Final Report: Technical Feasibility of Subsurface Intake Designs for the Proposed Poseidon Water Desalination Facility at Huntington Beach, California

Authored by the Independent Scientific Technical Advisory Panel

Under the Auspices of the California Coastal Commission and Poseidon Resources (Surfside) LLC

Convened and Facilitated by CONCUR, Inc.

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This report evaluates whether any of several subsurface intake designs would be technically feasible to build and operate as part of the Poseidon Resources (Surfside) LLC (Poseidon) seawater desalination facility proposed for the City of Huntington Beach, California. This report is the product of coastal development permit (CDP) review, the California Coastal Commission (CCC or the Commission) recommendations, and a scientific and technical review conducted by an independent expert panel (the Independent Scientific Technical Advisory Panel, or ISTAP) convened jointly by staff of the Commission and Poseidon.

Background

In 2002, Poseidon submitted a CDP application to the City of Huntington Beach for a proposed seawater desalination facility. In 2003, the City declined to certify the associated Final Environmental Impact Report (EIR) for the proposed project. In 2005, Poseidon re-applied to the City with a modified proposal. Later that year, the City certified the project EIR and in early 2006, approved a CDP for the portions of the project within the City's permit jurisdiction. That CDP was then appealed to the Commission. In May 2006, Poseidon submitted a CDP application to the Commission for portions of the proposed project in coastal waters offshore of Huntington Beach, which are within the Commission's retained permit jurisdiction.[1]

[1] The California Coastal Act, established by voter initiative in 1972 and made permanent by the Legislature in 1976, includes specific policies meant to provide public access to the coast, protect coastal resources, and ensure appropriate development within the state's Coastal Zone. The Coastal Zone extends along the length of the state and includes coastal waters to three miles offshore as well as areas ranging from several hundred feet to several miles inland from the shoreline.

Many forms of development proposed within the Coastal Zone are subject to provisions of the California Coastal Act and of Local Coastal Programs (LCPs), which are developed by local governments in association with the Coastal Commission. LCPs generally include more specific policies than those in the Act that reflect and more closely address locally important coastal resource issues.

Once the Coastal Commission certifies an LCP and an associated Land Use Plan (LUP), the local jurisdiction takes on most of the permitting authority provided by the Act. The Commission retains its permitting authority over state tidelands (i.e., offshore areas) and in areas of the Coastal Zone that aren't covered by a certified LCP or LUP. There are also areas or types of projects within local jurisdictions where the local government has permitting authority, but where those permits can be appealed to the Commission. Proposed projects that would be located within both the permit jurisdiction of a local government and the Commission may require a CDP from each. This is the case for the proposed Poseidon Water desalination facility in Huntington Beach. Additionally, the proposed project is within the Commission's appeal jurisdiction.

By the end of 2010 the Commission had approved and issued a number of CDPs for desalination facilities that used surface, subsurface, or screened intakes, including one issued to Poseidon for its Carlsbad Desalination Project, the first large-scale project approved in the State of California. In addition, the State Water Resources Control Board (State Board) had approved the Once Through Cooling Policy. These events provided information that was useful for permit review for the Huntington Beach Project. While the Commission was reviewing the CDP application and the appeal, Poseidon modified some components of its proposed facility and submitted a proposed project re-configuration for the long-term stand-alone operation of the desalination facility to the City, which required the City to conduct additional California Environmental Quality Act (CEQA) review and consider a new CDP for the project. In 2010, the City certified a Supplemental EIR and approved a new CDP, which was also appealed to the Commission.

California Coastal Commission Action

In November 2013, the Commission held a public hearing to determine whether to issue a CDP to Poseidon for the offshore portions of its proposed project and to determine how to resolve the appeal of the City's CDP. At that hearing, Commission staff recommended that the Commission conditionally approve both CDPs with a requirement that Poseidon construct a subsurface intake unless Poseidon presented additional information showing that intake method to be infeasible.

The hearing included several hours of public testimony and Commission deliberation, with one of the key issues being whether (a) subsurface intake(s) is feasible at or near the proposed site. Near the end of the hearing, several Commissioners recommended to Poseidon that it work with Commission staff to develop independent verification of whether any of several subsurface intake designs would be feasible for this project. Poseidon then withdrew its CDP application and the Commission voted to continue the appeal of the local CDP.

Shortly after that hearing, and in anticipation of Poseidon's submission of a new CDP application, Commission staff and Poseidon began discussing how to produce an independent scientific and technical review as recommended by the Commissioners. In January 2014, the two parties (known here as the

"Conveners") agreed to undertake an independent review, to be conducted in at least two phases. As part of this process, Poseidon agreed to contract with CONCUR, Inc., a firm specializing in analysis and resolution of complex environmental issues and in structuring independent review processes. While the Commission is not contracting with CONCUR, the agency staff agreed on the choice of CONCUR as the facilitator and convener of this independent review. CONCUR convened a panel of scientific experts – the Independent Scientific and Technical Advisory Panel (ISTAP) – to review the issues at hand and make recommendations to bolster the scientific underpinning of the permit application and review process. For this first phase, the two parties and CONCUR identified the expertise needed on the Panel and jointly agreed on the Panel members selected. The Panel's specific and limited purpose during this Phase I of the independent review was to investigate whether currently available alternative subsurface intake technology can provide a technically feasible method of supplying source water to Poseidon's proposed desalination facility. Working with CONCUR, Commission staff and Poseidon agreed on the Panel's initial scope of work and on its structure and operating procedures. These are described in Appendix B of this report, the Terms of Reference (TOR).

As noted above, the Conveners anticipate that multiple phases of work will be necessary for the Panel to complete it's charge, and that the composition of the Panel may be revised at each phase to provide the necessary expertise. The Panel's first phase of work was limited to evaluating the only the *technical* feasibility of subsurface intake methods rather than the all aspects of feasibility. In other words, the Panel was charged with investigating whether, given hydrogeologic and oceanographic site conditions, any of several currently available subsurface intake methods can be built and operated at the proposed Huntington Beach site. After agreeing upon the Panel composition, the Conveners also jointly developed a bibliography and jointly provided data sources for the Panel to use in its deliberations.

Panel Deliberation Process

The Panel started its work in June 2014. The Panel's initial organizational meeting, convened via conference call, was focused on introducing the Panel members, the parties, and CONCUR, describing and answering questions about the Terms of Reference, and establishing the expected schedule, review process, and other considerations. The parties posted relevant data, reports, and information for the Panel on the Commission's FTP site, with most being available to the interested public.

The Panel's first public meeting was held on June 2014 in Huntington Beach. It included presentations by Poseidon and technical advisors[2], discussions among the Panel members, and opportunities for public comment.

At this public meeting, the Panelists identified and requested additional information to support the analysis of technical feasibility[3]. Several weeks later, at a work session in San Francisco, the Panel evaluated the information made available through the FTP site, at the public meeting, and the additional information they had requested, along with published literature known to the Panelists, and worked to assess the technical feasibility of various subsurface intake designs.

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[2] Information provided to the Panel at that public meeting included:

- Slant Well Intake Investigation - Doheny Ocean Desalination Project - slant well technology at the proposed Doheny Beach desalination facility (presented by Richard Bell, a staff member from the Municipal Water District of Orange County.
- Groundwater Basin and Talbert Gap Overview - detailed information on the Talbert aquifer, local seawater barriers, local sediments, and the use of injection wells serving as water recharge points as well as seawater intrusion buffers (presented by Roy Herndon, a staff member of the Orange County Water District.
- Huntington Beach Project Site Characteristics - characteristics of the proposed Huntington Beach site, including site acreage, surrounding land use and existing infrastructure, and vegetation.
- Review of the Proposed Huntington Beach Project - the scope, goals, and status of the various phases of the Huntington Beach Project, the determination of "feasibility," characteristics of the site, proximity to water delivery systems, and other project components.
- Oceanographic Considerations of Alternative Intakes for the Huntington Beach Desalination Facility - tidal currents in relation to sea floor shelves, interaction with mobile sediments, and other oceanographic considerations.
- Oceanographic Siting - detailed evaluation of the seabed infiltration gallery (SIG) oceanographic siting.
- Conceptual design of a SIG.
- Constructability assumptions and options for the conceptual SIG.
- Alternate Intakes - the process undertaken in other desalination projects (particularly in California) to examine alternate intakes systems.
- Alternate Intake Technologies - evaluation at the Huntington Beach site.

