument cable connections. The nitrogen gas is required to prevent air being pulled into the well in order to minimize any potential oxidation of dissolved iron and manganese prior to the treatment processes.

Preliminary vault drawings are shown in Figure 9. Acoustical damping of the submersible pump noise to very low levels on the beach may be required.

Conveyance from the slant wells to the Desalination Plant site will be by pipeline/tunneling. Preliminary alternative alignments were identified in the Boyle Engineering Corporation Engineering Feasibility Study (March 2007). Two candidate alignments were recently laid out and costs estimated by Kiewit. A collection pipeline to each of the three well vaults will parallel the shoreline and then combine into a single line to cross under PCH and/or cross under San Juan Creek and then to the Desalination Plant. Excavation and microtunneling construction methods, with launch and reception shafts for construction under the beach, PCH and San Juan Creek will be required. The conveyance system will terminate at the Desalination Plant at the Feedwater Supply High Pressure Pumping Station. This pumping station must be in-line without a wet well to prevent air entrainment and oxidation of iron/manganese which is expected in the feedwater at low concentrations, at least during the initial start-up period.

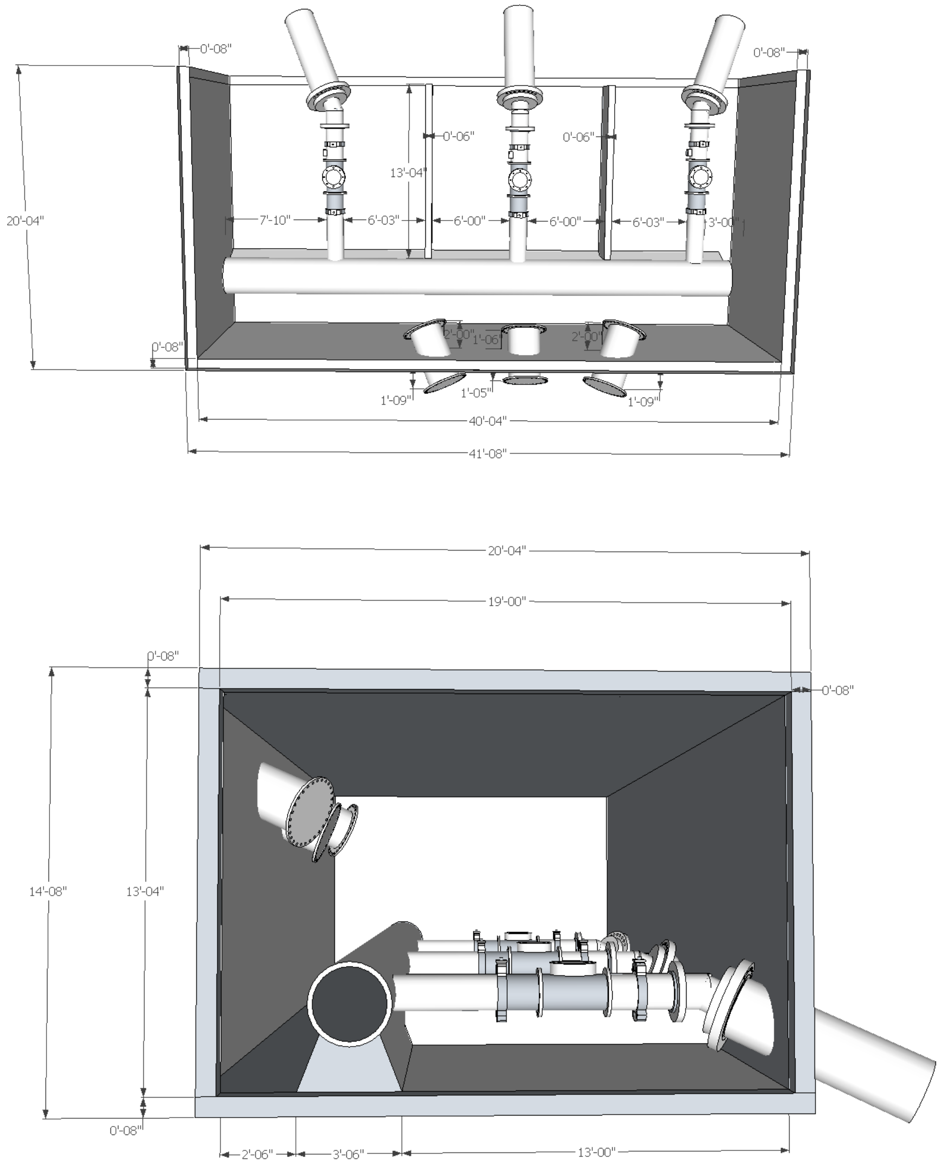


Figure 9 - Top and Side Views of Conceptual Wellhead Vault

Power Supply. Electrical service to the facility will be provided by San Diego Gas & Electric Company. SDG&E prepared an "Engineering Study for Electric Service at the Dana Point Ocean Desalination Plant" dated March 2007. An updated study will be required and is being discussed at this time. Based on an estimated load of 8.3 MW, one to two 12kV transmission circuit feeds would be extended to the plant site, with transformer, panels, cables and meter. About 1,000 feet in new trenches for 4-5" conduits would be required to extend existing feeds to the plant site. Additional facilities and equipment to step voltage down to 4kV or lower voltages would be the responsibility of the project and would be placed on the desalination plant site. The capital cost of these facilities is about $700,000 with the bulk of the power supply costs being built into the rates by SDG&E. The full options for power service will need to be evaluated. In addition, it may be possible to enter into a "demand shedding" agreement with SDG&E

for short-term "called" interruptions in the power supply to help them manage loads during peak demand periods. In exchange, a discount on the energy rate is provided. These options have not been fully explored at this time. Clearwell storage and/or reservoir storage would be used to maintain supplies during the few hours of "load shedding".

Renewable energy capabilities at the site and within the ocean are quite limited. Solar panels may be placed on the building roofs, but would only support minimal energy needs. Wave energy is considered infeasible in this location. Third party wheeling of renewable energy sources developed outside of the area is not available to water utilities at this time. Further, it would be expected that the costs for these types of renewable projects would be higher than what the electrical utility can develop. If the same requirements are placed on the project as incurred by the Poseidon Resources project, offset energy would be required to make the project carbon neutral with imported water deliveries. The cost of providing this mitigation is modest, estimated at about $50,000 per year.

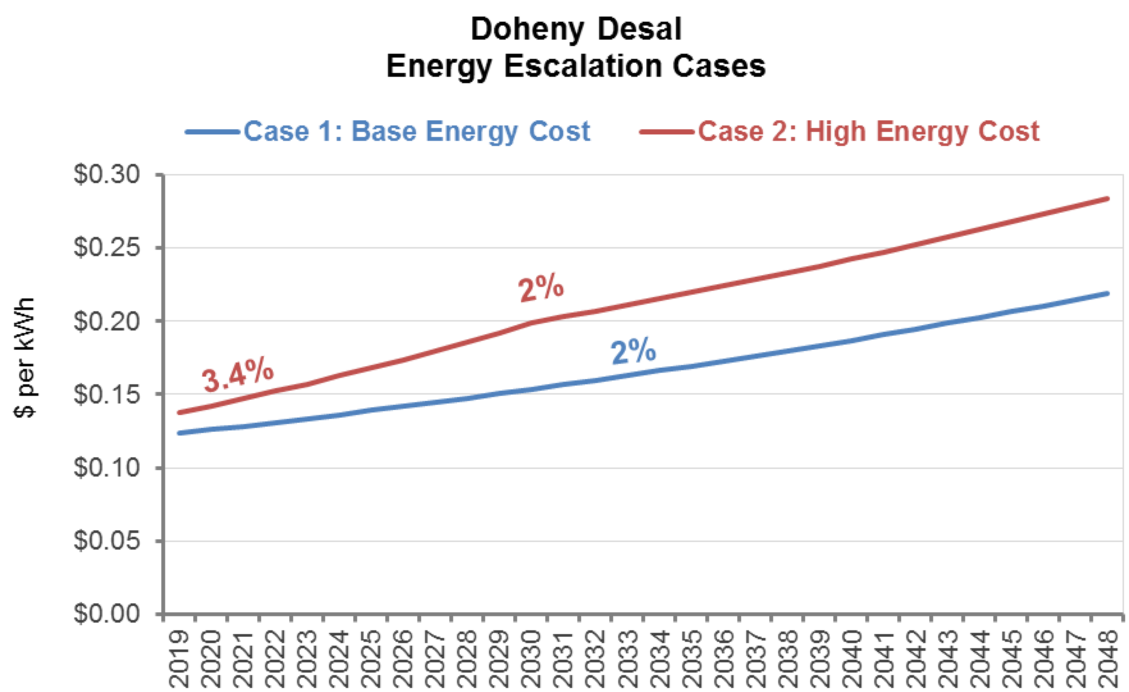
Projected Cost of Electricity for the Plant. Electricity charges are projected to bump up over the next 7 years and then level off due to several coincidental factors. There are three main causes for the bump up in rates: (1) California's mandate to achieve 33 percent renewable energy by 2020 which includes solar, wind and ocean generation, energy storage, and new transmission and distribution facilities, (2) phase out of once-through cooling systems and retirement of older inefficient generation facilities, and (3) closure of the San Onofre Nuclear Generation Station. Long-term estimates of electrical energy costs to supply the plant are difficult to make in California given the uncertainty in how far California will pursue renewable energy goals beyond the 2020 mandate, the effect of future increased distributed user generation and storage systems, long-term natural gas fuel prices, efficiency standards and usage, future population and economic growth drivers, and general inflation.

For the Doheny Desal economic analysis, two rate projection scenarios were evaluated. These rate projections were developed by SDCWA in July 2012 for their energy cost analysis for the Carlsbad Desalination Project and are considered applicable at this time. It should be recognized that actual energy prices will likely be higher or lower than the forecasts. It should be remembered that the Doheny Desal would be a base-loaded 24-7, 365 day per year operating facility. Recent changes by SDG&E in their cost of service have favored these types of facilities compared to typical residential customers, which has resulted in a lowering of the rates. The two cases analyzed are:

- Base Case 1 – Assumes significant RPS (renewable portfolio standard) and AB 32 implementation with electricity cost escalation at 2% annually through 2030 (5 successive 6% rate case increases from July 2012 – actual rate effective in July 2012 was 10.5¢ per kwhr) and then at 2% thereafter. The first bump up in rates occurred in late September 2013 when the AL-TOU rate increased from 10.54¢ to 11.54¢ per kwhr, a 9.5% increase in 15 months (7.6% annualized rate of increase).
- Higher Rate Scenario Case 2 – Assumes high RPS/AB 32 implementation with electricity costs escalation at 3.4% annually through 2030 (6 successive 10+% rate case increases from July 2012) and then reversion thereafter to 2%.

Figure 10 below shows a comparison of the two rate forecasts. Since energy costs account for about 30% of the project cost, the issue of future energy costs needs to be carefully tracked. Depending on future regulatory policy, renewable technology advancements, and shale gas production and natural gas prices, self-generation or investments in outside projects to deliver the energy to the site may be viable options, but competing with SDG&E at their cost of energy and based on the level of reliability they bring will be difficult.

Figure 10



Desalination Plant. The Desalination Plant site is a 5-acre parcel situated on the east side of San Juan Creek just north of PCH on land owned by South Coast Water District. This parcel is situated within the jurisdictional boundary of the California Coastal Commission under the category of "Appeal Jurisdiction". The parcel is currently rough graded to an elevation of approximately 22 feet msl. A geotechnical study is required to determine the design measures to reduce geotechnical hazards from either an earthquake, flood or tsunami. It is anticipated that the site will need to be raised to provide flood control protection with an allowance for sea level rise. 100 or 200 year storm flood protection and flow criteria will need to be determined for protection of the site. In addition, it is anticipated that the site will need to be excavated, compacted and stabilized to provide an adequate foundation for the facility structures.

The Desalination Plant will consist of the following main system components: (1) Electrical Service Sub-Station and Equipment, (2) High Pressure Feedwater Supply Pumping Station, (3) possible Pretreatment Facilities, (4) Reverse Osmosis Desalination Building and Equipment, (5) Post-Treatment Facility, (6) Concentrate Brine Holding Storage and Discharge Connection to the adjacent San Juan Creek Ocean Outfall, (7) a potable clearwell reservoir and (8) a booster pumping station. The site will also consist of roads, parking areas and other related storage, equipment, chemical storage and feed system, and related appurtenances. The structures will need to be constructed in an architecturally pleasing style fitting to the area and will be constructed to be energy efficient with possible solar roof panels and/or green roofs and other related "green" energy systems.

The plant will receive feedwater at 30 MGD. Due to the limitations on yield, it is recommended that a recovery rate of 50% be designed in order to yield 15 MGD of product water. Energy recovery pressure exchanger devices will be utilized to recover 95% of the energy in the high pressure brine stream.

Subject to regulatory and economic feasibility, the Doheny Desal project may be designed to recover the RO concentrate streams from the City of San Juan Capistrano and South Coast Water District groundwater recovery plants by using those flows as feedwater. It is estimated that both of these plants will be enlarged from their current combined 6 MGD capacity to 10 MGD in the future, producing about 2 MGD of brine at a concentration of approximately 10,000 mg/l. This could result in an increased Doheny Desal Project plant yield by up to 1 MGD. This approach appears promising as it would reduce costs to both the City of San Juan Capistrano and South Coast Water District and to the Doheny Desal Project. The feasibility of an integrated brine recovery plan should be evaluated.

Post-Treatment for the RO permeate will be required to stabilize the water so that it is not corrosive to the distribution system. The standard method is to add in lime to the permeate to produce a stabilized water. Some locations, such as Israel now also require the addition of magnesium to achieve a more balanced cation mix. One option that will be considered for regulatory and economic feasibility is to further condition the water with about 1 MGD of brackish water, potentially from one of the SCWD wells, treated for removal of dissolved iron and manganese, disinfected and blended back with the permeate. This will allow production of water that more closely resembles in quality imported water, including providing a more natural blend of cations (calcium, magnesium, potassium) and anions (carbonate, bicarbonate, chloride, sulfate). Additional stabilization with respect to calcium carbonate saturation will be required.

Product water quality criteria will be developed for the desalination system. Key considerations are the level of bromide and boron in the product water. A second pass system at a minimum of 40% capacity is being planned to lower bromide to acceptable levels that prevent accelerated decay of chloramine disinfection residuals in the finished water. Boron levels will also be reduced when achieving the bromide levels. This will provide a product water that is fully protective of ornamental landscape plants.

Brine Concentrate Disposal. The waste brine concentrate from the Reverse Osmosis unit process will be co-disposed with treated municipal wastewater in the adjacent San Juan Creek Ocean Outfall. Due to the diurnal flow pattern of the wastewater flows, a regulatory storage basin at the desalination plant will be required. The concentrate will have a concentration of approximately 66,000 mg/l and will be combined with wastewater having a concentration about 800 mg/l. The current average dry weather municipal wastewater flow in the outfall is 17 MGD. It is anticipated that this flow rate will decrease in the future with additional upstream recycling.

The SWRCB (State Water Resources Control Board) is in the process of amending its California Ocean Plan for Ocean Desalination Intakes and Brine Disposal. When the plan is amended it is anticipated that more stringent requirements for brine discharges will be required.

The ocean outfall diffusers may need to be modified to meet the new SWRCB Ocean Plan Amendment requirements. Modifications might include new diffusers, such as tidal or rosetta valves, or other diffuser devices to increase initial dilution to meet new regulatory requirements. The San Juan Creek Ocean Outfall has an estimated hydraulic capacity of 85 MGD. Plant operations and brine disposal will be ceased only during major storms when total wastewater and infiltration/inflow rates exceed the ability to discharge the brine. This is a rare event and only occurs during very wet years when the collection system trenches are saturated and when stormflows greater than an estimated 25 year intensity occur.

The existing outfall requires structural improvements at the ocean junction structure and at the surge chamber connection from the Latham Plant to the outfall where it joins with the Santa Margarita Water District land outfall on the east side of San Juan Creek. These improvements would be undertaken by South Orange County Wastewater Authority as they are needed for wastewater disposal. The brine concentrate line would connect to the surge chamber structure which is located adjacent to the project site. Flow and water quality monitoring will be required for the discharge. SOCWA approval is required. For project participants not discharging wastewater to the San Juan Creek Outfall, it will be necessary to acquire capacity in the system. The current San Juan Creek Ocean Outfall capacity and ownership are shown in the following Table 1. Cost allowances for the outfall capacity have not been included in the Project Cost Estimate because final capacity selection by agencies have not yet been made and nor has an engineering study been completed, which needs to be held off until the new SWRCB Ocean Plan Amendments are finalized.

Table 1 – SOCWA San Juan Creek Ocean Outfall – Agency Ownership

Agency	Ownership Percentage (%)	Capacity Ownership (mgd)	
		80 mgd	85 mgd
Moulton Niguel WD	15.51	12.42	13.18
San Clemente	16.62	13.30	14.13
San Juan Capistrano	11.08	8.86	9.42
Santa Margarita WD	44.32	35.46	37.67
South Coast WD	12.47	9.98	10.60
	100.00	80.00	85.00

Ref: SOCWA Hydraulic Capacity Evaluation, Carollo Engineers, June 2006

System Integration. The project water will be pumped into the Joint Transmission Pipeline and the Water Importation Pipeline. The hydraulic grade line is approximately 450 feet in both pipelines. Both pipelines cross near the Desalination Plant site on South Coast Water District property, requiring short pipelines to the two points for interconnection. Connections to Laguna Beach County Water District will require a small pump station addition at the existing SCWD/LBCWD interconnection station. Some additional provisions to assure maintenance of the disinfection residual at sag points may be required.

Conceptual Level Cost Opinion

Arcadis (Malcolm Pirnie) prepared a conceptual level cost opinion update for the project in 2011. The cost estimate was modified for the RO system cost, based on cost reviews provided by three firms.

Operation and Maintenance costs were estimated for labor, replacements and repairs, chemicals and feed systems, maintenance materials, and energy. These costs are shown in Table 2. Without energy, the O&M costs are estimated at about $5.8 million per year which is equal to $363/AF. Energy costs are estimated at $7.1 million per year which is equal to $446/AF. Total O&M, plus energy is estimated at $809/AF.

The overall adjusted project capital cost opinion was $152,800,000 (2012$) for the case without iron/manganese removal as shown on the following Table 3. The reviewers had more recent bid data and recommended reducing the RO system cost by 20% ($8 million). The costs include a 25% contingency ($22.6 million) and 15% for professional services ($18.8 million).

The unit cost of water from the project, in current dollars, assuming high iron and manganese removal is not required, is estimated at:

- $1,611 per AF without the MET subsidy of $250 per AF
- Capital at $588 per AF (includes contingency and professional services)
- O&M at $363 per AF
- Energy at $446 per AF
- Land Lease at $47 per AF
- GW Mitigation at $167 per AF for take of 1,660 AFY on average

- Accounting for the MET subsidy results in a cost of water of $1,361 per AF (2012 dollars)
- For comparison purposes, MET avoided water costs in 2013 (Tier 1 + Capacity Charge Readiness to Serve Charge) amounts to $953 per AF

More detailed cost information is shown in the subsequent cost and economic analysis section.

Areas of greatest cost uncertainty are: (1) electrical energy and (2) brine disposal. The projected rate of increase in electrical energy costs over the next decade is a major uncertainty due to a combination of factors: implementation of AB32 and renewable energy, elimination of coastal power plants once through cooling systems, and the shutdown of the San Onofre Nuclear Generation Station (SONGS). These costs will need to be closely followed and incorporated into the project economic analysis.

Brine disposal costs for purchase of capacity in the San Juan Creek Ocean Outfall for those needing new or additional capacity are not yet included in the costs. The costs to modify the outfall diffuser to allow meeting discharge requirements are unknown at this time and no estimates have been included. A placeholder for modifications to the outfall junction structure at $2 million has been included. The outfall costs may further increase if significant recycling depletes the wastewater discharge. Evaluation of new diffuser systems and the performance of the system under the forthcoming SWRCB brine disposal regulations will need to be undertaken to determine the cost for brine disposal. This work also will require brine dispersion modeling and possibly some marine biology assessments.

Table 2 - Full Scale Doheny Desal Project O&M Cost Opinion

Excluding Electrical Energy Malcolm Pirnie (2011)	
	No Pretreatment
Labor	$1,260,000
Replacements/Repairs (Includes RO membranes & other)	$1,937,000
Chemicals/Feed Systems	$1,300,000
Maintenance Materials	$750,000
Other	$550,000
Subtotal O&M	$5,797,000
O&M $/AF	$363
Energy	$7,112,900
Energy $/AF	$446
Total - $/AF	$809

Notes

1. Average Labor rate updated to $105,000/year (OCWD GWRS O&M labor cost plus benefits)
2. Malcolm Pirnie assumed 12 FTE no Pretreatment
3. Replace First Pass RO Membranes every 3 years and Second Pass every 5 years; plus includes all other equipment replacements.
4. Energy at 4,228 kwhr/af and 10.5¢/kwhr
5. O&M increases to $421 per AF if high iron and manganese treatment is required.

Table 3 - Doheny Ocean Desalination Project Capital Cost Opinion

South Orange Coastal Ocean Desalination Project Conventional Design-Bid-Build Project Cost Opinion (Oct 2011)				
Major Activity Cost Item	**Description/Sub-Activities**	**Estimated Schedule (Months)**	**Case 1 Fe/Mn Pretreatment**	**Case 2 No Pretreatment**
PRE-CONSTRUCTION PHASE				
Preliminary Engineering Work	Engineering Work and Support for Environmental and Permitting Work	24	$750,000	$750,000
CEQA/NEPA Work	Baseline Environmental Monitoring	12	$300,000	$300,000
	Prepare and Process EIR/EIS	18	$500,000	$500,000
Additional Studies & Investigations	Outfall Modeling & Modification Engineering	15	$250,000	$250,000
	San Juan Creek Property Geotechnical and Site Investigations	15	$100,000	$100,000
	Offshore Geophysical Investigation	12	$400,000	$400,000
	Offshore Hydrogeology/Downcoast Drilling/Testing Investigation	12	$3,600,000	$3,600,000
	Power Supply Plan	12	$100,000	$100,000
Permitting and Approvals	Agency Meetings (Parks, CDPH, RWQCB, ACOE, CCC, SLC etc)	24	$400,000	$400,000
	Permit Applications Supporting Technical Data/Analyses			
	Permit Applications Preparation and Submittals			
	Permit Processing and Approvals			
JPA Formation, Legal/Financial Advisors	JPA Formation	12	$300,000	$300,000
	Legal and Financial Advisor			
Design/Construction Team Selection	RFP Development and	12	$300,000	$300,000
	Design Engineer Selection			
SUBTOTAL UP FRONT ACTIVITIES COST	Subtotal		$7,000,000	$7,000,000
	Contingency at 20%		$1,400,000	$1,400,000
	Total		**$8,400,000**	**$8,400,000**
DESIGN & CONSTRUCTION PHASE		30		
Design/Construction Project Costs	Intake and Raw Water Conveyance		$44,759,000	$44,759,000
	Pretreatment for Fe/Mn Removal		$43,300,000	$0
	RO Treatment		$53,534,000	$53,534,000
	Post Treatment		$15,636,000	$15,636,000
	Miscellaneous (Brine, SDGE, State Parks, Mitigation)		$11,648,000	$11,648,000
	Subtotal Construction Contractor Cost		**$168,877,000**	**$125,577,000**
	Base Construction Contractor Cost		$138,503,250	$102,991,000
	Contingency (25%) **(1)**		$30,373,750	$22,586,000
	Prof Services (Design & Construction Phases at 15%)		$25,331,550	$18,836,550
	Subtotal Contstruction Cost		**$194,208,550**	**$144,413,550**
Total Project Duration and Capital Cost		**70**	**$202,608,550**	**$152,813,550**

(1) Cost of pump-out and treatment of high iron and manganese laden water prior to start of operations estimated at $4.5 million, assumed part of contingency

Cost Comparison to Imported Water and Economic Analyses

Local projects that develop new sources of supply provide both source and system reliability benefits. In the case of ocean desalination, there is also a water quality benefit derived by production of desalinated water that has lower salts and hardness than the imported supply. Typically, when evaluating new projects, the cost of the new supply is first compared to the projected cost of MET water. The desalination supply will offset MET water purchases and in time these costs are projected to be less than imported water costs resulting in a net positive savings (benefit #1). In addition, ocean desalination improves system reliability (benefit #2), provides a drought proof supply (benefit #3) and provides improved water quality (benefit #4). The question is how to more accurately account for these benefits. Since the local agency drought benefit is reduced under the current approach taken in MET's Water Supply Allocation Plan and water quality benefits are derived by the end-user through longer water fixture life, the analysis conducted focused only on the direct supply and reliability benefits.

The unit costs were favorably compared to the projected costs of imported water, showing a possible cross over in about 10 years after start of operations. The investment cost was also favorably compared to the value of system reliability provided by the project when compared to alternative emergency reservoir costs and capabilities.

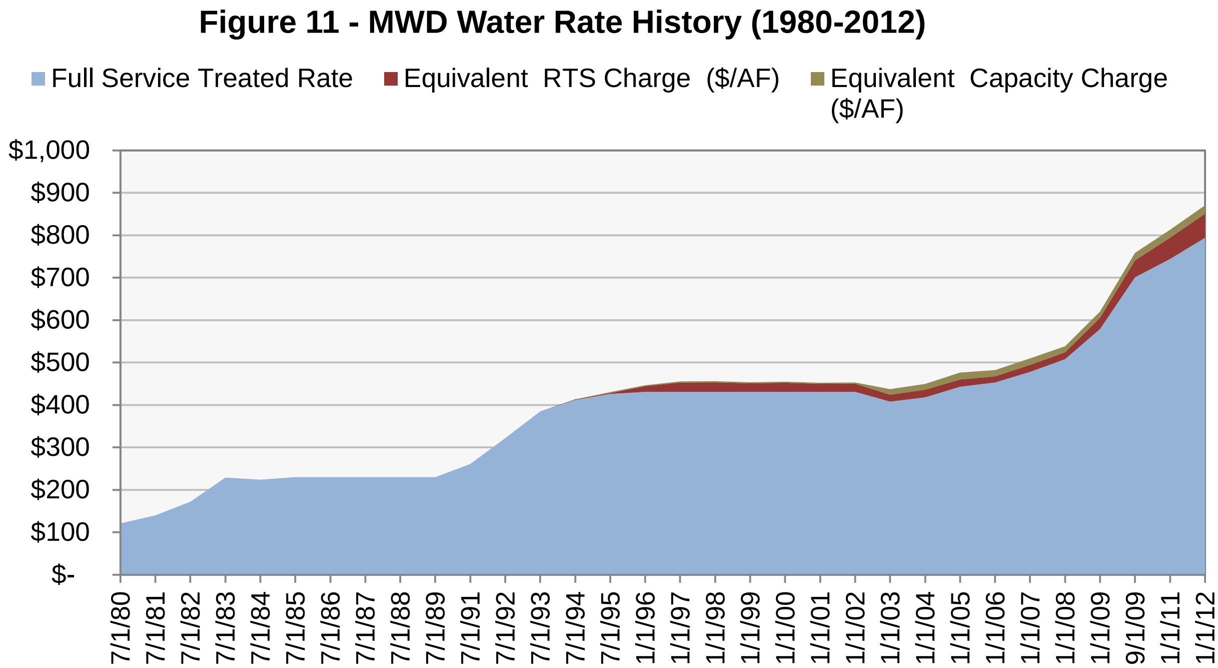
Cost of MET Water. MET has recently updated the projected cost of water to 2017. MET staff believes the near-term projection of rates is a reasonable estimate. Many factors that will result in upward pressure on MET rates have been reflected in these projections including a lower water sales assumption. The effect of a lower water sales assumption by MET is more conservative and, hence, is able to provide more flexibility for covering unexpected rate impacts in the future. Discussions with MET staff indicated that out-year projections beyond 2017 would best be covered by looking at a range of escalation factors from 3 percent on the low side to 6 percent on the high side.