[3]The parties jointly provided the identified information including:

- CCC Nov 2013 Report and Background documents used to evaluate alternatives,
- San Diego County Water Authority (SDCWA) – Feasibility Study for Intake Options,
- Commission's Draft Sea Level Rise Policy Guidance document,
- Sediment management (disposal/reuse) policy excerpts from the Commission,
- Poseidon's proposed Vibracore sampling methodology,
- Studies comparing intake alternatives and key factors in determining feasibility,
- Poseidon's site specific Vibracore data re: determination of range of hydraulic conductivity/K-values,
- Poseidon's documents used to determine the configuration of proposed intake structures, and
- Documents used to assess hydraulic challenges of the current SIG design/technology.

The Panel's work continued in subsequent weeks through conference calls, drafting of writing assignments, and exchange of several iterations of its draft reports. To maintain the Panel's independence, the report preparations and Panel deliberations occurred without input from the Conveners. Only when the Panel had completed a final draft of its report were the parties asked to review and propose edits, though the suggested edits were limited to concluding whether the report was consistent with the agreed-upon scope of work as defined in the Terms of Reference and recommending correction of factual points, as needed. The Conveners were not provided the opportunity to modify the Panel's conclusions or question its technical review. On September 22, 2014, the Commission posted the Panel's Phase I Draft report on its website for public review.

As a final step of this first phase of this independent review process, the Panel invited public comments at a meeting convened in Huntington Beach on September 29, 2014 to address relevant comments on the report. After that meeting, the Panel prepared this final Phase 1 report, which will be used by a new Panel in the Phase 2[4] work and which will become part of the Commission's record for Poseidon's upcoming CDP application. Pursuant to the Terms of Reference, all Panel members are joint authors of the final Phase 1 report, as documented on the signature page of this Report.

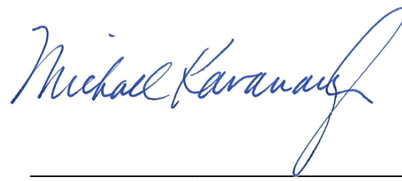
Note: During much of this same period, the State was developing a policy meant to help guide development of seawater desalination and clarify the regulatory requirements for proposed intake and discharge facilities. Starting in 2007, the State Water Resources Control Board (State Board) convened its own expert panels and held public workshops and hearings, and in August 2014, released a draft policy that identifies the proposed performance standards, study methods, mitigation measures, and other requirements desalination facilities will be required to meet. The State Board anticipates adopting a final policy later in 2014. Commission staff and Poseidon participated in the policy development, and both parties believe the Panel's work is consistent with the approaches anticipated in the draft policy.

[4] According to the TOR, Phase 2 of the panel is described as: "Still focused on the Huntington Beach site, the Panel would characterize the technically feasible subsurface intakes identified in Phase 1 relative to a broader range of evaluation criteria, as recommended by the parties and determined by the Panel, such as size, scale, cost, energy use, and characteristics related to site requirements and environmental concerns consistent with the California Coastal Act's definition of feasible, and as compared to the proposed open intake (Appendix B)."

iii. Signature Page

WE, THE UNDERSIGNED MEMBERS OF THE CCC-POSEIDON PROPOSED HUNTINGTON BEACH DESALINATION FACILITY INDEPENDENT SCIENTIFIC TECHNICAL ADVISORY PANEL, AUTHORED AND HEREBY CONFIRM OUR CONCURRENCE WITH THE FULL TEXT OF THIS PHASE 1 REPORT:

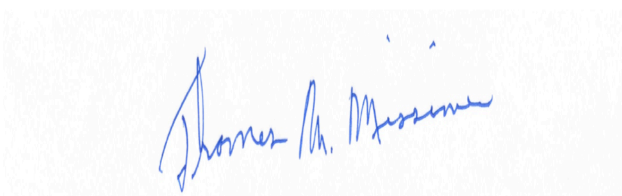
ROBERT BITTNER



MICHAEL KAVANAUGH

MARTIN FEENEY

ROBERT MALIVA



THOMAS MISSIMER

iv. Panelists' Executive Summary

a. Introduction

The Independent Scientific and Technical Advisory Panel (ISTAP or "Panel") was established by an agreement between the California Coastal Commission (CCC or Commission), and Poseidon Resources (Surfside) LLC (Poseidon) to undertake an independent assessment of the technical feasibility of using one or more potential subsurface intake technologies to supply the feed water to a seawater desalination facility using the Sea Water Reverse Osmosis (SWRO) technology. The facility would be located in Huntington Beach with a presumed hydraulic capacity to meet a goal of producing 50 Million Gallons per Day (MGD) of potable water. Background on the rationale for establishing the ISTAP process is provided in the convener's preface to this report.

The process of establishing the ISTAP and coordinating ISTAP deliberations and preparation of a Phase 1 consensus technical report is being managed by CONCUR, Inc. (CONCUR), a California firm specializing in facilitation and mediation processes to resolve complex technical disputes. Under the direction of CONCUR, the CCC and Poseidon, designated as "Conveners" in this process, jointly selected five experts on various technical aspects of subsurface intake options. Qualifications for the ISTAP members are provided in Appendix A. CONCUR established a contract with each Panel member that defines the scope of work for the feasibility assessment. The structure and operating procedures of the scientific and technical review and specific charge to the Panelists are defined in the Terms of Reference (TOR) document jointly developed by Poseidon and the CCC with CONCUR's assistance prior to Panelist recruitment (see Appendix B). Additional background on the process is provided in the convener's preface.

The full ISTAP assessment of feasibility will be carried out over the course of two or more phases. The objective of Phase 1 is bounded to examine only the "Technical Feasibility" of subsurface intakes at or near the proposed site at Huntington Beach, California. For the Phase 1 Report, the working definition of "Technical Feasibility" was specified in the expert contract documents as: "Able to be built and operated using currently available methods". The specific question posed to the ISTAP in Phase 1 then is: ***Will any of the currently available subsurface intake designs be technically feasible at the proposed site at Huntington Beach?***

The ISTAP also determined that "Technical Feasibility" should be further defined by generally recognized factors as documented in the California Coastal Act of 1976. This Act provides the following definition:

> *"Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors. (Section 30108 of the California Public Resources Code)*

Of these four factors, the Phase 1 Assessment focuses primarily on technological factors. The ISTAP also concluded that the definition of "technical feasibility" should be informed by the recent State Water Resources Control Board Draft Desalination Policy published July 3, 2014. The Draft Policy specifies 14 factors, identified in the introduction to this report that should be considered to determine subsurface intake feasibility. The ISTAP has determined that the following six factors are technological in nature, namely, (1) geotechnical data for the site, (2) hydrogeology, (3) benthic topography, (4) oceanographic conditions, (5) impact on freshwater aquifers, and (6) other site and project-specific factors. These six factors thus comprise the "Technical Factors" considered in this Phase 1 assessment, consistent with interpretation of the California Coastal Act definition of "Feasible". Consideration of the other eight factors identified in the Draft Policy may be incorporated into Phase 2 of the overall Panel process to assess feasibility of those technologies deemed "Technically Feasible" in the Phase 1 assessment.

b. Approach

The ISTAP has relied upon both technical information provided by the Conveners as well as an extensive body of published data on all technical considerations for subsurface intake structures associated with desalination facilities worldwide using the SWRO technology. In addition, the ISTAP participated in a public meeting held in Huntington Beach, CA on 9-10 June, 2014, which included presentations by representatives of the conveners and comments from other interested parties. Materials presented at this public meeting are available on the CCC website. Subsequently, the ISTAP met in San Francisco on 28 and 29 July, 2014 to deliberate on the large amount of technical information. On September 22, the Coastal Commission released the Panel's Phase 1 Draft Report, and opened the opportunity for the public to provide comments. On 29 September, 2014, CONCUR convened a public meeting at the Huntington Beach Main Library. The purpose of the information-sharing meeting was for the Panel to present its findings and conclusions, offer clarifications where requested, and receive and consider public comments. Public comments received in writing and verbally as of 3 October, 2014 have been considered by the ISTAP. After consideration of these comments, the ISTAP has incorporated appropriate edits in this Final Report.

In preparing this Report, the first step undertaken by the ISTAP was to identify all possible subsurface intake options that have at least one application of the technology worldwide for the purposes of delivering water from a surface source regardless of economic considerations, or the other factors identified in the California Coastal Act definition of feasibility. These purposes could include not just intakes for desalination plants, but also any subsurface intake technology used to obtain fresh, brackish or saline water from a surface water body. The ISTAP considered that these technical options would be considered as "currently available methods".

The ISTAP then established a list of criteria and subfactors that address all of the technical factors noted above. Information was then developed, based on technical information available to the ISTAP or using professional judgment, to address all technical factors for each of the selected subsurface intake options. The matrix developed through this process then served as the foundation of the ISTAP's determination as to whether or not any of the options were feasible based on technological factors solely. In simple terms, this means that cost and other factors normally considered under the California Coastal Act definition of feasible were not addressed in Phase 1 of the assessment.

c. Site and Project Description

The proposed location of the desalination facility is a 12-acre site inshore of the Pacific Coast Highway, five to ten feet above mean sea level (MSL), adjacent to AES Huntington Beach generating station, approximately two miles south of the Huntington Beach (HB) Municipal Pier, and one mile north of the mouth of the Santa Anna River. The site has an existing 1,800-ft long seawater surface intake that is being used to bring cooling water into the power plant and a 1,500-ft outfall used to discharge the water back to the sea. The beach area that fronts the proposed site is designated for “Public” or “Semi-Public” use. The HB State and City Beaches see more than eight million beach goers annually. The proposed site is adjacent to the Huntington Beach Wetlands Conservancy. The closest ocean Marine Protected Areas (MPAs) to the proposed site are the inlet to the Bolsa Chica estuarine/wetlands complex about three miles north and Crystal Cove, eight miles south of the proposed desalination facility site.

The proposed project site is located on the southwest (SW) edge of the Orange County Water District, which pumps 70% of the water demand for 2.4-million people from 200 wells in Orange County. The proposed site overlies the western portion of the Talbert aquifer, which is a significant groundwater source for Orange County’s water needs. The Talbert aquifer is a confined aquifer that extends and outcrops on the seafloor. As the result of a reversed seaward gradient, seawater intrusion has occurred at the coast and threatens inland portions of the aquifer system. Orange County injects 30 MGD of treated wastewater into the aquifer system to replenish the basin and control seawater intrusion.

The proposed facility is in close proximity, about five miles, from the regional water delivery system, and Poseidon’s intent is to construct a pipeline to use this existing distribution system for acceptance of product water from the desalination facility. Several active faults run parallel to the shoreline, underlie the proposed site, and intersect the Talbert aquifer. These faults pose an earthquake risk that could cause liquefaction and settlement at the facility. The shore near the site is a high-energy zone, characterized by large swells and ocean currents. The nearshore seabed in front of the proposed site is subject to seasonal changes due to wave erosion and seasonal equilibrium changes. As a result, the inshore sediment cover is subject to large-scale seasonal bottom profile changes.

Although Poseidon has withdrawn their permit application at this time, the ISTAP has assumed that the initial permit application and subsequent response by the Coastal Commission staff (Staff Report on Poseidon Application, 10 October, 2013, E-06-007) defines the likely attributes of a future permit application pending the outcome of this assessment process. Thus, the ISTAP considered that each subsurface intake technology would need to be capable of withdrawing 100 to 127 million gallons per day (MGD), the hydraulic capacity needed to meet a production goal of 50 MGD using the SWRO desalination technology. The maximum capacity of 127 MGD was determined by Poseidon to meet concentrate water quality discharge standards in the receiving waters, using 27 MGD to dilute the concentrate from the desalination process with discharge of the diluted concentrate through a conventional outfall design. The lower hydraulic capacity of 100 MGD would still be sufficient to meet the production goal of 50 MGD of potable water. Under this scenario, concentrate disposal would be conducted through appropriately designed diffuser outfalls to meet the water quality discharge standards.

d. Findings

The ISTAP evaluated nine types of subsurface intakes for technical feasibility at the Huntington Beach site. These subsurface intake options included: (1) vertical wells completed in the shallow aquifer above the Talbert aquifer, (2) vertical deep wells completed within the Talbert aquifer, (3) vertical wells open to both the shallow and Talbert aquifers, (4) radial collector wells tapping the shallow aquifer, (5) slant wells tapping the Talbert aquifer, (6) seabed infiltration gallery (SIG), (7) beach gallery (surf zone infiltration gallery)[5], (8) horizontal directional drilled wells, and (9) a water tunnel. The evaluation of the technical feasibility of each of these options, based on analysis of numerous technical factors is presented in Table 5.1. A condensed version of this matrix is shown below in Table ES-1. This evaluation by the ISTAP was based on the hydrogeologic and oceanographic conditions specific to the proposed Huntington Beach AES site and proximate areas. The technical infeasibility of a particular intake technology at this location should not be generalized to feasibility considerations of any intake type in different settings or locations.

[5] The ISTAP uses the terms "surf zone gallery" and "beach gallery" interchangeably in this Report.

Table ES-1- Subsurface Intake Summary Matrix

	Subfactor	Vertical wells completed above confining unit	Vertical wells completed below confining unit	Vertical wells completed above and below confining unit	Radial collector in shallow aquifer	Slant Wells completed in Talbert aquifer	Engineered seafloor infiltration gallery	Surf zone infiltration gallery	HDD wells in shallow aquifer	Water tunnel
Hydrogeology										
	Impact on fresh water aquifers	Yes	Yes	Yes	No	Yes	No	No	No	No
Design Constraints										
	Performance risk - degree of uncertainty of outcome	Low	Low	Low	Medium	Medium	Medium	Medium	High	Unknown
Oceanographic										
	Sensitivity to sea level rise	High	High	High	High	Medium	Low	Low	Low	Low
Geochemistry										
	Risk of adverse fluid mixing	Low	High	High	Low	High	Low	Low	Unknown	Low
Precedent on large scale in similar geological conditions		Jeddah, Saudi Arabia; 5 MGD from 10 wells	No precedent	No precedent	Pemex system in Mexico, 3 collectors with total capacity of 12 Mgd	No precedent	Fukuoka, Japan. 27 MGD intake capacity	No precedent	Alicante, Spain; designed for 34 MGD, operating at 17 MGD	Alicante, Spain, 17 MGD
Key considerations / fatal flaw(s)		Performance risk: inadequate aquifer capacity and great drawdowns. Low yields would require extremely high number of wells, major water quality risk	Complications with seawater intrusion management and production from Orange Groundwater Basin	Complications with seawater intrusion management and production from Orange Groundwater Basin	High performance risk due to inappropriate geologic conditions	Complications with seawater intrusion management and production from Orange Groundwater Basin; geochemical impacts	Construction complexity	Construction complexity in high energy environment, potential restrictions on allowable construction times/beach closure, impacts of beach renourishment	Performance risk concerns over granular materials and maintenance of well performance	Complex construction involving ground freezing. High performance risk - no precedence for project scale. Cost likely prohibitive
Technically Feasible? Y or N		**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**N**	**N**

The ISTAP carefully evaluated fatal flaws of each subsurface intake type considered for application at Huntington Beach. Only the seabed infiltration gallery and the surf zone (beach) gallery survived the fatal flaw analysis, and both are deemed technically feasible. Both gallery types would face constructability challenges related to subsea construction. The surf zone gallery was judged to have particularly challenging construction issues (and thus a lesser degree of technical feasibility) related to construction in a high-energy environment. The ISTAP does not consider the existing scale of use of any particular subsurface intake compared to the capacity requirement at Huntington Beach to be a fatal flaw for technical feasibility (e.g., the only existing seabed infiltration gallery has a capacity of 27 MGD compared to the lower hydraulic capacity of 100 MGD required for the proposed Huntington Beach project, and no large scale implementation of a beach gallery has been constructed and operated as of September 2014).

The Panel interpreted its charge relative to the Terms of Reference to be the evaluation of the technical feasibility of subsurface intake technologies linked to the scale of a likely project proposal. Consistent with that approach, the Phase 1 Panel considered nine technologies keyed to a potential project with hydraulic capacity in the range 100 to 127 MGD. The Panel did address the broad issue of downward scalability where it saw relevance, but did not consider a full or parsed range of scale options for any of the nine technologies, as doing so would have exceeded the agreed-upon scope of work defined in the TOR. Scalability issues could be addressed in subsequent assessments of other feasibility factors at the discretion of the Conveners.

It is the collective opinion of the ISTAP that each of the other seven subsurface intake options for the target hydraulic capacity range (100-127 MGD) had at least one technical fatal flaw that eliminated it from further technical consideration. The shallow vertical wells would create unacceptable water level drawdowns landward of the shoreline and could impact wetlands and cause movement of potential contaminants seaward. The deep vertical wells would have a significant impact on the Talbert aquifer that would interfere with the management of the salinity barrier and the management of the interior freshwater basin. The combined shallow and deep-water wells would adversely impact both the shallow aquifer and Talbert aquifer, and in addition, would produce waters with differing inorganic chemistry, which would adversely affect SWRO plant operation. Radial collector wells constructed into the shallow aquifer would have to be located very close to the surf zone which would make them susceptible to damage during storms and would be impacted by the projected sea level rise. Slant wells tapping the Talbert aquifer would interfere with the management of the salinity barrier and the management of the freshwater basin, and further, would likely have geochemical issues with the water produced from the aquifer (e.g., oxidation states of mixing waters). A water tunnel constructed in the unlithified sediment at Huntington Beach would have overwhelming constructability issues.

e. Recommendations

The ISTAP recommends that consideration be given solely to seabed infiltration galleries (SIG) and beach gallery intake systems in the Phase 2 assessment. As noted, the ISTAP was not asked to evaluate the economic considerations of using a subsurface intake versus a conventional open-ocean intake during Phase 1 of the assessment. The ISTAP recommends that in the next phase, the Panel should focus primarily on the constructability of the seabed infiltration and beach gallery intake systems, because this greatly affects the economic viability of their potential use. Other factors should be considered consistent with the definition of "feasibility" in the California Coastal Act.