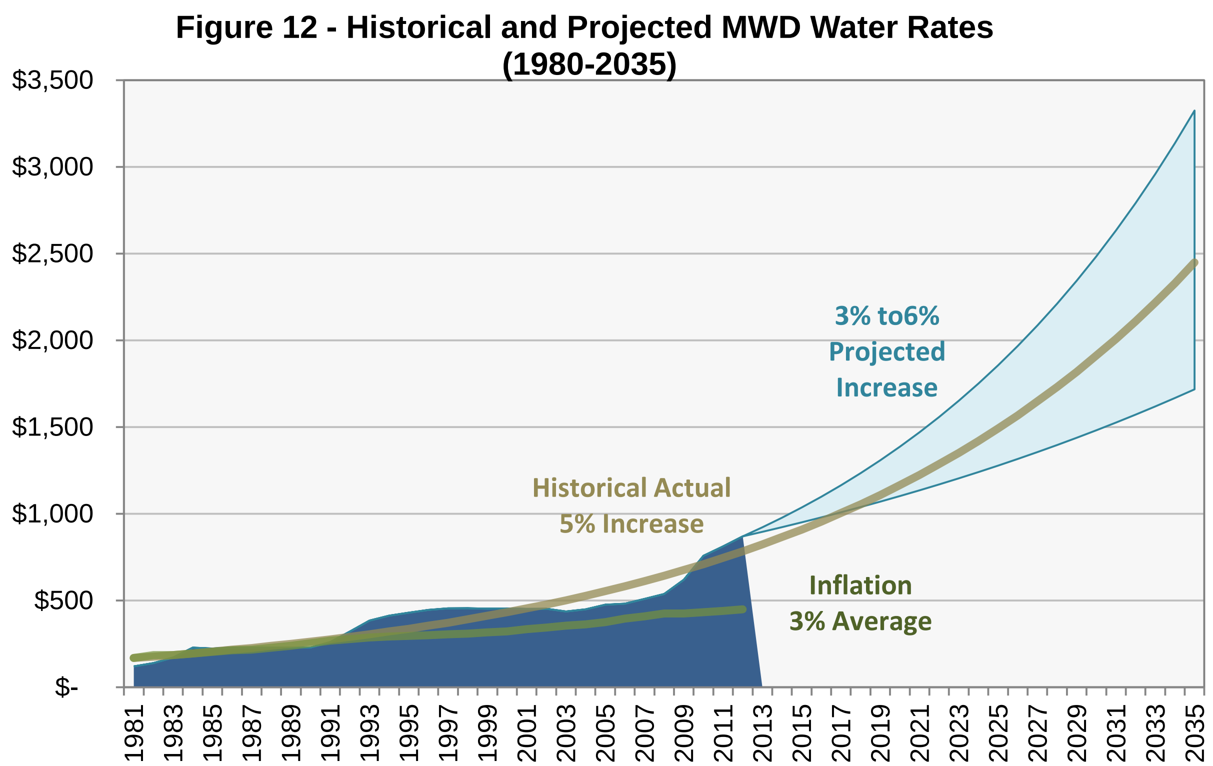
The future cost of water from MET is sensitive to a number of variables, making it difficult to develop an accurate long-term projection. Following are potential factors that could impact rates into the future:

- Energy Costs – The impact of California's Global Warming and Solutions Act (AB 32) on electricity prices is not factored in and is unknown at this time. Higher energy rates are forecasted due to several factors: AB32 mandated requirement for a higher mix of renewable energy sources, replacements and expansions in the Statewide electrical transmission system, phase out of Once-Thru-Cooling coastal power plants, and the shutdown of the SCE SONGS Plant (San Onofre Nuclear Generation Station) and its replacement. MET and the State Water Project Contractors are also facing a particular nuance of the AB 32 legislation whereby the electricity they import from out-of-state for Colorado River Aqueduct and State Water Project pumping may be assessed by California Air Resources Board as an "energy generator" in the state. MET staff is in the process of negotiating a method to provide relief and at this time ARB has indicated that they may provide MET some allowances, but not to the SWP. The impact of this decision could impact MET costs on the order of several million dollars per year.

- Bay-Delta Conservation Plan (BDCP) – A portion of the future costs of the BDCP have been factored into the near-term forecasts with the remaining portion of the costs to be included in the escalation range. The most recent estimate of costs for the fix, assuming MET pays for about 25%, is the cost of water for capital amortization and O&M costs estimated around $200 per AF on the MET water rate. Depending on what actually occurs, the costs could likely be either higher or lower, but would probably tend to cluster towards a higher cost. These are factored in between now and 2026 when the project is expected to start-up. Inflation is not included in these costs.
- MET Rehabilitation and Repair (R&R) Costs of Infrastructure (PAYGO funding) – MET has over $6 billion of investments in the ground not including their share of the SWP. These assets require periodic R&R or replacement. MET's asset management analysis completed several years ago estimated that the R&R program can be achieved at an annual cost of $125 M per year. This program is funded annually through the Pay-As-You-Go (PAYGO) funding, which is still considered sufficient at this time. When inflation picks up, the spending over time will have to correspondingly increase to keep in step with the R&R and replacement needs.
- SWP R&R – It is widely reported that the SWP is not maintained in nearly as good a condition as the MET system. Currently, the SWP is limited by facility conditions to about 70% of the delivery capacity of the SWP and hydropower generation has been reduced because of the failure at the Oroville facilities. MET has included some additional costs of future requests for SWP R&R funding in their budget (higher than what the State is requesting). This may or may not be sufficient to cover the deficiencies in the SWP needs. The SWP contracts expire in 2035 and as the contracts are renewed, it is possible that the renewed contracts will allow for additional levels of R&R and replacement funding without rate increases when the original debt of the SWP is fully repaid. MET and DWR are currently looking at options for the SWP R&R needs.
- Treatment Costs – The full capital and O&M costs associated with the ozone retrofit project at all five of MET's treatment plants are fully captured in the near-term projected water rates.
- Pension/Health Costs – A portion of the (not all) MET pension costs are already built into the rate projections. Other Post Employment Benefits (OPEB) have about a $500 million unfunded liability. MET believes they can eliminate the exposure with an annual contribution of about $50 M per year over the next 10 years. This is not fully reflected in the near term water rates. The other possibility is that by setting a more conservative assumption on water sales, any excess revenue, should it occur, could be used to fund this liability.
- The most recent population projections for the MET service area show an increase of 7.5 million by 2060. This increase in population will require additional new water supply at an increased cost to the region. The share of these costs between MET and the retail suppliers is the subject of future decisions.
- MET staff is examining methods to increase their fixed revenue. One such method is to change the basis of future AV tax revenue so that the percentage of tax levy remains fixed into the future at the current level rather than having the tax levy transition to zero between now and 2035 as planned. The additional tax levy, if successful, would tend to hold rates down in the future because of the estimated $80 million or so in fixed revenue that would accrue each year.

Figures 11 and 12 provide a summary of historical and projected MET water rates. Note the stair step pattern seen in the historical chart. This pattern is caused by water sales, costs and reserve variations.





Discussions with MET staff indicate that outyear cost projection beyond 2017 ranging from an annual escalation of about 3% per year on the low side to about 6% per year on the high side can be expected. Discussions with various sources in the industry note more cost pressures pushing rates towards the higher side of this range although recent discussions with MET staff indicate the potential that MET costs will trend towards the lower side of the range over both the near and mid-term, depending on future inflation rates and other potential unexpected costs.

Sensitivity Modeling. A sensitivity analysis approach was utilized to set up an economic analysis which would allow various input assumptions to be tested to understand the effects on both the cost of water from the Doheny Desal Project and to evaluate the project cost cross over point with MET rates (the point in time when the project cost would be less than imported water costs). This allows an analysis of the potential net present value difference between Doheny Desal and MET water rate scenarios. Figure 9 presents the "base case" analysis. The model provides the ability to vary the following parameters:

- Cost and escalation assumptions for Doheny Desal, the level of contingency assumed and whether or not pre-treatment facilities for iron and manganese will be needed
- Energy consumption and cost information can be varied. Two periods of energy escalation were provided, 2012 to 2030 and then after 2030 to allow the rate assumptions to be tested
- General inflation rates
- Project financing assumptions including the bond interest rate and whether any grant funds will be provided
- For the economic analysis, the Present Value factor can be modified
- A place-holder for land costs and an escalation factor is provided
- The MET rates are hard coded into the analysis through 2017 and then an escalation rate is used for rates beyond 2017
- The calculation summary provides the capital and O&M cost breakdown
- The Net Present Value function calculates the difference between the project rate and the MET rate and provides a present value to 2012 dollars. The purpose of this calculation is to understand the amount of costs above the MET rates up to the point of cross over and then it also quantifies the amount of costs less than the MET rate after the cross over and summarizes the full 30-year Net Present Value (positive = savings).
- A Reliability Benefit is the last input function. This is a measure of the system reliability benefit for the project. There are good reasons for investing in a project, even if the initial cost of water

from the project may be above the cost of MET water. These include the reliability provided by having a local production facility able to supply system needs during an outage of the imported system in the event of a major earthquake or other cause and through an extended drought, as the desalination supply is independent of hydrology. The project would provide a significant emergency supply, system reliability benefit to protect the area from an outage of the imported water system as well as a drought supply benefit.

Discussion of Economic Assumptions in Table 4. Nine different economic scenarios were run to test the sensitivity of the assumptions in the sensitivity model, and the results can be found in Table 4. The findings indicated that the Doheny Desal Project supply cost is generally competitive with projected imported water costs. When considering the system reliability benefit of avoided investment in other local projects, the project provides a substantial cost savings and economic value to the community. The cross over point and net present value savings is most sensitive to future MET rates escalation assumption, e.g. higher MET rates improve the project comparisons. The detailed presentations of the nine sensitivity cases are included in the Appendix. The nine scenario runs include the following assumptions:

- **Reliability Benefit**. A project benefit is the ability to continue providing water into the local system in the event of an outage of the import system. The ocean is analogous to an emergency reservoir. Santa Margarita WD recently constructed the Upper Chiquita Reservoir Project at a cost of $50 M. This facility can provide emergency water supply at 23 cfs for about 2 weeks. The Doheny Desal Project can supply 23 cfs continuously. For a one month outage, the desal project provides the same emergency supply as two Upper Chiquita Reservoirs. The cost of two reservoirs would be about $100 M, which is the equivalent emergency reliability benefit that would be provided by the Doheny Desal Project assuming a 30 day outage. The value increases with the length of outage. Taking this benefit into account by amortizing it at the same rate and period as the overall project results in lowering the "cost" line (shown below by a second "project cost line" by about $385 dollars per AF (amortized cost of $100M). Accounting for the second benefit does not truly lower the cost of the project, but it does help identify and account for the emergency supply value of the project and the avoided cost of new reliability projects.

- **Fe/Mn Treatment.** The basis for the iron/manganese pretreatment system cost estimate was the assumption that Fe/Mn concentrations would remain at 6 mg/l throughout the project life, resulting in a capital cost for the oxidized filtration system at $50 million. Based on our expert panel review, it is expected that the old marine groundwater which is high in Fe/Mn would be pumped out in about a year, leaving just the 5% contribution from the brackish groundwater which has Fe/Mn concentrations around 2 mg/l. Under this scenario, the steady state Fe/Mn concentration would be 0.10 mg/l, not 6 mg/l. At this low level, pretreatment is not likely necessary, or if it is the costs would be substantially below the $50 million estimate as much higher loading rates could be utilized in the oxidized media filters. Also, use of an injection barrier along the coast to mitigate the project's take of brackish groundwater would eliminate in about a year or so the Fe/Mn contribution from brackish groundwater, thus eliminating any need for Fe/Mn removal.

- **Energy Scenario.** For the base case, energy costs have been escalated at 2% per year and have been projected at that same rate based on studies by SDG&E and others before the shutdown of the SONGS and increase in renewable requirement to 33% by 2020. For the high energy rate escalation scenario, 3.4% was used out to 2030 and 2% thereafter, based on work done by SDCWA.
- **Project Financing.** Project financing was assumed at an interest rate of 4.5% (current municipal AA bond rates). It is likely the project could receive a low interest loan from the State Water Resources Control Board State Revolving Fund that would further reduce the interest rate (at one-half of the State's prior year's general obligation bond rates).

- **Additional Benefits.** The project would also provide seawater intrusion control and water quality benefits to the basin, avoiding the need for a dedicated seawater intrusion control barrier. The project supports optimum utilization of the San Juan Basin without the basin having to incur the cost for seawater intrusion control. The basin benefits have not been factored into the economic analysis. This benefit was NOT specifically addressed in this analysis and is likely better to be accounted for in any future mitigation discussions.