However, the ISTAP recommends that in the Phase 2 evaluation of the subsurface intake options, a detailed lifecycle cost analysis should be provided to the succeeding committee. This lifecycle cost analysis should contain at least four scenarios, including:

1) the lifecycle cost over an appropriate operating period obtaining the feed water from a conventional open-ocean intake without considering the cost of potential environmental impact of impingement and entrainment,

2) the lifecycle cost over an appropriate operating period obtaining feed water from a conventional open-ocean intake considering the cost of potential environmental impact of impingement and entrainment,
3) the lifecycle cost over an appropriate operating period obtaining the feed water from a seabed gallery intake system (or beach gallery intake system) using the same pretreatment design as used in treating open-ocean seawater, and
4) the lifecycle cost over an appropriate operating period obtaining the feed water from a seabed gallery intake system (or beach gallery intake system) using a reduced degree of pretreatment, such as mixed media filtration and entry into the cartridge filters.

In each of these scenarios, the ISTAP recommends that the selected design hydraulic capacity match both the minimum and maximum flow rates consistent with the desired production rate of a 50 MGD desalination facility using the SWRO technology. The definition of an “appropriate” operating period should follow accepted industry standards for such lifecycle cost analyses. Typically, a period of 30 years is used, but given concerns on the potential for sea level rise impacts, analysis over a longer operating period (e.g. 50 years) may be desirable. In addition, the ISTAP questions the need for the use of seawater to dilute the concentrate discharge given the well-known use of diffuser outfalls to meet ocean discharge requirements.

The ISTAP also recommends that the Phase 2 Panel continue to rely on the definition of “Technical Feasibility” as defined by generally recognized factors as documented in the California Coastal Act of 1976 *(Section 30108 of the California Public Resources Code)*

Chapter I. INTRODUCTION

Poseidon Resources (Surfside) LLC (Poseidon) has proposed construction of a seawater desalination facility using the Sea Water Reverse Osmosis (SWRO) technology in Huntington Beach, California. The California Coastal Commission (CCC or the Commission) acting under the California Coastal Act is responsible for review and approval of the permit application for such facilities. Poseidon's permit application proposed the use of an existing open ocean intake for supply of feed seawater to the facility. However, it has been reported that open ocean intakes can cause unacceptable levels of impingement and entrainment of marine life and have the potential for degrading the local or regional marine ecosystem(s). Because of these concerns, the CCC recommended that Poseidon work with CCC staff to conduct an independent assessment of the feasibility of using subsurface intake technology, with the intention of reducing ecological impacts while still providing a sufficient volume of feed water to the proposed facility.

As a result of this request, Poseidon has temporarily withdrawn the permit application and, with the assistance of CONCUR, has worked with the CCC to form the ISTAP for the express purpose of preparing a concise summary of the technical feasibility of using one or more potential subsurface intake systems for supplying feed water to the proposed Huntington Beach seawater desalination facility (See the convener's preface for the background in establishing the ISTAP process). The specific question to be answered by the ISTAP is: ***Will any of the several potential subsurface intake designs be technically feasible at the proposed site at Huntington Beach?***

CONCUR, CCC, and Poseidon have provided the ISTAP with a wide range of technical information regarding the proposed desalination facility, including specific information on the characterization of the geophysical, hydrological, and geochemical features of the proposed site. However, the aim of CCC and Poseidon has been to conduct an independent scientific fact - finding and review process where the findings and conclusions of the assessment are completed without intervention from CONCUR, CCC or Poseidon. In addition, the ISTAP has not relied solely on the information provided by CONCUR, CCC or Poseidon but has conducted its own search for published literature, relevant case study reports, and available on-site studies of similar or comparable SWRO desalination facilities around the world. For a listing of the documents reviewed by the ISTAP please see Chapter VII of this report – Reports on Subsurface Intakes.

The following brief summary of the proposed project and a site description was developed from information provided to the Panel.

1.1 General

The selected location of the proposed desalination facility is a 12-acre site inshore of the Pacific Coast Highway, five to ten feet above MSL, adjacent to AES Huntington Beach generating station, approximately two miles south of the Huntington Beach Municipal Pier, and one mile north of the mouth of the Santa Anna River. The site has an existing 1,800-ft long seawater intake previously used to bring cooling water into the power plant and 1,500-ft outfall used to return the water. The beach area that fronts the proposed site is designated for "Public" or "Semi-Public" use. The Huntington Beach State and City Beaches see more than eight million beach goers annually.

1.2 Environmental

The proposed site is adjacent to Huntington Beach Wetlands Conservancy. The closest ocean Marine Protected Areas (MPAs) to the proposed site are the inlet to the Bolsa Chica estuarine/wetlands complex about three miles north and Crystal Cove, eight miles south of the proposed desalination facility site.

1.3 Economical

The proposed facility is about five miles from the regional potable water delivery system operated by the Municipal Water District of Orange County and other water utilities, and the intent is for Poseidon to construct a pipeline to this existing distribution system for distribution of the output of the facility.

1.4 Hydrological

The proposed project site is located on the SW edge of the Municipal Water District of Orange County, which pumps 70% of the water demand for 2.4-million people from 200 wells in Orange County. The proposed site overlies the western portion of the Talbert aquifer, which is a significant water supply source for Orange County's water needs. The Talbert aquifer is a confined aquifer that extends and outcrops on the seafloor. As the result of a reversed seaward gradient, seawater intrusion has occurred at the coast and threatens inland portions of the aquifer system. Orange County injects 30 MGD of highly treated reclaimed wastewater into the aquifer system to replenish the basin and control seawater intrusion.

1.5 Seismic activity

Several active faults run parallel to the shoreline, underlie the proposed site, and intersect the Talbert aquifer. These faults pose a risk of liquefaction and settlement at the facility.

1.6 Oceanographic setting

The nearshore area of the site is a high-energy zone, characterized by large swells and ocean currents. In the neighborhood of the Huntington Beach, average incident wave heights of between 0.9 m and 1.2 m prevail 87% of the time during a typical year in an El Niño-dominated climate period. This wave height range occurs primarily during the spring, summer and fall seasonal periods. During the remaining 13% of the time (primarily during winter months), average incident wave heights near the Huntington Beach increase to 2.4 m to 2.7 m, with some waves reaching significant heights as large as 4 m to 6 m.

The nearshore seabed in front of the proposed site is subject to seasonal changes due to wave erosion and seasonal equilibrium changes. As a result, the inshore sediment cover is subject to large-scale seasonal bottom profile changes.

1.7 Constructability

The high-energy surf zone environment off Huntington Beach prevents the use of conventional floating construction equipment and necessitates the use of access trestles or elevated bridging structures built out from shore to allow construction cranes and personnel to safely travel and work above the waves. This method of construction is extremely slow and expensive.

To provide clarity of purpose in preparing this concise short report, the definition of "feasible" has been taken from **California Coastal Act of 1976 Definitions § 30108.**

FEASIBLE

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

The State Water Resources Control Board Draft Desalination Policy published July 3rd 2014 states the following factors should be considered to determine subsurface intake feasibility:

1. Geotechnical data
2. Hydrogeology
3. Benthic topography
4. Oceanographic conditions
5. Presence of sensitive habitats
6. Energy use
7. Impact on freshwater aquifers
8. Local water supply and existing users
9. Desalinated water conveyance
10. Existing infrastructure
11. Co-location with sources of dilution water
12. Design constraints (engineering, constructability)
13. Project lifecycle costs
14. Other site- and factory-specific factors

This independent review is structured in two Phases. The objective in Phase 1 is to examine the "Technical Feasibility" of subsurface intakes at or near the proposed Huntington Beach site. For the Phase 1 report, the TOR's working definition of "Technical Feasibility" is:

“Able to be built and operated using currently available methods”. For this Phase 1 report, ISTAP has considered six of the above listed criteria: 1, 2, 3, 4, 7, and 12 as relevant to technical considerations for a feasibility assessment. The Phase 2 ISTAP Report may consider, among other issues, the remaining criteria: 5, 6, 8, 9, 10, 11, 13 and 14.

Chapter II. APPROACH

2.1 Introduction

The ISTAP conducted this analysis of the technical feasibility of subsurface intake options under the guidance of the Coastal Commission staff and the Project Advocate, Poseidon, who established the Terms of Reference (TOR) for Panel members that describes in general terms the procedures to be followed by the ISTAP members. The main deliverable from the ISTAP is this Phase 1 Report (Report) detailing the deliberations, findings and conclusions of the ISTAP. A public meeting was held in Huntington Beach on 9-10 June 2014, and documentation on the meeting agenda and presentations are available online (http://ftp.coastal.ca.gov[6]). Subsequently, the ISTAP met in San Francisco on 28-29 July, 2014 to deliberate on the large amount of technical information provided both at the public meeting as well as information made available via the Coastal Commission website. On September 22, the Coastal Commission released the Panel's Phase 1 Draft Report, and opened the opportunity for the public to provide comments. On 29 September 29, 2014, the CONCUR convened a public meeting at the Huntington Beach Main Library. The purpose of the information-sharing meeting was for the Panel to present its findings and conclusions, offer clarifications where requested, and receive and consider public comments. Public comments received in writing and verbally as of 3 October, 2014 have been considered by the ISTAP. After consideration of these comments, the ISTAP has incorporated appropriate edits in this Final Report.

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[6] To access the ISTAP meeting information, go to http://ftp.coastal.ca.gov, then go to General Public folder, enter user name: public, password: ocean03. Then select the Expert Panel Public Review folder.

This section of the report provides a brief summary of the approach used by the ISTAP to address the principal question addressed to the ISTAP, namely, is there a “technically feasible” subsurface intake option that “is able to be built and operated using currently available methods?”

The ISTAP relied upon the definition of “technically feasible” established under the California Coastal Act in 1976 in considering the feasibility of subsurface intake options. This definition defines four factors to be considered in determining the feasibility of a project. The ISTAP agreed that in Phase 1 of the study, the exclusive focus would be on the “technological” factors, with a possible Phase 2 study to address issues associated with the other three factors. Thus, the ISTAP considered all possible subsurface intake options that have at least one application of the technology worldwide for the purposes of delivering water from a surface source regardless of economic considerations, or the other factors identified under the California Coastal Act definition. These purposes could include not just intakes for desalination plants, but also any subsurface intake technology used to obtain fresh, brackish or saline water from a surface water body. The ISTAP considered that these technical options would be considered as “currently available methods”.

With this definition agreed to by all ISTAP members, a wide range of technologies were considered as potentially technically feasible options for the Huntington Beach Desalination Project (Project). One initial challenge in this approach was the specification of the Project design attributes, particularly the desired maximum hydraulic capacity of the proposed Project needed to meet the proposed goal of producing 50 MGD of potable water.

Although Poseidon has withdrawn their permit application at this time, the ISTAP has assumed that the initial permit application and subsequent response by the Coastal Commission staff (Staff Report on Poseidon Application, 10 October, 2013, E-06-007) defines the likely attributes of a future permit application pending the outcome of this Panel Process. The ISTAP considered subsurface intake technologies that would be capable of producing 100 to 127 million gallons per day (MGD), the hydraulic capacity needed to meet a production goal of 50 MGD using the SWRO desalination technology. The maximum capacity of 127 MGD was determined by Poseidon to meet water quality discharge standards, using 27 MGD to dilute the concentrate from the SWRO desalination process. The lower capacity of 100 MGD would be sufficient to meet the desired hydraulic performance of the proposed Project.

2.2 Potential technologies that meet hydraulic capacity goals

During the San Francisco meeting, the ISTAP conducted a screening analysis to determine the technical feasibility of a wide range of subsurface intake technologies. In addition to the technologies discussed during the Public Meeting in June, the ISTAP also considered other options known to the Panel members based on experience and knowledge of the literature on subsurface intake structures, some of which was written by Panel members. The nine options considered by the ISTAP in the screening analysis are listed below:

1) Vertical wells completed in the shallow aquifer above the Talbert aquifer upper confining unit
2) Vertical wells completed in the Talbert aquifer (below confining unit)
3) Vertical wells completed above and below confining unit
4) Radial (Ranney) collector wells in the shallow aquifer
5) Slant wells completed in the Talbert aquifer
6) Engineered seafloor infiltration gallery
7) Surf zone (beach) infiltration galleries
8) Horizontal directional-drilled (HDD) wells underneath the sea floor.
9) Water tunnels.

The ISTAP then established the factors to be used in the screening analysis. As discussed, the primary technical factors, derived in part from the State Water Resources Control Board Draft 2014 Desalination policy included the following:

- Hydrogeology

- Design constraints
- Oceanographic conditions (including benthic features)
- Geochemistry.

In addition, the ISTAP considered two precedence questions, namely, (a) has the technology been successfully implemented in geologic conditions similar to those expected to be encountered at the Huntington Beach site and (b) has the technology been successfully implemented at a large scale in similar geologic conditions? The ISTAP considers “large scale” to be greater than 10 MGD.

For each of these general factors, the ISTAP considered a series of qualitative and quantitative subfactors that characterize the technical features of each of the screened technologies, including whether or not a technology suffered from a “fatal” flaw that would eliminate that option from further consideration. Details of these subfactors, their relevance to the decision on technical feasibility, and what constitutes a “fatal” flaw are presented later in this Report. Following a thorough screening-level consideration of all the subfactors, as applied to each of the nine technologies considered, the ISTAP then deliberated as to whether or not a technology was: (a) technically feasible or (b) not technically feasible. It should be stressed again that cost was not a factor in screening the nine technologies. Furthermore, the evaluation performed was based on the hydrogeologic and oceanographic conditions specific to the Huntington Beach AES site and proximate areas. The infeasibility of a particular intake type at this location should not be construed as indicating the ISTAP’s conclusion that this intake type is not feasible in a different setting or location.

Chapter III. Subsurface Intake Options Considered

3.1 Introduction

Subsurface intake systems have been successfully used at numerous global locations to provide feed water to SWRO water treatment facilities (Missimer, 2009; Missimer et al., 2013). The predominant type of subsurface intake used is vertical wells, but they are most commonly used to supply small (<10,000 m3/d; <2.6 MGD) to medium (10,000-50,000 m3/d; 2.6-13.2 MGD) capacity SWRO plants. Gallery systems are a relatively new class of subsurface intake systems. Beach galleries (referred to herein as either "beach galleries" or "surf zone galleries") were introduced by Missimer and Horvath (1991), Missimer (2009), and Maliva and Missimer (2010). These intakes use a gallery system underlying the intertidal surf zone (Maliva and Missimer, 2010). Seabed galleries are constructed offshore in the seabed and act similar to a slow sand filter (Crittenden et al, 2005; Missimer, 2009).

Additional innovations in SWRO systems are being developed in different parts of the world. A tunnel intake system was designed and constructed at Alicante, Spain (Rachman et al., 2014). This system produces water from a horizontal tunnel that contains lateral screens, similar in concept to a Ranney well. Other systems, such as landward excavations filled with rock and artificial marine filter structures, are also being developed.