Figure 13 – Doheny Ocean Desalination Project Economic Analysis – Base Case

Doheny Ocean Desalination Project - Economic Analysis - DRAFT VERSION 1.8

Input

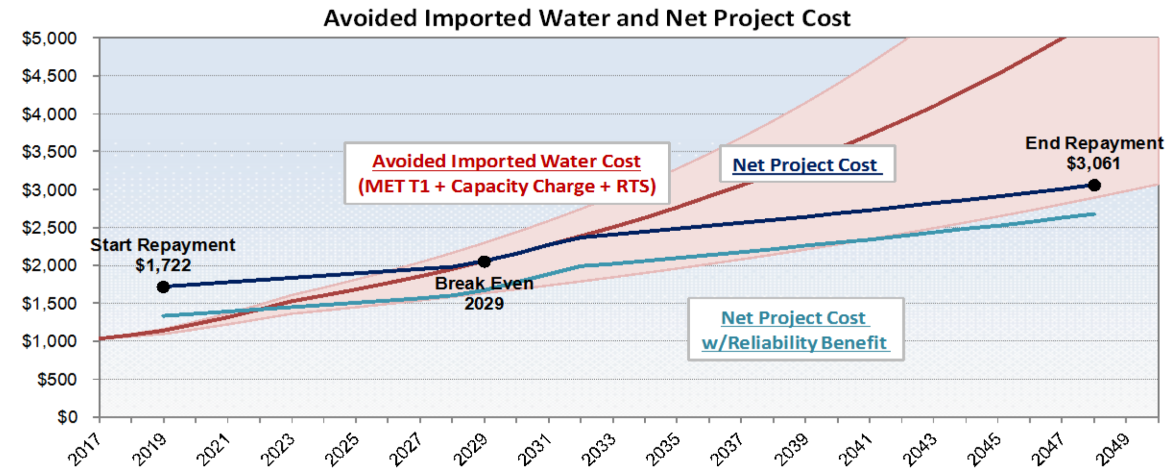
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)		**$ 0.105**
Energy Escalation 2012 - 2030		**2.0%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$ 47**	
Lease Escalation Rate	**2.5%**	
General Inflation Rate		
Current - 2020	**2.5%**	
2021 - Future	**2.5%**	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs		
Esc. Rate After 2017	5.0%	
Melded Rate- % Tier 1	100%	

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($31,436,811)
Break Even to End	$72,613,733
Total Savings	$41,176,923

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Table 4 - Summary of Economic Analyses							
Case	Description	Fe/Mn Treat.?	Energy Scenario	MET Esc.	Cross Over Year	30 Year PV Savings	With Reliability Added
1	Base Case – Expected w/ 4.5% Finance	No	Base	5%	2029	$41 M	$141 M
2	With Fe/Mn	Yes	Base	5%	2032	$-6 M	$94 M
3	High Electrical Costs	No	High	5%	2032	$7 M	$107 M
4	Expected with $15 M Grant	No	Base	5%	2028	$55M	$155 M
5	Low Interest Rate at 2.5%	No	Base	5%	2026	$72M	$172M
6	Base w/Low MET Costs	No	Base	3%	2046	$-7M	$93M
7	Fe/Mn with High Energy	Yes	High	5%	2035	$-10 M	$90 M
8	Fe/Mn with Low MET Costs	Yes	Base	3%	2048	$-10M	$90M
9	Low Interest & Low MET Costs	No	Base	3%	2040	$-5M	$95M

Cost Comparison to the Poseidon Resources Huntington Beach Project

Comparison of the cost of ocean desalination projects from location to location can be difficult, especially when comparing a public project to a private project. Typically, public financing offers cost advantages compared to private equity financing. Private projects can be crafted in a manner to take on additional responsibilities and risks when they are providing water to public entities. Site characteristics can also vary and result in cost differences from project to project.

For the Doheny Desal Project, there are several site and other factors that make the costs very competitive:

- For the size of the Doheny Desal Project, slant wells are less expensive than open intakes which also require pretreatment systems to remove sediments and organic materials. Slant wells provide highly filtered water via the natural filtration process provided by the marine aquifer, thus avoiding the cost of having to construct and operate conventional pretreatment strainers, filtration and solids handling/disposal facilities. It has been determined from the results of the extended pumping test that the use of a slant well intake system will avoid the need for conventional pretreatment costs estimated at $56 million in capital and about $1 million in O&M costs, thus reducing the costs compared to other sites by more than $300 per AF.

- Co-disposal with wastewater through an existing outfall with sufficient hydraulic capacity avoids construction of a new brine discharge line and should make compliance with brine discharge easier to meet.

- System integration is relatively simple as the regional pipelines cross the desalination plant site and the pumping lift is relatively moderate at 450 feet. The savings of this integration system when comparing to other locations can be over $100 per AF or more.

- Public financing costs are typically lower than private financing

For the Huntington Beach site:

- Quite a bit of work has been done at the site and the engineering and permitting for moving forward with a construction project is nearly complete.

- Initially, the project can use the existing intake and outfall system. Uncertainties exist with the need for potential regulatory driven future changes to the intake and outfall systems. Use of the open ocean intakes also requires investments for the pre-treatment of the water.

- System integration is more complex than at the Doheny site.

- The methodology for capital recovery is on an escalated basis at 2.5% per year and has the result of lowering the early year costs and increasing the later year cost. This is an appropriate technique for phasing the costs of the project with future escalation; however, it results in a "different" cost compared to equalized annual debt recovery. The approximate first year impact is a decrease of about $300 per AF. If Doheny Desal used the same technique, the first year cost would be about $180 per AF lower.

- The costs also include repayment of private equity at considerably higher interest rates than available to public financed projects, project development costs, profit, and franchise tax and related payments. However, Poseidon has also agreed to take on much of the construction and performance risks for providing potable drinking water that meets specific quality criteria at the purchased water price.

The Poseidon Huntington Beach project unit cost as of February 2013 is around $1,800 per AF, including all costs and assuming a contribution from MET of $250 per AF. The Doheny Desal Project cost, **assuming an escalation of debt repayment similar to the Huntington Beach Project at 2.5%**, is currently estimated around $1,200/AF including all costs and assuming a contribution from MET of $250 per AF. Most of the differential in costs between the two projects can be explained by the factors noted above with the exception that:

- Poseidon found that their early cost estimates were overly optimistic compared to what was finally agreed upon. We will not have a more detailed estimate for Doheny until additional work is completed

- The element of "risk" taken on by Poseidon is not able to be defined as a cost per AF value.

Conclusion and Recommendations

The project is awaiting decisions by the project participants, SJBA and MWDOC on the next activities for the Project. The only work scheduled at this time is the upcoming Foundational Action Plan work; each of the Phase 3 Participants are now considering what their interest and role will be in that work. Key remaining issues for the project include how best to mitigate the drawdown and take impacts from the project on the San Juan Basin, the produced water quality from the slant wellfield over time, energy costs, and project costs. The groundwater basin and project mitigation alternatives questions will be answered through the work to be undertaken through the MET Foundational Action Program proposed work. This work includes groundwater basin management planning and additional project groundwater modeling work that will be completed over the next year or two by both SJBA and several of the Doheny Desal partners. This work will be important in formulation of the final project concepts and configuration.

Over the past several years of work, a great deal of information on the basin and the project has been developed. Our understanding of the basin and the project interaction has evolved over these years but additional information, study and project development work remain necessary. With respect to the groundwater basin, the necessary work falls under the following areas:

- Complete project impact analysis using a more detailed coastal model
- Evaluate alternative project mitigation measures – providing make-up water from the project or injecting recycled water along the coast to mitigate the drawdown and take impacts of the project on the basin.

- Evaluate seawater intrusion control effectiveness with a more detailed, coastal model

- Evaluate any project impacts to the seasonal coastal lagoon water levels

- Coordinate and track work with the SJBA on its implementation of the Groundwater Management Plan Recommended Alternative No. 6 and opportunities for coordinated and/or joint facility development and use.

The work has resulted in a "lot of new news" and a better understanding of the relationship among these various parameters. At this time, both the work to be conducted by the SJBA and several of the Doheny Desal partners needs to occur to focus in on the final projects configuration.

At any time, the pre-design CEQA and permitting work could be started. The critical path items are the environmental baseline monitoring, offshore geotechnical work, and preliminary engineering for the ultimate project, or the schedule could include a waiting period to finish the work at hand. Discussions with the five Doheny Desal Participants regarding how they would like to move forward will be occurring over the next several months.

The Participants recommended staff develop a "watch" list of issues that could ultimately impact the cost and/or feasibility of the Project. The following Table 5 identifies issues to keep within our monitoring efforts as we move forward.

Table 5 Doheny Desal Cost Impact "Watch" List
These are issues that could impact the ultimate cost of water from the Doheny Desal Project and so should be reviewed from time to time for their status and impact to the project assessment:
1. Financing has been at record low levels.
2. Outside funding may be available from State or Federal sources, either via grants or legislative actions; the State Revolving Fund and anticipated Water Infrastructure Finance and Innovation Authority (WIFIA) funding and 2014 State Bond are examples.
3. Technology Improvements can lower the costs of desalination.
4. The bidding environment has been at record low levels; many companies are interested in getting involved in ocean desalination in the U.S. and California.
5. The cost of energy is difficult to predict in the State of California due to implementation of AB 32, related regulatory policies and programs, hydraulic fracking and natural gas prices, changes in solar energy technology and costs, etc.
6. Iron and manganese pretreatment may be necessary (the costs have been estimated) but at what level is uncertain at this time.
7. The State Water Resources Control Board Ocean Plan Amendment is pending and the cost implications are unknown. New regulations could impact brine discharge through the SOCWA outfall.
8. Other regulatory issues that might arise during permitting.
9. Future costs will be higher due to inflation but are uncertain on a real dollar basis with improvements in technology and increased competition.
10. Mitigation costs with the San Juan Groundwater Basin have to be negotiated – a placeholder has been included in the conceptual level cost opinion.
11. Fisheries issues (e.g., southern Steelhead) in San Juan Creek and the Seasonal Coastal Lagoon due to groundwater drawdown may need to be worked out.
12. Design/Build and Operate, and Design/Build/Operate delivery mechanisms could offer savings in life cycle project costs compared to the conventional Design, Bid, Build, Operate method.
13. As other projects in California get up and operating, relevant knowledge can be transferred to the project.
14. Drought supply shortages and an increasingly greater public recognition of the value of water may spur increased public and political support and willingness to pay for improved supply reliability.

C. Goals and Objectives

The three main goals for Phase 3 were:

- Conduct an extended pumping and pilot plant test to determine the performance of the well and aquifer, to determine water quality over time, and to determine the pretreatment effectiveness of the aquifer

- Evaluate the project impacts and mitigation approaches on the groundwater basin using a regional watershed and groundwater model by first estimating the basin yield and its performance without the project and then determine the effect on the basin with the project.

- Conduct a conceptual level assessment of the full scale project and its costs.

To support the overall goals of the Phase 3 work, 10 specific objectives were developed:

1. Obtain long-term well performance, salinity, and drawdown data and use in validating and refining the groundwater model that will be used in aiding in the design of the feedwater supply system and evaluating project impacts. Conduct natural isotope testing on the extracted water to quantify the sources of water pumped from the well over the extended test period.

2. Collect and analyze slant test well water quality to determine the character of groundwater produced over the extended pumping period. Assess how water quality may change over time as the well pulls in offshore marine groundwater and ocean water. Evaluate how potential changes in ocean water quality, such as red tides, may influence the produced well water. This information will also help to validate the existing SEAWAT groundwater model predictive capability and develop source water quality specification that can be used for project environmental review and permitting.

3. Conduct corrosion studies to determine appropriate materials for the wells, pumps, and system piping and valves.

4. Evaluate the effectiveness of using a nitrogen blanket in the test slant well headspace to minimize introduction of air into the well. This step is intended to control microbiological growth and oxidation/precipitation of dissolved iron and manganese in the produced well water and to facilitate evaluation of any oxygenated ocean water entry into the well over the test period.

5. Conduct studies to identify and measure the extent of microbiological growth over the extended pumping period on the well and selected materials, which are anticipated to result from both brackish and ocean water influences. Determine the speciation of natural organisms that may grow in the well/conveyance facilities and evaluate control approaches as necessary.

6. Evaluate the pretreatment effectiveness of the aquifer and well through the use of standardized testing procedures (e.g., silt density index (SDI), turbidity, pilot unit RO membrane performance); evaluate microbial, colloidal, and particulate fouling; and determine and test any additional pretreatment that may be necessary.

7. Conduct an extended "Under the Influence of Surface Water" study for determining if the well production is affected by San Juan Creek water quality, evaluate applicable California Department of Public Health (DPH) treatment requirements, and develop testing protocols with DPH review.

8. Test RO process performance using test slant well water initially without pretreatment then with the addition of pretreatment, if necessary.

9. Develop a regional watershed model to generate streamflows and a groundwater model to determine groundwater basin yield over an extended period of time including a dry period and to determine the impact of the project on the basin and mitigation approaches.

10. Conduct conceptual level assessment of the full scale project to develop an opinion of probable construction and O&M costs.

The Phase 3 investigation accomplished all of the above objectives.

D. Phase 3 Project Implementation

MWDOC was responsible for carrying out the implementation of the Phase 3 test project. This work included:

Environmental Documentation

A consultant was retained who prepared the project description and mitigated negative declaration for the Phase 3 facilities construction and their operation and maintenance, publication, processing and adoption. This work was done by Chambers Group, an environmental consulting firm.

Permitting and Approvals

This work included the preparation of information and special studies for the permit applications, the permitting process, including agency meetings, and execution of the permits. The following permits and approvals were required and issued: (1) California Department of Parks and Recreation (Right of Entry Permit), (2) State Lands Commission (amended lease), (3) California Regional Water Quality Control Board (NPDES Discharge Permit and a Water Quality 401 Certification), (4) California Department of Fish and Game (Streambed Alteration Agreement), (5) U.S. Army Corps of Engineers (404 Outfall Nationwide Permit), and (6) California Coastal Commission (Coastal Development Permit).