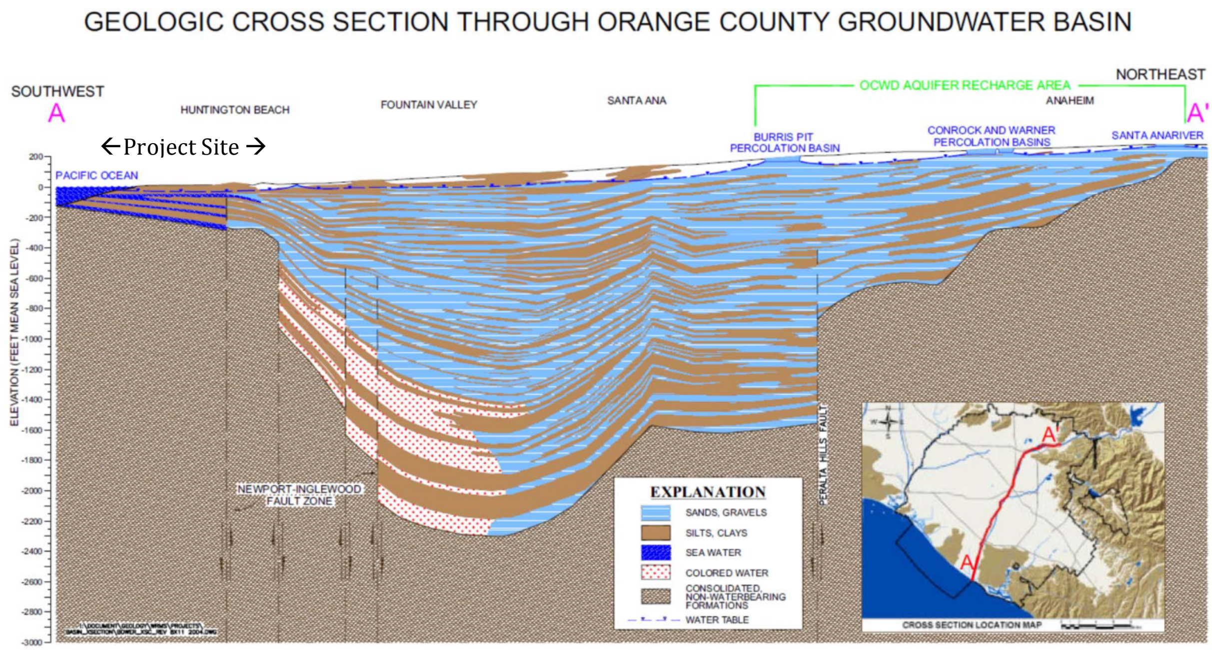
There are several reasons why subsurface intake systems are used instead of open-ocean intake types. The primary benefits of subsurface intakes are reductions of possible environmental impacts associated with impingement and entrainment, chemical usage required for pretreatment prior to the RO system, the complexity of in-plant pretreatment processes, and overall SWRO costs, particularly operational costs (Wright and Missimer, 1997; Missimer et al., 2010; Missimer et al., 2013). Additionally, several provisions of California state policies require that entrainment effects be minimized to the extent feasible, which generally requires that subsurface intake methods be assessed as part of environmental and permit review of proposed desalination projects.

The key challenge in the design of subsurface intakes for SWRO facilities is that the technical feasibility of using a given type is site-specific, based on local hydrogeologic and oceanographic conditions. There are limits on the yield of various modular units, such as a single well or a single gallery cell.

3.2 Hydrogeology of the Huntington Beach area

The project area lies on the coastal edge of the Orange County Groundwater Basin. The hydrogeologic setting has been discussed in detail in several of the references cited (Herndon and Bonsangue, 2006, and others) and will not be repeated in this document. Briefly, the nearshore area of Huntington Beach is underlain by a sequence of Holocene and Pleistocene sediments to a depth of approximately 200 feet. These materials mostly constitute the coastal extension of the Talbert aquifer. The thickness of the aquifer decreases seawards as a result of uplift along the Newport-Inglewood Fault. Non-water-bearing consolidated materials have been uplifted on the south side of the fault, reducing the aquifer thickness. In addition to reducing overall aquifer thickness at the coast, movement along the fault has elevated non-water-bearing materials[7] above current sea level, creating natural barriers to groundwater flow. The so-called “Talbert Gap”, located just inland from Huntington Beach, is a subsurface erosional feature in this uplifted block that connects the coastal portion of the basin with the inland portion. A diagrammatical explanation of the Basin is presented below.

[7] Non-water-bearing materials are typically fine-grained sediments or consolidated rocks that do not transmit water easily.



From the Orange County Water District Groundwater Master Plan (OCWD, 2004) and Edwards et al., (2009)

Figure 3.1. Hydrogeologic section from the Pacific Ocean through the Talbert Gap into the basin (from the Orange County Water Groundwater Master Plan and Edwards et al., 2009)

The Talbert aquifer has been impacted by seawater intrusion. Inland extractions have lowered water levels significantly below sea level and reversed the seaward gradient such that seawater now moves inland toward and through the Talbert Gap and threatens the water quality in the thicker portion of the groundwater basin north of the Newport-Inglewood Fault. Local water management agencies have instituted management efforts to control seawater intrusion into the inland portion of the basin by raising groundwater levels within the Talbert Gap with injection wells.

Based on exploratory work performed by Psomas (2011), GeoSyntec (2013) and others, the localized generalized sequence of sediments in the project area consists of shallow silty-sand deposits to a depth of approximately 70 feet where a 10- to 20-foot thick finer-grained layer is encountered. This finer-grained layer constitutes the aquitard that overlies the sand, gravel and clay deposits that comprise the Talbert aquifer. The base of the Talbert aquifer is at a depth of approximately 200 feet. Groundwater occurs under unconfined conditions in the geologic materials above the aquitard, and confined conditions in materials below the aquitard.

3.3 Well intake systems

3.3.1 Introduction

Globally, the highest capacity subsurface intakes using wells for a SWRO facility are located at Sur, Oman (42.2 MDG), Tordera at Blanes, Spain (33.8 MGD), Pembroke, Malta (31.7 MGD), and Bajo Almanzora, Mallorca, Spain (31.7 MGD) (David et al., 2009; Missimer et al., 2013). Very large capacity Ranney well systems are used in the United States as intakes of freshwater along rivers (Missimer, 2009). All of these seawater facilities use conventional vertical wells that are constructed in high permeability limestone aquifers. These geologic settings in consolidated strata contrast with the unconsolidated materials at the proposed project site in Huntington Beach. The largest capacity vertical well intake systems that produce from unlithified, siliciclastic aquifers are located in Saudi Arabia along the coast of the Red Sea (Al-Mashharawi et al., 2014). A large number of smaller capacity systems have been documented globally (Schwartz, 2000, 2003; Voutchkov, 2005; Bartek et al., 2012). These facilities have a maximum capacity of up to about 15 MGD (Al-Mashharawi et al., 2014; Dehwah et al., 2014).

3.3.2 Vertical wells completed above upper confining unit

Although not specifically presented as a potential source for this project, this possibility is included because this source has precedent in California. The wells would be less than 100 feet in depth and would be designed to produce from shallow sediments above the aquitard and in direct hydraulic continuity with the ocean.

Shallow wells producing from beach deposits have been used to supply feedwater for small desalination facilities worldwide. Wells producing from beach deposits typically provide high-quality water with SDI[8] values less than 2. In California, Marina Coast Water District operated a beach well to supply their desalination facility in the 1990's. This well was approximately 60 feet deep, produced from medium-grained sand, and had a production rate of approximately 400 gpm (Fugro 1995). The currently operating desalination facility in Sand City, California uses shallow (approximately 60 feet in depth) beach wells to provide feed water for the small (~ 0.3 MGD) facility. The beach sands at Sand City are finer grained than Marina.

The ultimate yield of any well source would be dependent on the number of wells; the number of wells is a function of the location of the wells, the spacing of the wells and the materials from which they produce. In general, water produced from beach wells would be derived from both inland and offshore sources - the ratio between these sources again being a function of the location and the hydrogeologic setting.

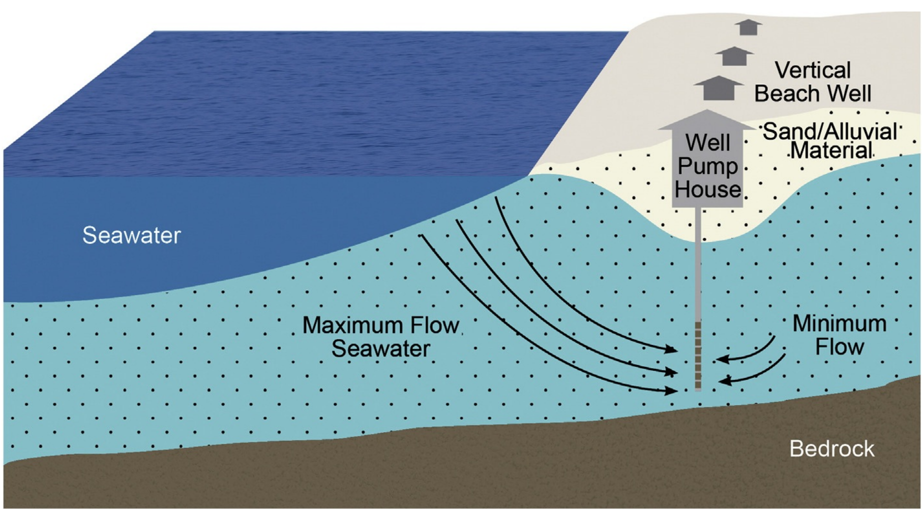


Figure 3.2. Conceptual diagram of the beach well (from Missimer et al., 2013).

3.3.3 Vertical wells completed below confining unit

Deep vertical wells completed in the Talbert aquifer was formally discussed and evaluated by Poseidon (Psomas 2011, Geosyntec, 2013). These wells would be perforated below

[8] SDI is an abbreviation for Silt Density Index. This is a parameter used by membrane manufacturers and consultants to determine the potential for membrane fouling. It is commonly used in SWRO plant design, especially for pretreatment systems.

the regional aquitard. The source of the produced water would be a blend of native ground water, induced vertical leakage from the ocean, and horizontal flow from the outcrop of the sediments that comprise the Talbert aquifer on the seafloor. The blend would be a function of the distance to the subsea outcrop and the vertical leakage through the aquitard.