Design, Procurement and Construction of the Test Facilities

This work included consultant selection and design, procurement and construction of the test facilities. The test facilities were designed, procured, or constructed under the direction of MWDOC, who served as the project manager. This work included: (a) well inspection and redevelopment, (b) design and procurement of a submersible pump, (c) installation of the submersible pump, (d) design and procurement of a Mobile Test Facility, and (e) design and construction of appurtenant test facility infrastructure (placement of the Mobile Test Facility, pipelines, conduits, control and metering vault, outfall diffuser and electrical service).

These facilities were located entirely within Doheny State Beach. GEOSCIENCE/Boart Longyear provided the well work and Carollo Engineering provided the design and construction observation services for the test facility. Williams McCaran, Inc. designed the Mobile Test Facility, which was then procured by MWDOC. MWDOC procured this item due to its long-lead time in manufacturing and special features that were required for the Phase 3 extended pumping and pilot plant test. This also allowed MWDOC to control overall quality of the facility. MWDOC also solicited bids as part of this effort. Intuitech, a company specializing in assembling pilot water and wastewater process test equipment, manufactured the test facility. Prior to installation at Doheny State Beach, Intuitech performed shakedown testing using a freshwater supply to make sure that all process equipment, instrumentation, and electrical equipment was functioning properly. This work was observed by WMI to ensure all work was completed in compliance with the design.

Pilot Facilities Start-up and Operation

After installation and construction of the test facilities, SPI was selected to operate the test facility and to conduct the various testing work over the extended pumping test.

Remove/Destroy/Abandon Test Facilities and Restore Site

Participant funds are being reserved to eventually remove the test facilities and restore the project site. Currently, an agreement with State Parks allows the test facility to remain in place. Permits are also maintained. The temporary facilities that will eventually be removed are: (1) the mobile test facility (this is planned to be salvaged and moved to the full scale plant site for use during start up and for future testing work); (2) test slant well submersible pump, wellhead, discharge piping and outfall diffuser; (3) temporary electrical and instrument conduits run from the test facility to the wellheads and; (4) the meter and electrical conduit supply to the test facility. Additionally, the test horizontal/slant well and nested monitoring well MW1 located on the beach will be abandoned or destroyed if there is no future use for these facilities. MW1 is expected to be transferred to San Juan Basin Authority which will require a long-term use agreement with State Parks.

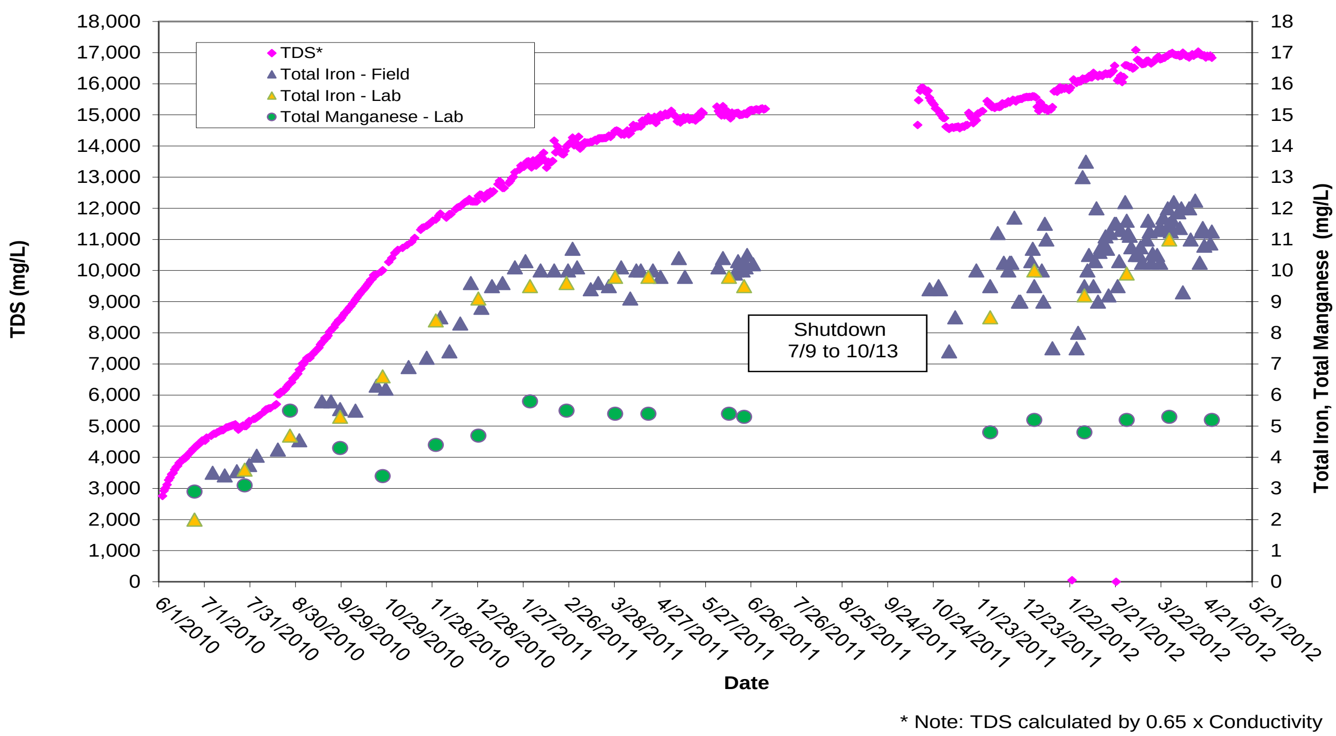
E. Project Results – What Was Learned

Following is a summary of results, findings and conclusions gained from the Phase 3 work.

Feedwater Supply

1. Construction and operation of slant wells along Doheny State Beach is feasible.
2. Old Marine groundwater was encountered and was found to be enriched with dissolved iron and manganese and remained anoxic (without oxygen) throughout the nearly two year extended pumping test. This test showed a continuing increase in salinity and of ocean water (from isotope data) being pulled into the well. See Figure 14.

Figure 14 - Slant Well TDS, Total Iron and Total Manganese



3. We believe the pocket of old marine groundwater will be pumped out over time. Geochemical modeling or offshore geophysics and borings are required to more accurately estimate the time required to pump out the old water.
4. The Marine Aquifer provides excellent filtration as evidenced by nearly two years of pumping and testing data.

5. The natural isotope study provided excellent information on the rate of connection to the ocean and the data can be used to refine the coastal groundwater model calibration. The data clearly showed an increasing trend in the amount of ocean water being pumped (which is a good trend).
6. The corrosion study recommends 2507 Super Duplex Stainless Steel for the wells. This was the material used to construct the test submersible pump.
7. The microbial biofouling study showed very low levels of microbial biofilm growth.
8. The slant wellfield configuration is expected to consist of 3 clusters of 3 wells located along Doheny State Beach for a total of nine wells. Preliminary study indicates that the wells would be about 520 feet long at an angle of about 23 degrees. The actual wellfield configuration, well and wellhead design, and wellfield capacity needs to be determined. In the future, the offshore geophysics survey will be needed for both the coastal groundwater model update and wellfield configuration design work.
9. The slant wellfield can be permitted as a water supply. The subsurface intake is regarded favorably by the regulatory agencies based on verbal comments and staff reports by the Coastal Commission for other projects. Further, the State Water Board draft Ocean Desalination Policy is also supporting a slant well subsurface intake approach. Using a subsurface intake will save significant permitting time and costs. Drawdown impacts on the lagoon are expected to be minor. Environmental baseline monitoring is required to support the environmental impact report and permitting activities.
10. Based on work being conducted by West Basin MWD, an open ocean intake system may also be feasible with the use of wedge wire screens. However, conceptual work indicates that it will be a very expensive proposition to construct a "new intake" structure via tunneling if pursued at the Doheny site. Another potential option is to put the intake in the easterly basin in Dana Point Harbor, but limited depths and fueling operations would make this option problematical. This approach was not investigated.

Lower San Juan Basin Groundwater Yield and Integrated Operations

1. The 2007 preliminary groundwater model has been significantly improved through development of a basin wide surface water flow model and updated groundwater model for the Lower San Juan Basin completed in April 2013. This work was developed in close cooperation with San Juan Basin Authority (SJBA) and with their Groundwater Management Plan development work.

2. The groundwater model has been recently re-calibrated to a reasonable level of accuracy for planning purposes over the more recent period, 2004-2010, a period with higher groundwater pumping than under historical operations.

3. Groundwater production in the basin during the period 2004-2010 averaged 5,370 AF per year. Under this level of production, groundwater discharges to the ocean from rising water and subsurface outflow were estimated at 1,880 AFY. The near-term pumping by San Juan Capistrano and South Coast in the Lower San Juan Basin will increase over these historical levels which will

significantly reduce the rising water and subsurface outflow losses. Continued increased pumping can result in seawater intrusion.

4. Without the Doheny Desal Project, the 2013 modeling results indicate that net basin water supply on average came out to 9,150 afy and during a repeat of the 30-year dry period the supply would decrease to 8,040 afy. These values include ocean water intrusion, rising groundwater outflow to the ocean, subsurface outflow to the ocean and change in basin storage. Under this run, ocean water intrusion began to occur; the South Coast wells were turned off after nine years when the salinity reached 2,600 ppm. It is likely these basin yield values are over estimated by about 300-400 AFY as the modeled pumping amounts results in seawater intrusion. The breakdown of this analysis is shown below in Table 6:

Table 6 - Groundwater Modeling Production Analysis – Base Case (2i/2j)
Pumping Water Level Constraint with Salinity Constraint

	Groundwater Pumping Yield (afy)	
Producer	Dry	Average
City's GWRP Wells	5,808	6,690
City's Other Wells	823	942
Subtotal City	6,631	7,632
SCWD	559	664
Private Wells	850	850
Total	8,040 afy	9,146 afy

5. With the Doheny Desal Project intake production at 30 mgd, the groundwater modeling indicates that on average about 5% of the slant well production (1.5 mgd, 1,660 afy) will be San Juan Creek brackish groundwater. This estimate was made by averaging the Doheny Desal draw on the basin of 1,495 afy in dry periods and 1,820 afy in average periods, averaging about 1,660 afy.

6. The modeling indicates that South Coast Water District wells (the wells in the basin closest to the ocean) would be potentially impacted by a drop in groundwater elevation between 15' to 20' with slant wellfield production level at 30 mgd. The drawdown impacts to the City of San Juan Capistrano wells further up in the basin would be approximately 1 to 3 feet.

7. The 30 mgd slant wellfield production level will protect the SCWD wells and the lower basin (e.g., Latham WWTP) from ocean water intrusion.

8. The leaking underground storage tanks at the gasoline stations in the vicinity are in the process of being cleaned up and are not expected to impact the project start up. Continued coordination with the Orange County Heath Care Agency (OCHCA) and oversight is required.

9. Drawdown impacts to the San Juan Creek seasonal lagoon at the ocean interface will likely be small as the lagoon is underlain by a shallow highly permeable aquifer and an areal extensive clay layer. The seasonal lagoon receives ocean water recharge as well as streamflow from storms and urban runoff. A more detailed coastal groundwater model will be needed in the future to assess this impact as well as intrusion through the shallow aquifer.

Desalination Facility, Product Water Quality and System Integration

1. The desalination facility site (5 acres) is proposed to be located just north of PCH on existing South Coast Water District property. South Coast Water District has generally reserved the site for the project. Negotiations for use of the plant site will have to be completed. The current cost estimate has a placeholder lease cost for the site. The site will require geotechnical work to prepare the foundation for location of a new plant. The rough grade of the site will need to be raised to protect against flooding including an allowance for sea level rise.

2. Product water quality will be driven by the level to which bromide and boron need to be reduced. A bromide level of 0.3 mg/l will provide adequate protection for disinfection residual stability. This requires about a 40% second RO pass. This will also produce a boron level around 0.5 mg/l which will be protective for ornamental plants. Typical second pass RO configurations for plants range from 30% to 100%.

3. System integration is relatively low in cost, as both imported water pipelines cross near the Plant site. The water would be boosted out of a clearwell reservoir to a 450 foot hydraulic grade line to match with the imported water system (Joint Regional Water Supply System (JRWSS) and Water Importation Pipeline (WIP)). Additional pumping of about 110 feet would be required to supply the water to the Laguna Beach 400 zone from the SCWD 290 zone.

Brine Disposal

1. The San Juan Creek Ocean Outfall has adequate capacity to dispose 15 mgd of brine flow from the Doheny Desal Project. The outfall has a capacity of about 85 mgd and present day average daily dry weather flow is about 17.5 mgd; the current permitted capacity is 30 mgd. In the future the average daily dry weather flow will likely decrease with additional recycling and water use efficiency measures.

2. The brine disposal point of connection would be into the surge chamber junction, located adjacent to the Desalination Facility site.

3. A brine disposal study needs to be undertaken with South Orange County Wastewater Authority (SOCWA) to determine if any modifications are necessary to the outfall and its diffuser for compliance with SOCWA's National Pollution Discharge Elimination Standard (NPDES) permit. The study would need to evaluate ranges of blending with wastewater for co-disposal of 0% up to about 50%.

4. Non participants in the SOCWA outfall will have to acquire capacity from agencies with excess capacity.

5. The SWRCB is in the process of amending its California Ocean Plan which will include new regulations and standards for brine disposal. This amendment is expected to be completed either late this year or in early 2014.

Energy Supply and GHG Offsets

1. The project will have an electrical load of about 8.2 megawatts (MW). The project is estimated to consume 4,228 kilowatt-hours (kwhr) of electrical energy per acre-foot (AF) of produced water, including the pumping lift for system integration. For comparison purposes, imported water delivered to the area from the East Branch of the SWP through the Water Importation Pipeline uses a net of about 3,440 kwhr/af.

2. An electrical service study by SDG&E was completed in 2007; we are working with SDG&E to update this study. As of this time we don't have any response from SDG&E on the cost of the new work or time required to complete the update.

3. SDG&E is embarking on a $500 million reliability upgrade to their electrical distribution system in its Orange County service area.

4. The SDG&E reliability improvements include a new enlarged San Juan Capistrano substation. This should reduce the cost of running a 12 kV service to the Desalination Facility (the previous study ran the 12 kV line from the Laguna Niguel substation).

5. SDG&E has indicated that their worst case power outage would be for 12 hours. Based on this, no back-up power would be required for this short of an outage. This does not include any electrical reliability issues that have arisen with the recent SONGS plant closure.

6. SDG&E offers programs to shed load for electrical cost savings. The two main programs are their Critical Peak Pricing and Base Interruptible schedules. These will be further explored to reduce costs to the project.

7. A new law allows an agency, not a Joint Powers Authority (JPA), to build and wheel up to 3 MW of renewable energy through the PUC regulated agency grid. However, typically these costs are higher than grid energy from SDG&E.

8. SDG&E service environmental impacts could be covered under the Doheny Desal Project EIR.

9. SDG&E indicated that 2 years are required to design and construct their service facilities.

10. Energy costs will increase due to reliability improvements, expansion of the State's transmission and distribution system, meeting renewable energy targets of 33 percent by 2020, phase out of power plants using Once Thru Cooling (OTC) technology, impact of SONGS closure and replacement power, and general rate increases. However, natural gas fuel costs continue to stabilize the cost of energy from natural gas fired power plants. Predicting future energy costs with a reasonable degree of certainty is difficult at this time. Future decisions on SONGS replacement (assumed) and consumer liability by the PUC and SDG&E have not yet been made and no projections are available.

11. Greenhouse gas (GHG) offsets will likely be required by the State Lands Commission and Coastal Commission. Without any mitigation, the annual cost for GHG offsets is not expected to be significant, at about $50,000 per year at today's market rate.

Project Costs and Economics

1. Project capital cost is estimated at $153 million ($2012).

2. Capital and Project Unit Costs ($/AF) are lower than other desalination projects due to the attractive project location: slant wells avoid pretreatment costs compared to an open intake system, land is available near the coast, outfall capacity is available, system integration and pumping lift costs are very low, and SDGE is investing $500 million to improve electrical service reliability to the area (which should slightly reduce the electrical service cost to the Doheny Desal Project). Slant well intakes have unit costs per capacity similar to open intake systems, but can be built at lower capacities at much reduced capital cost than open intakes, which are best suited to large scale plants.

3. Estimated project unit costs (at this time) in 2012 dollars without grants or low interest loans are:

    - $1,611 per AF without the MET subsidy of $250 per AF
    - Capital at $588/AF (includes a 25% contingency and a 15% allowance for professional services)
    - O&M at $363/AF
    - Energy at $446/AF
    - Land at $47/AF
    - GW Mitigation at $167/AF for take of 1,660 afy on average
    - Total of all costs = $1,611 per AF.
    - Accounting for the MET subsidy results in a cost of water to the local agencies in 2012 dollars of $1361 per AF
    - For comparison purposes, MET avoided water costs in 2013 (Tier 1 + Capacity Charge + Readiness to Serve Charge) amounts to $953/AF.

4. Projected imported and desalination water costs cross about 8 to 10 years out (or further depending on the assumptions used) from which point on the desalination water costs would be

lower than imported water costs. Nine different economic scenarios were run to test the sensitivity of the assumptions. The most sensitive assumption was the out-year escalation of MET water rates (a higher MET escalation makes the Doheny Desal Project look more favorable and a lower escalation of MET rates is not favorable to the economics of the project).

5. One of the scenarios included higher energy cost escalation, which would increase the cost of the project. Current energy escalation costs are somewhat speculative. Future work should focus on refining the energy costs inputs to the project.

6. The system reliability benefit of the project has been estimated at about $100 Million when valued on the cost of storage at Upper Chiquita Reservoir Project. The project also provides benefits during droughts and helps prevent water shortages during emergency situations – these last two benefits have not been captured in the economic analysis.

F. Conclusions Regarding Slant Wells

Water supply wells when properly designed, constructed and developed can last for 75 years or more. There is no difference with Slant Wells as these will be built using tried and true water well technology along with the design and construction experience and innovations gained from the construction and operation of the Test Slant Well. We expect the Slant Wells to perform very well over the long- term and expect a useful life of 75 years.

Well Production Capacity

Based on the Test Slant Well pumping test at 2,100 gpm and recent groundwater modeling, we expect the full scale wells will be able to produce 3,000 gpm. Drawdowns, including well interference, will be approximately 90 feet vertically from mean sea level to the pumping water level in the well to produce the 30 mgd from seven pumping wells with two wells on rotational standby. The aquifer thickness is about 200 feet along the coastline, which is sufficient to allow the expected drawdowns and well yield. Should a problem occur during the summer when beach access is restricted there will be two standby wells that can then be turned on to continue uninterrupted production at the 30 mgd level. Drawdown impacts to wells in the San Juan groundwater basin will only be significant to the most nearby wells owned by South Coast Water District.

Well Design, Construction and Development

Design and construction of the full scale slant wells will need to be approached similarly to conventional water well design and drilling, but since the wells will be relatively flat in slope, additional care must be taken in gravel placement and well development. The design and construction will be aided through the experience gained in design and construction of the Test Slant Well. A key to the long-term success of the wells will be to provide thorough development work to assure minimum levels of sand clogging to the gravel pack. Sand clogging can occur over time in a well when it is not properly designed, constructed and/or developed. Causes include too large of well screen slot spacing, too large of gravel size in the gravel pack, gaps in the gravel pack, and most commonly, insufficient development of the well. The well screen and gravel pack size can be properly sized assuming the well designer has good technical capability and experience. Improper well development can occur due to insufficient swabbing, bailing and/or air lifting and due to insufficient development pumping rate and time.

For the full scale slant wells development, the development pumping rate needs to be around 1.5x the production rate with development pumping over a sufficient period of time to allow complete removal of entrainable fines from the near borehole formation. Assuming the full scale well capacity at 3,000 gpm, the development pumping rate should be specified at 4,500 gpm.

To assure adequate development pumping, procurement of high speed 4,500 rpm pump(s) in advance of the construction will be required. Well contractors typically do not stock submersible pumps of this capacity that would be able to fit into the well. Contractors often use suction development pumping, but this option will not be possible, as these pumps are limited to a suction or drawdown of 32 feet and a greater lift will be required. The designed drawdown will be approximately 45 feet below sea level (lower low water) and the wellhead floor elevation will be approximately minus 2 feet MSL, a differential of 43 feet, exceeding suction limits.

Another consideration in the construction of the nine wells is the ability to complete the work within the 8-month winter time window. This will likely require three well drilling crews working concurrently. The advantage of three wells drilled from a single site is the time and cost savings from moving the drill site. The well driller will need to possess well in advance of construction three large dual rotary drill rigs (DR-40) and trained crews. Sufficient lead time will need to be provided to acquire any additional rigs from the manufacturer.

Well and Pump Materials and Corrosion Protection

The Slant Wells will be constructed with Super Duplex 2507 Stainless Steel, an alloy which showed very little corrosion over the extended pumping test and which is considered suitable for achieving a long useful life for the well. Over the nearly two year extended pumping test, this alloy showed no corrosion. It is used in many ocean desalination projects worldwide. Super Duplex 2507 will not support biofouling iron bacteria that are common in carbon steel cased wells. It is considerably less costly than AL-6XN, another superior stainless steel used in ocean applications.

Long-Term Aquifer Performance

Over the nearly two-year extended pumping test, the step drawdown test indicated no observable change in aquifer losses. Aquifer loss can occur in certain types of aquifers that are susceptible to biochemical in-situ encrustation or precipitation, especially in limestone formations. For the alluvial aquifer system offshore of San Juan Creek this condition will not occur.

During the initial start up pumping period, the wells will pump out the old (age 7500 years) marine groundwater that is anoxic and enriched with dissolved iron and manganese. As the wells pump, the ocean water, which is oxic and has only trace levels of iron and manganese, will slowly recharge the aquifer and flow towards the well. No mixing will occur along the boundary of the marine groundwater and recharge front of ocean water, except for trace convective diffusion effects which will have no observable effect on aquifer permeability due to any minimal oxidation along the front as the masses in the boundary zone are insignificant.

The oxic ocean water will slowly become less oxic as microbial activity consumes the available organic carbon and dissolved oxygen as the recharging ocean water flows through the aquifer to the wells. Since the ocean water will have some dissolved oxygen over part of its flow course to the wells, this oxic condition will not cause any further dissolution of iron and manganese minerals that might remain in the sediments. Likely all of the iron and manganese mineral oxides in the original sediments were fully dissolved out of the formation since the time the ocean flooded these sediments, some 7,500 years ago ("old marine groundwater"). Over the extended pumping test, the well was pulling in about 20% ocean water, which became anoxic by the time it reached the well. This ocean recharge most likely entered the well near its upper screens that are only 50 feet below the ocean floor. Sufficient organic carbon was available to the naturally occurring aerobic bacteria in the seafloor sediments. The travel path to the remainder of the screens is longer and will allow for further uptake of any dissolved oxygen in the recharging water. The San Juan Creek and lagoon produce significant organic carbon loads which are swept out to the ocean by periodic storms. This condition is likely to indefinitely continue into the future.

Within the aquifer, where the ocean water groundwater flow and brackish groundwater flow boundary occurs, there will be a small mass reaction over time along this boundary due to slowly varying heads and tidal forces that will result in some convective diffusion along the boundary area which would cause some iron oxide precipitation within this brackish/ocean water flow boundary. However, the masses are quite small compared to the volume of the alluvium pore space that it would take a very long time to seal this flow boundary with iron oxy-hydroxide precipitates. The effect would be to reduce the amount of brackish groundwater that would enter the wells, which is a desirable outcome.

The project microbiologist, Dr. Sunny Jiang from UCI studied biofouling rates over the two year extended pumping test. Biofouling rates were found to be very low with biofilms less than 10 µm in thickness on the stainless steels. She does not expect much biofouling activity in the full scale wells.

Under the initial period of pump out, a large portion of the pumped water was brackish groundwater. This water has a much higher TOC than the old marine groundwater and ocean water. Initial levels of naturally occurring bacterial growths were fairly high but declined dramatically as the TOC levels dropped significantly as the ocean water was pulled into the well. It is uncertain what impact if any the project will have on the seasonal lagoon associated with San Juan Creek, as this area is underlain by an extensive 4-foot plastic clay layer that minimizes drawdown effects on water levels in the lagoon. The reverse condition is also true – the lagoon should have very little if any effect on the water quality produced from the slant wells.

Well Oxidation Control

The wells will be designed to be fed nitrogen gas into the headspace in the well above the pumping water level to prevent oxygen transfer into the water. This was used successfully over the Phase 3 extended pumping test and performed quite well.

Well and Pipeline Cleaning

If the ocean water that enters the wells contains some dissolved oxygen it will then mix with any anoxic brackish groundwater that has dissolved iron and manganese that enters the well. Once the mixing is initiated the oxidation reaction times are fairly rapid. If the DO levels are above about 1 ppm, this will lead to oxidation during the movement of water through the pipeline to the plant of dissolved iron and manganese. Under this condition, some accumulations of iron deposits along the walls in the upper well screen area, through the pump column, and along the conveyance pipeline can be anticipated. A mitigation design measure is to size the conveyance system to maintain high velocities around 8 to 9 fps, within a reasonable headloss, to help to scour and minimize iron deposition accumulations.

The submersible pumps will be serviced or replaced once every 5 to 10 years along with well inspection and any required maintenance. It may be necessary to acquire a dual rotary drill rig with angled set up to allow for less costly well maintenance, as the mobilization costs can be high as these rigs are often kept out of state as they are frequently used in the mining industry. In the future, the merits of this approach should be evaluated.

Phase 3 Final Reports

Separately published Project reports from Phase 3 are listed below in Table 7.