The yield per well would be a function of aquifer transmissivity and well spacing (which controls interference between wells). The per-well yield advanced by Poseidon is 1.2 MGD per well, an estimate that appears reasonable for the materials. The per-well yield is less sensitive to setback from the ocean than shallow wells – however, water quality in the blend would have some sensitivity to the distance from the ocean. Extractions from the confined Talbert aquifer would have on-land drawdown impacts. These drawdown impacts would complicate seawater intrusion management efforts and could have undesirable impacts on coastal wetlands (Geosyntec, 2013).

3.3.4 Vertical wells completed above and below confining unit

Another subsurface option would be a supply developed utilizing vertical wells that produce from both the shallow and the Talbert aquifers. No data was provided by Poseidon on this option. This could be in the form of individual wells that are perforated in, and produce from, both aquifer systems or co-located well couplets of two wells, one producing from the shallow the other from the deeper aquifer. This later concept would avoid the complications of interconnection of the aquifer systems and would allow capitalization on the infrastructural investment (power, access road, piping, etc.) in each well location.

Individual dual-perforated well or well couplet yields, depending on the actual materials, could be approximately that of the summation of the two estimated yields, or approximately 2 MGD per installation. However, whereas the multi-aquifer wells or well couplets could increase per-installation yields, the on-land drawdown impacts associated with extractions from the Talbert aquifer would be unmitigated.

3.3.5 Radial collector in shallow aquifer

A collector well consists of a large diameter (typically 18 feet) caisson from which lateral perforated spokes are advanced out from the caisson toward or under a proximate water body (Figure 3.3). Collector wells have been used for the development of drinking water sources from rivers in the United States for over 80 years. Typical installation involves advancement of 200- to 300-foot-long laterals into the coarse gravels underlying riverbeds. In these geologic settings, discharge rates of 10 to 15 MGD per collector well can be achieved. Collector wells have also been used for production of seawater. However, the experience using them is more limited, and because materials are finer-grained, per-well yields are significantly lower.

The construction of a collector well has an advantage over conventional vertical wells in that the location of the structure that contains pumping equipment is offset from the location of the source of water by the length of the lateral. The yields are significantly higher than conventional wells because the effective radius of the well can be measured in tens of feet rather than in inches.

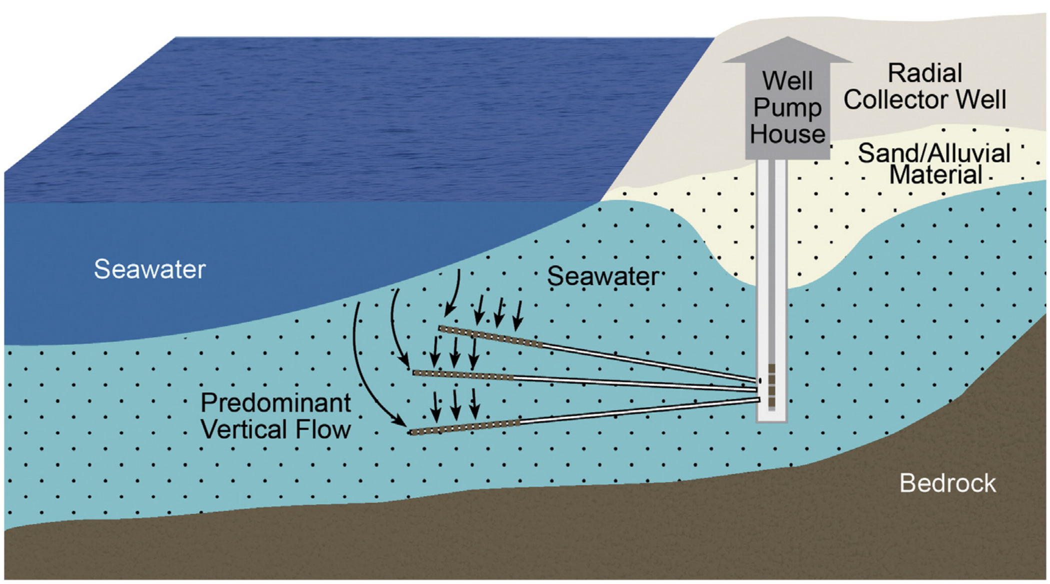


Figure 3.3. Conceptual diagram of the collector well (from Missimer et al., 2013).

For the subject project, collector well yields of 5 MGD have been suggested by Poseidon. Given the materials described and the hydrogeologic setting, this estimate appears reasonable.

Based on the information provided by Poseidon, it appears that this estimate was based on collector wells that would produce from the Talbert aquifer. A more appropriate target aquifer for this technology might be the shallow aquifer - that is, the materials above the confining layer. However, given the finer-grained materials and reduced available drawdown in the shallow aquifer, yields from collector wells would likely be lower**.**

The largest capacity SWRO intake system is located at the PEMEX Salina Cruz Refinery, Mexico with three wells of 4 MGD each, yielding a total capacity of about 12 MGD (Voutchkov, 2005). This is consistent with the assessment and design work performed by Staal, Gardner and Dunne/Ranney Corporation (Staal, Gardner and Dunne, 1992) in Marina, California that suggested a per-well yield of 4 MGD for collectors producing from the shallow beach sands.

3.3.6 Slant wells completed in shallow aquifer

Advancing drilling technology has allowed the construction of conventional wells at an angle (Figure 3.4). Although it is believed that angles as small as 10 degrees from horizontal can be achieved, the sole successful well was drilled at an angle of 22 degrees in Dana Point, California (USBR, 2009, GeoScience, 2012). The ability to construct wells at an angle allows the perforated portion of the well to be placed closer or under an adjacent water body to more effectively induce vertical flow through the overlying beach sands from this water body into the well. The amount of flow derived directly from the overlying water body is a function of the depth of cover and the vertical hydraulic conductivity of the overlying materials.

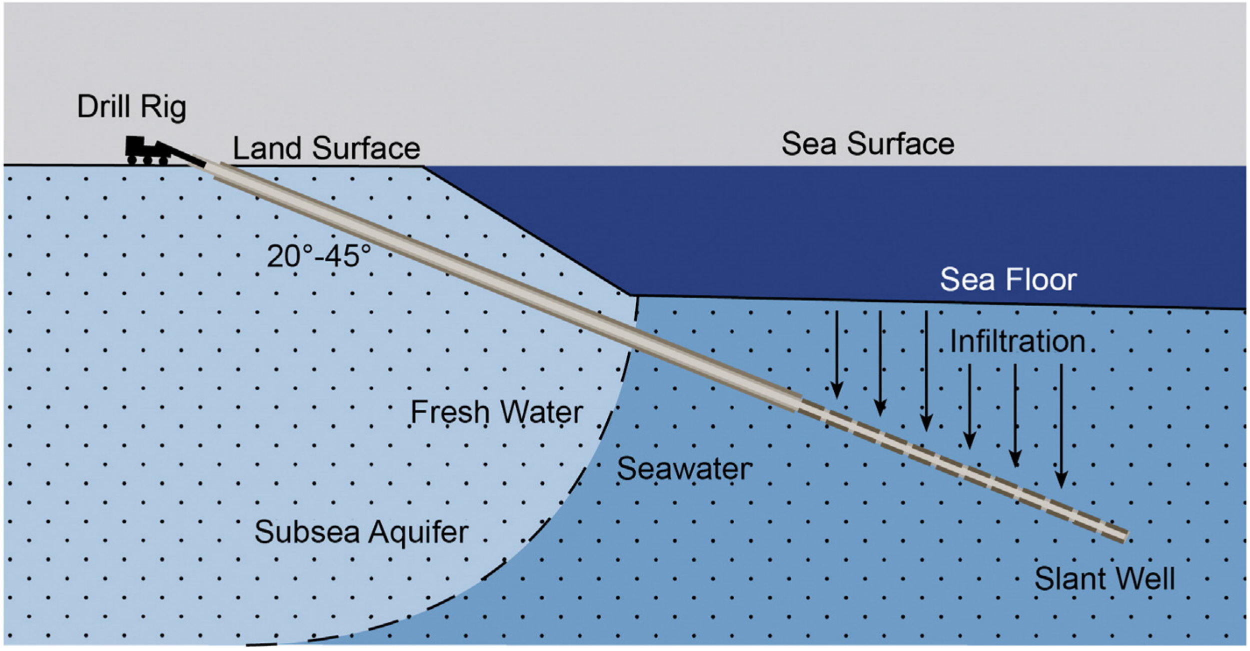


Figure 3.4. Conceptual diagram of the slant well (from Missimer et al., 2013).