Table 7 - Phase 3 Final Reports

#	Title	Author	Issued
1.	Project Summary Report	MWDOC	Final Jan 2014
2.	Volume 1 – Phase 3 Project Development Report	MWDOC & Carollo Engineers	Final Sep 2013
3.	Volume 2 – Pilot Plant Operations, Testing, Evaluation Report	SPI	Final Aug 2013
4.	Volume 3 – Phase 3 San Juan Basin Regional Watershed and Groundwater Models Report	Geoscience	Final Nov 2013
5.	Pilot Testing of Slant Well Seawater Intakes and AWT Pretreatment Technologies for Control and Removal of Iron and Manganese	SPI	Final July 2013
6.	Expert Panel Workshop Report: Offshore Hydrogeology/Water Quality Investigation Scoping, Utilization of Slant Beach Intake Wells for Feedwater Supply	Dr. Susan Paulson, Flow Science and MWDOC	Final Oct 2012
7.	Final Report: Desalination Corrosion Study	Dr. Joseph King, Engineering Materials	Final May 2012
8.	Natural Isotope Tracer Study: Test Slant Well Phase 3 Extending Pumping Test	Matthew A. Charette, Ph.D. - Coastal Groundwater Consulting & WHOI	Final Nov 2012
9.	TECHNICAL MEMORANDUM: Aquifer Pumping Test Analysis and Evaluation of Specific Capacity and Well Efficiency Relationships, SL-1 Test Slant Well	Geoscience	Final Sept 2012
10.	Microbial Testing – Phase 3 Extended Pumping Study	Dr. Sunny Jiang, UCI	Final Nov 2012

Appendix

Project Photographs

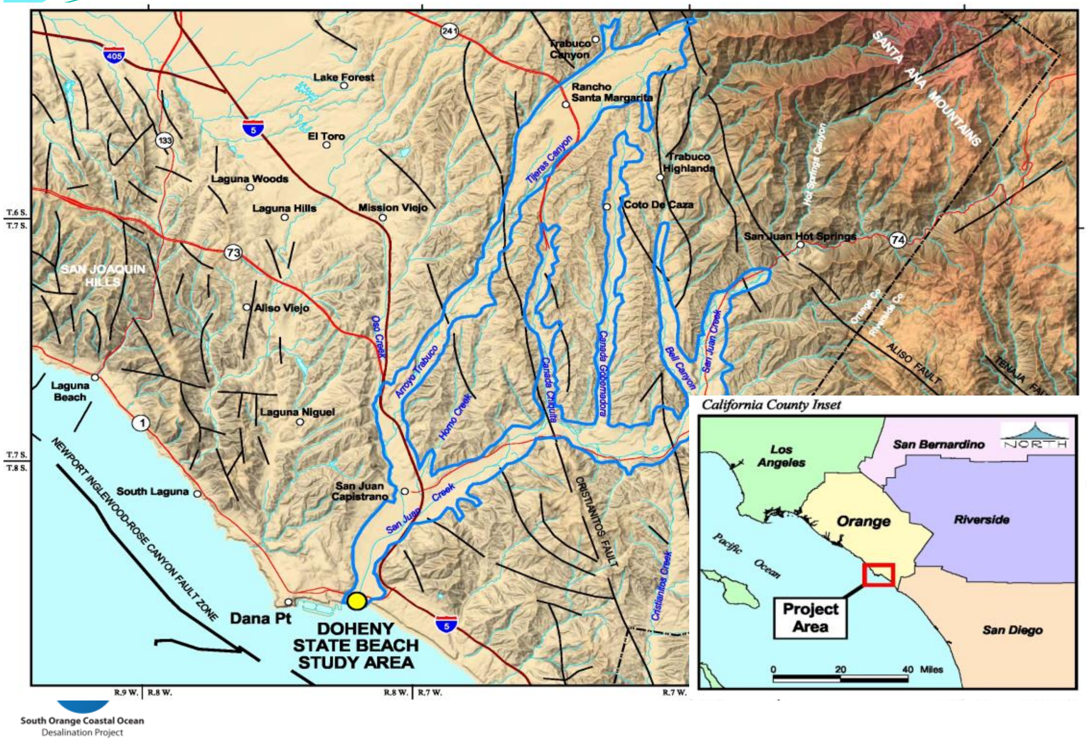
Groundwater Modeling Exhibits

Project Economic Analyses Scenarios

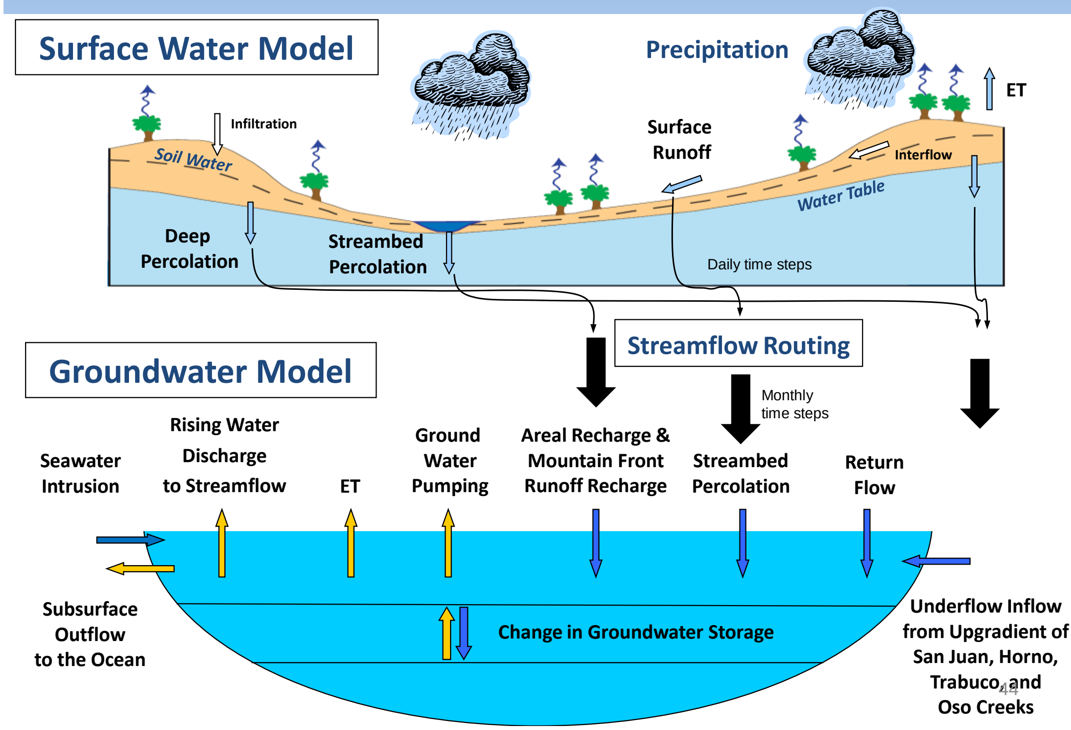
View of Slant Well and Test Facility Site Doheny State Beach

Mobile Test Facility

San Juan Groundwater Basin



Surface Water Model/Groundwater Model Interface



Project Economic Analyses Cases

Economic Analysis – Case 1 Base
No Fe/Mn Pre-treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

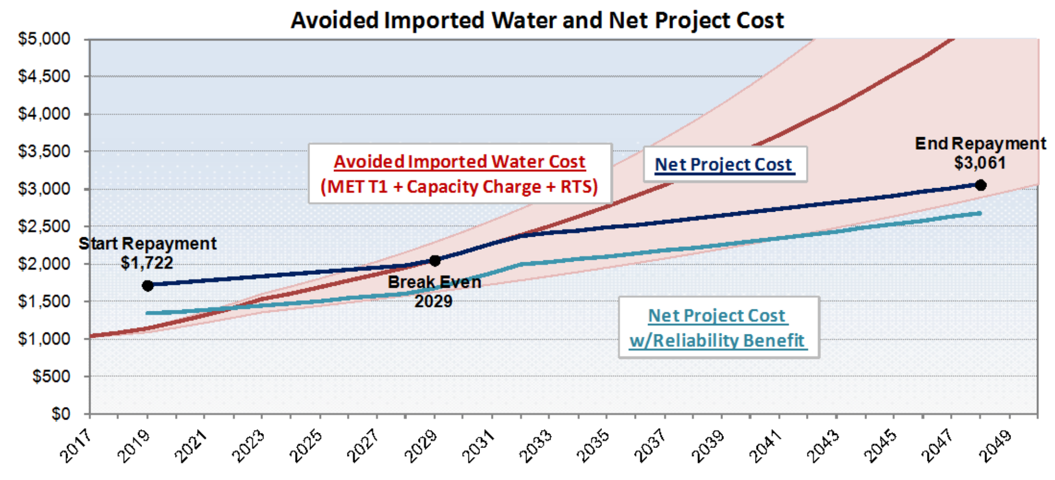
Capital Cost	
Fe/Mn Treatment?	No
Contingency of Const.	25%
Start of Construction	2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($31,436,811)
Break Even to End	$72,613,733
Total Savings	$41,176,923

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 2
Base Case with Fe/Mn Pretreatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

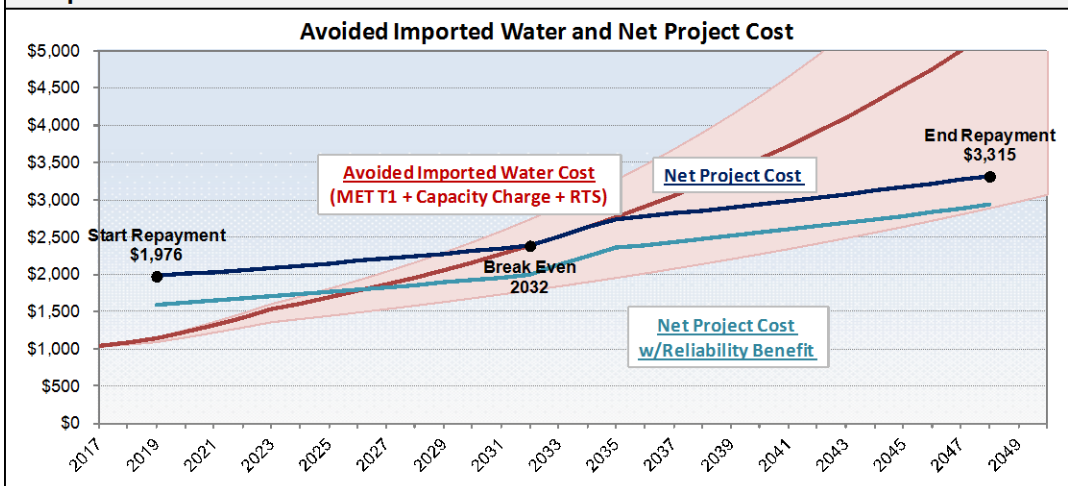
Capital Cost	
Fe/Mn Treatment?	Yes
Contingency of Const.	25%
Start of Construction	2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

Costs per AF	Current Year 2012	First Year 2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$522
Annual Cost	$1,646	$1,937
Annual Cost w/ Land	$1,693	$1,994
Mitigation Costs	$196	$231
Total w/ MET Subsidy	$1,640	$1,976

Net Present Value	
Up to Break Even	($59,808,624)
Break Even to End	$53,308,026
Total Savings	($6,500,598)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 3
No Fe/Mn; High Electrical (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

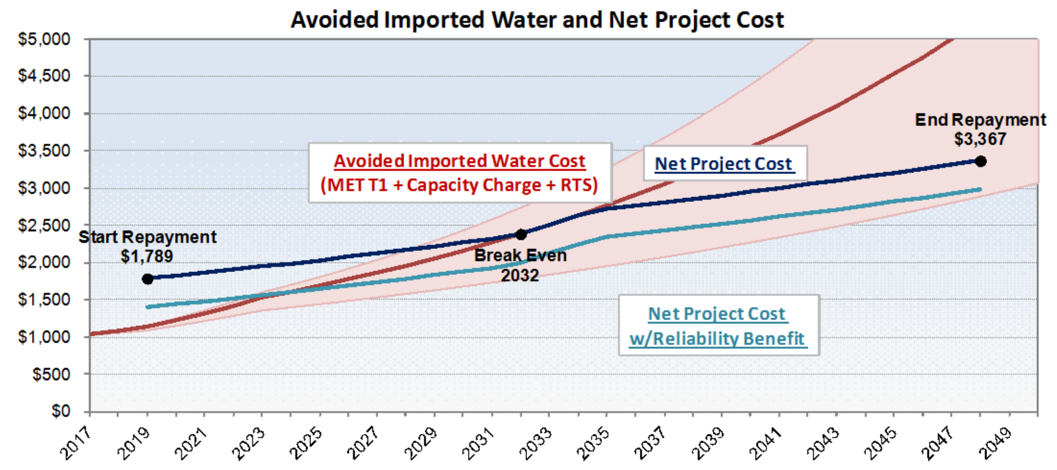
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction	2017	

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)	**$**	**0.105**
Energy Escalation 2012 - 2030		**3.4%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$**	**47**
Lease Escalation Rate		**2.5%**
General Inflation Rate		
Current - 2020		**2.5%**
2021 - Future		**2.5%**

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		**4.00%**

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	**2012**	**2019**
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$582
Annual Cost	$1,397	$1,769
Annual Cost w/ Land	$1,444	$1,827
Mitigation Costs	$167	$212
Total w/ MET Subsidy	$1,361	$1,789

Net Present Value	
Up to Break Even	($45,288,833)
Break Even to End	$52,460,361
Total Savings	$7,171,528

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 4
Base Case with $15M Grant; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

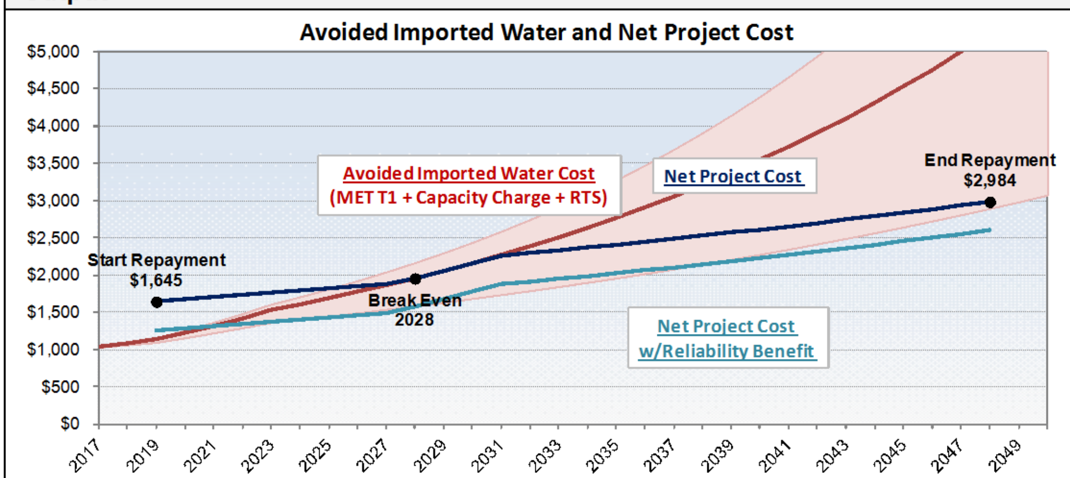
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction	2017	

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)	**$**	**0.105**
Energy Escalation 2012 - 2030		**2.0%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$**	**47**
Lease Escalation Rate		**2.5%**
General Inflation Rate		
Current - 2020		**2.5%**
2021 - Future		**2.5%**

Project Financing		
Grant Amount		$ 15,000,000
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		**4.00%**

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$15,000,000**
Contingency	**$22,586,000**
Total Cost (2011)	**$137,813,550**
Total Cost Escalated to Midpt. of Const.	$163,817,004

	Current Year	First Year
Costs per AF	**2012**	**2019**
Capital Cost	$530	$630
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,339	$1,641
Annual Cost w/ Land	$1,386	$1,698
Mitigation Costs	$161	$197
Total w/ MET Subsidy	$1,297	$1,645

Net Present Value	
Up to Break Even	($24,278,982)
Break Even to End	$79,452,496
Total Savings	$55,173,514

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 5
Low Interest Rate; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

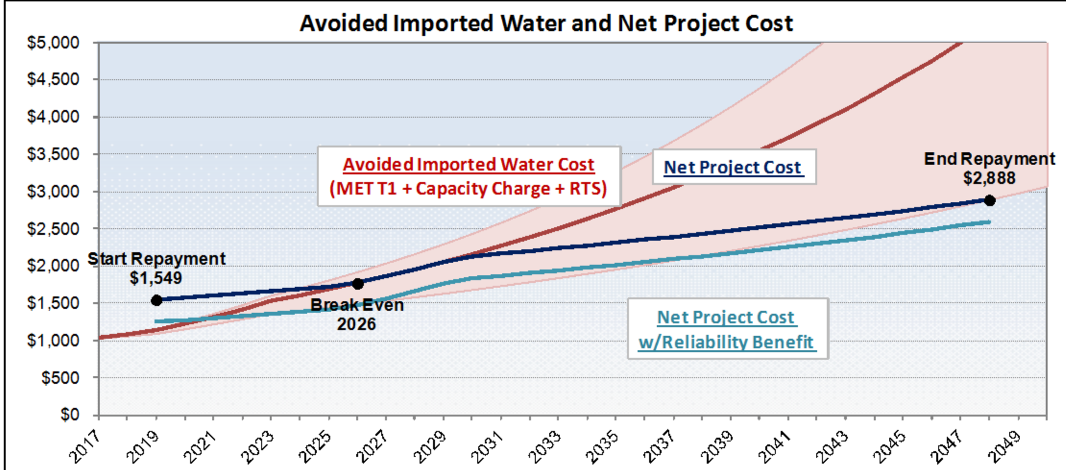
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)	**$**	**0.105**
Energy Escalation 2012 - 2030		**2.0%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$**	**47**
Lease Escalation Rate	**2.5%**	
General Inflation Rate		
Current - 2020	**2.5%**	
2021 - Future	**2.5%**	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	2.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	**2012**	**2019**
Capital Cost	$457	$544
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,266	$1,554
Annual Cost w/ Land	$1,313	$1,612
Mitigation Costs	$152	$187
Total w/ MET Subsidy	$1,216	$1,549

Net Present Value	
Up to Break Even	($16,445,195)
Break Even to End	$88,913,956
Total Savings	$72,468,761

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 6
Base with Low MET Escalation; No Fe/Mn (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

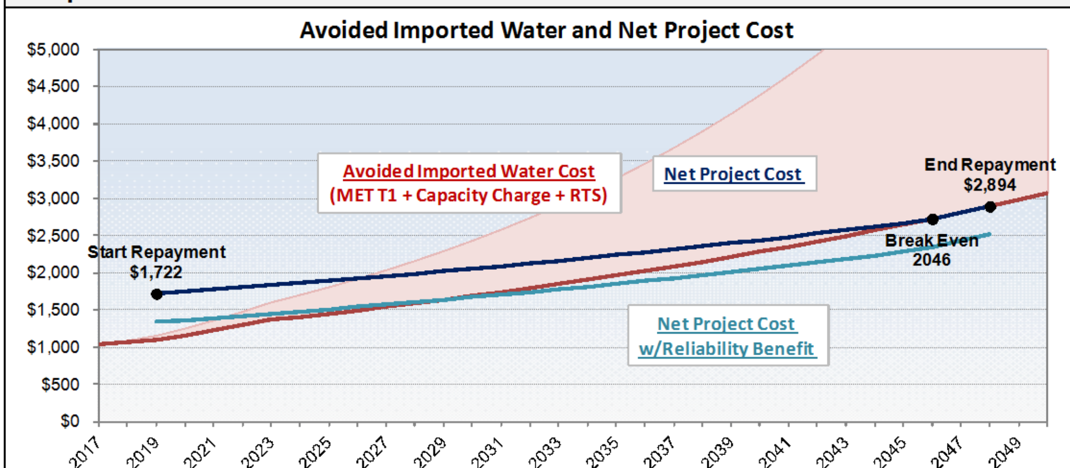
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	**25%**	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		**4,228**
Base Energy Rate ($/kWh)	**$**	**0.105**
Energy Escalation 2012 - 2030		**2.0%**
Energy Escalation after 2030		**2.0%**
Land Cost		
Land Cost per AF (2011)	**$**	**47**
Lease Escalation Rate	**2.5%**	
General Inflation Rate		
Current - 2020	**2.5%**	
2021 - Future	**2.5%**	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	4.50%	
PV Discount Rate	**4.00%**	

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	**$130,227,550**
Grants	**$0**
Contingency	**$22,586,000**
Total Cost (2011)	**$152,813,550**
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	**2012**	**2019**
Capital Cost	$588	$699
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,397	$1,709
Annual Cost w/ Land	$1,444	$1,767
Mitigation Costs	$167	$205
Total w/ MET Subsidy	$1,361	$1,722

Net Present Value	
Up to Break Even	($72,772,358)
Break Even to End	$65,495,638
Total Savings	($7,276,720)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 7
High Electrical & Fe/Mn Pre-Treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

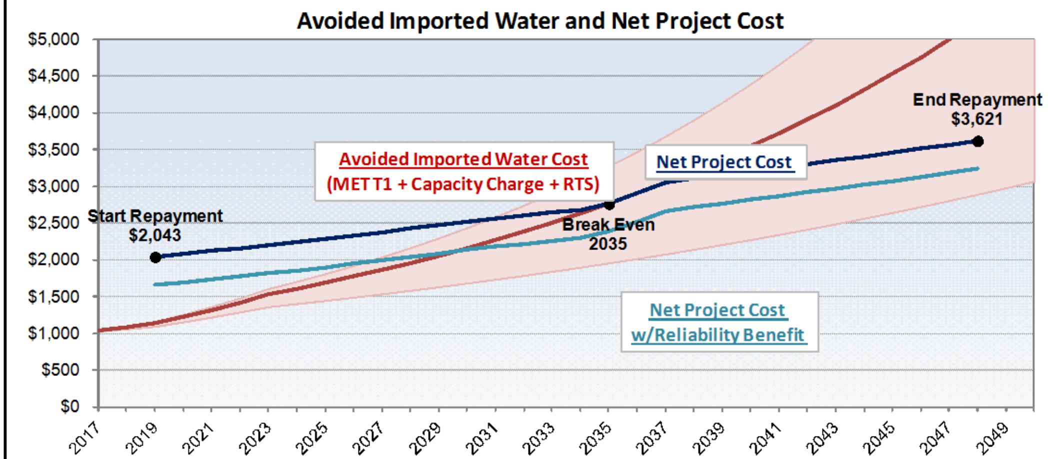
Capital Cost		
Fe/Mn Treatment?	Yes	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		3.4%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	5.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$582
Annual Cost	$1,646	$1,997
Annual Cost w/ Land	$1,693	$2,054
Mitigation Costs	$196	$238
Total w/ MET Subsidy	$1,640	$2,043

Net Present Value	
Up to Break Even	($78,811,738)
Break Even to End	$68,285,103
Total Savings	($10,526,635)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 8
Low MET Escalation with Fe/Mn Pre-Treatment (with MITIGATION costs)

Doheny Desalination Project - Economic Analysis - Draft Version 1.8

Input

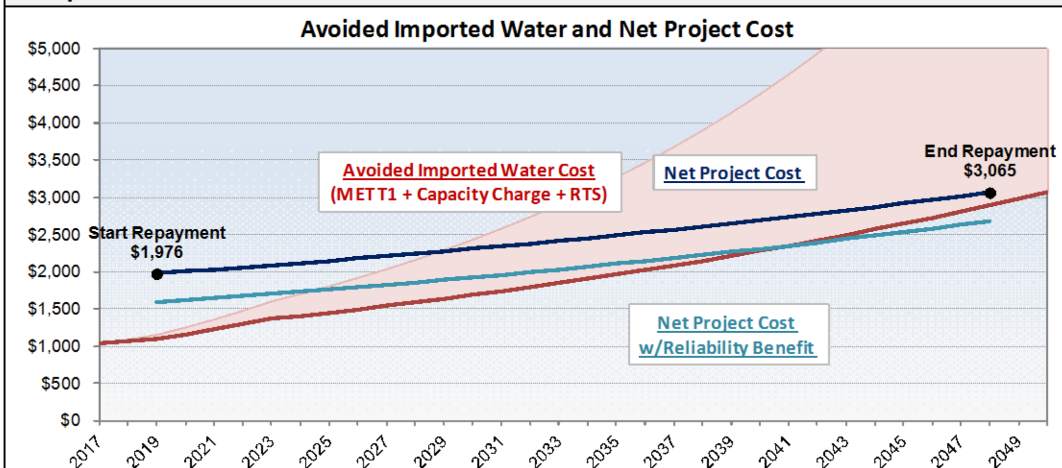
Capital Cost		
Fe/Mn Treatment?	Yes	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,259
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate		2.5%
General Inflation Rate		
Current - 2020		2.5%
2021 - Future		2.5%

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate		4.50%
PV Discount Rate		4.00%

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$172,234,800
Grants	$0
Contingency	$30,373,750
Total Cost (2011)	$202,608,550
Total Cost Escalated to Midpt. of Const.	$240,837,897

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$779	$926
O&M	$421	$489
Energy	$446	$522
Annual Cost	$1,646	$1,937
Annual Cost w/ Land	$1,693	$1,994
Mitigation Costs	$196	$231
Total w/ MET Subsidy	$1,640	$1,976

Net Present Value	
Up to Break Even	($125,500,571)
Break Even to End	$115,260,666
Total Savings	($10,239,905)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000

Economic Analysis – Case 9
Low MET Escalation with Low Interest (with MITIGATION costs)

South Orange Coastal Desalination Project - Economic Analysis - DRAFT VERSION 1.8

Input

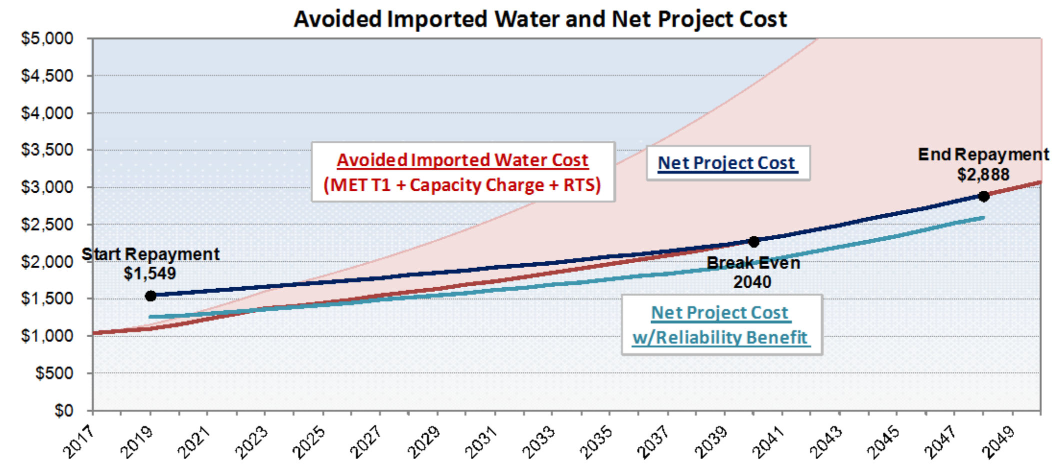
Capital Cost		
Fe/Mn Treatment?	No	
Contingency of Const.	25%	
Start of Construction		2017

O&M Costs		
Energy Costs		
Energy Usage (kWh)		4,228
Base Energy Rate ($/kWh)	$	0.105
Energy Escalation 2012 - 2030		2.0%
Energy Escalation after 2030		2.0%
Land Cost		
Land Cost per AF (2011)	$	47
Lease Escalation Rate	2.5%	
General Inflation Rate		
Current - 2020	2.5%	
2021 - Future	2.5%	

Project Financing		
Grant Amount		$ -
Bond Repayment	Select →	30
Bond Interest Rate	2.50%	
PV Discount Rate	4.00%	

MET Avoided Costs	
Esc. Rate After 2017	3.0%
Melded Rate- % Tier 1	100%

Output



Project Capital Costs	
Capital Cost (2012)	$130,227,550
Grants	$0
Contingency	$22,586,000
Total Cost (2011)	$152,813,550
Total Cost Escalated to Midpt. of Const.	$181,647,290

	Current Year	First Year
Costs per AF	2012	2019
Capital Cost	$457	$544
O&M	$363	$489
Energy	$446	$522
Annual Cost	$1,266	$1,554
Annual Cost w/ Land	$1,313	$1,612
Mitigation Costs	$152	$187
Total w/ MET Subsidy	$1,216	$1,549

Net Present Value	
Up to Break Even	($40,765,490)
Break Even to End	$35,505,320
Total Savings	($5,260,170)

Additional Reliability Benefit	
Storage Reservoir	$100,000,000