Analysis presented by Poseidon suggested that to produce the required 127 MGD, as many as twelve three-well pods producing 12.9 MGD each would be required at a spacing of 600 feet. A separate analysis of the feasibility of the slant wells was performed by Geosyntec (2013). This analysis estimated that each well could produce 2200 gpm, 40 wells would be needed, and three miles of beachfront would be required to produce the required 127 MGD.

Only one slant well has been successfully constructed to date, although a major installation to provide 20 MGD of feedwater capacity is under consideration in the Monterey Bay area. The successfully completed well is at Dana Point. When it was built and tested in 2006, it was test pumped at 2000 gpm and displayed a well efficiency of 95%. Recent longer term testing of the completed test well in 2012 documents the reduction in well efficiency from the original value of 95% in 2006 to 52% in 2012 (GeoScience 2012). Given this observed reduction in efficiency over a short period, the long-term performance of the technology has yet to be confirmed.

Assuming the slant wells would be constructed at a 22-degree angle, and are located 100 feet inland from the shoreline, the end of the perforated portion of the slant well will be at least 150 feet below the seafloor. As considered, extractions will be from the Talbert aquifer system with previously noted inland drawdown impacts.

3.3.7 Horizontal directionally drilled (HDD) wells underneath the sea floor

HDD wells are directionally drilled borings that would be drilled from a common location on the shoreline (Figure 3.5). The boreholes would fan out at a shallow distance under the seafloor and then exit the seafloor at a distance offshore where a permeable flexible casing would be pulled back from the ocean location into the borehole. Feedwater would be derived from the ocean through vertical infiltration through the seafloor. The productivity of the wells is the function of the permeability of the overlying sediments comprising the seafloor. This approach has been used with some success in the desalination facility in Alicante, Spain. This HDD array was originally sized for 45 MGD. However, actual performance has been lower and water quality problems have occurred (Rachman et al., 2014).

Figure 3.5. Conceptual diagram of the HDD wells at Huntington Beach (from Neodren, 2014).

Preliminary analysis by of the project in Alicante, Spain for Poseidon suggests that the required 127 MGD of feedwater could be provided by 60 wells in two fans of 30 wells. However, after receipt of the recent hydraulic conductivity values from the vibracore samples, this estimate (provided by Poseidon) was reported to range between 84 and 231 wells contained in three to eight fans.

3.4 Gallery intake systems

3.4.1 Introduction

Gallery intake systems are designed based on the concept of slow sand filtration. However, there are differences in how the gallery intake systems function within the seawater environment. In freshwater sources, such as a river, a surface film forms on slow sand filters, called the "schmutzdecke" (i.e., dirty layer in German), which is biologically active and is a key part of the treatment process (Huisman and Wood, 1974; Crittenden et al., 2005; Hendricks, 2001, 2011). Slow sand filters have a long history of successful operation for treatment of water for potable purposes worldwide, beginning in the early 1900s. As a result of the bio-active layer formation, most of the reduction of water constituents that require removal prior to RO treatment occurs within the upper few inches of the filter surface. In seawater gallery systems, this upper layer does not form, and therefore, the treatment occurs throughout the uppermost two to six feet of the gallery (unpublished research conducted at the King Abdullah University of Science and Technology, Saudi Arabia [2014]).

3.4.2 Surf zone infiltration galleries

Beach (surf zone) gallery intake systems are a type of slow sand filter constructed beneath the intertidal zone of the beach (Figure 3.6). The gallery is constructed with a series of sand layers, fine at the top with a progressive increase in grain size with depth. The top layer is constructed with the native sand on the beach so that it is compatible with it. The lowest layer is gravel and is used as a support and water collection layer. Seawater is pumped from the bottom layer using a header pipe and a series of screens, similar in concept to a seabed infiltration gallery system (SIG). While slow sand filters rely upon gravity to operate, a beach gallery is pumped to create suction head and pull the water through the filter. This pumping allows (a) adjustments to be made to the infiltration rate, or (b) increases or decreases in suction pressure to be made, to make the inflow rate constant.

A key aspect of a beach gallery system is that it underlies the surf zone of the beach, fully or in part. This means that the active infiltration face of the filter is continuously cleaned by the mechanical energy of the breaking waves and is therefore self-cleaning (Maliva and Missimer, 2010). Also, the location within the intertidal zone allows the gallery to be continuously recharged with no impact on the inland shallow aquifer system.

The vertical flow of water from the sea assures that the inorganic chemistry is not significantly altered over time. The water quality should remain relatively constant based on the hydrology of the Huntington Beach area. The gallery system is unaffected by variations in the deeper groundwater, which could be fresh or brackish in nature at the shoreline. The uppermost natural sand layer is the primary treatment zone within the filter and will likely allow the removal of all algae and a high percentage of bacteria and naturally occurring organic compounds (e.g., natural organic matter). The long-term data collected at the seabed gallery in Japan shows that the SDI was reduced below two, which is at the approximate level produced by conventional SWRO pretreatment systems (Shimokawa, 2012).

The beach gallery would reduce or eliminate the impingement and entrainment of marine fauna. Also, upon completion of construction, the gallery would be located below the surface and could not be observed by beach users.

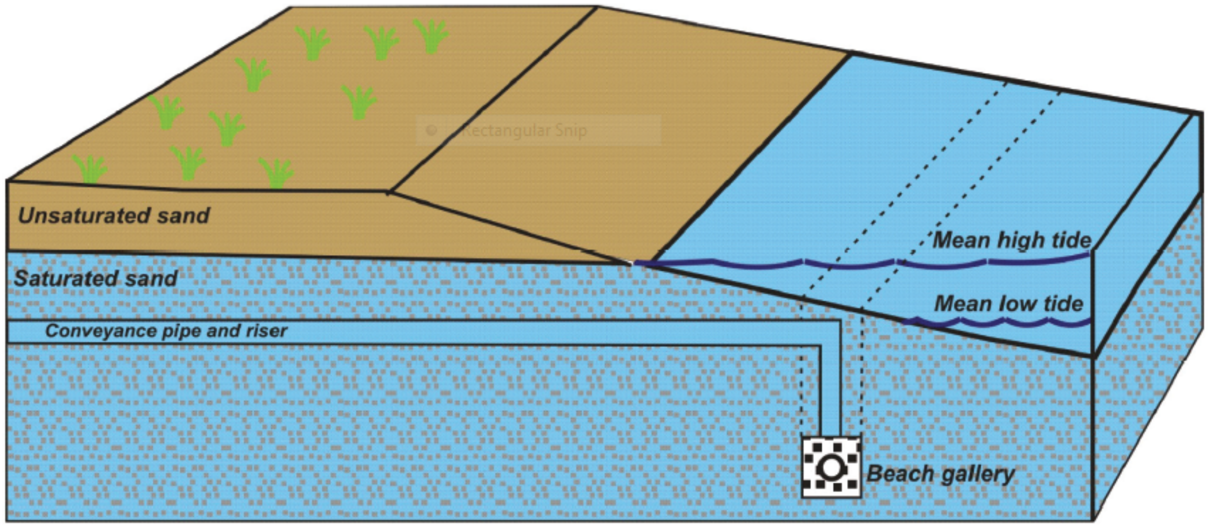


Figure 3.6. Conceptual diagram of the beach gallery (from Maliva and Missimer, 2010).

3.4.3 Engineered seafloor infiltration galleries (SIGs)

A seabed (or seafloor) gallery or seabed infiltration gallery (SIG) is constructed offshore in a stable location. It is another engineered and constructed filter. It uses the concept of slow sand filtration, and the uppermost layer is the part of the filter that contributes most to treatment of the infiltrating water.

The largest SIG system in operation worldwide is the Fukuoka in Japan with a capacity of about 27.2 MGD (Figure 3.7; Hamano et al., 2006; Shimokawa, 2012). A significant SIG test facility has been constructed at the City of Long Beach, California (Wang et al., 2007; Wang et al., 2009).

There are a number of different configurations that can be used in the design of a SIG with implications for system reliability. The Fukuoka SIG has one collection pipe leading from the pumping station on the coast to the offshore SIG. It is a single cell design with no backup pump or means of conducting maintenance during operation. The operation of the Fukuoka SIG has been very successful over the last eight years with no maintenance of the gallery surface and production of seawater with a very low silt-density index (Shimokawa, 2012; Sesler and Missimer, 2012), resulting in very infrequent cleaning of the membranes. The site is located in sheltered water with lower wave heights and currents compared to the open-coast of Huntington Beach. The plant site is subject to intense storm activity.

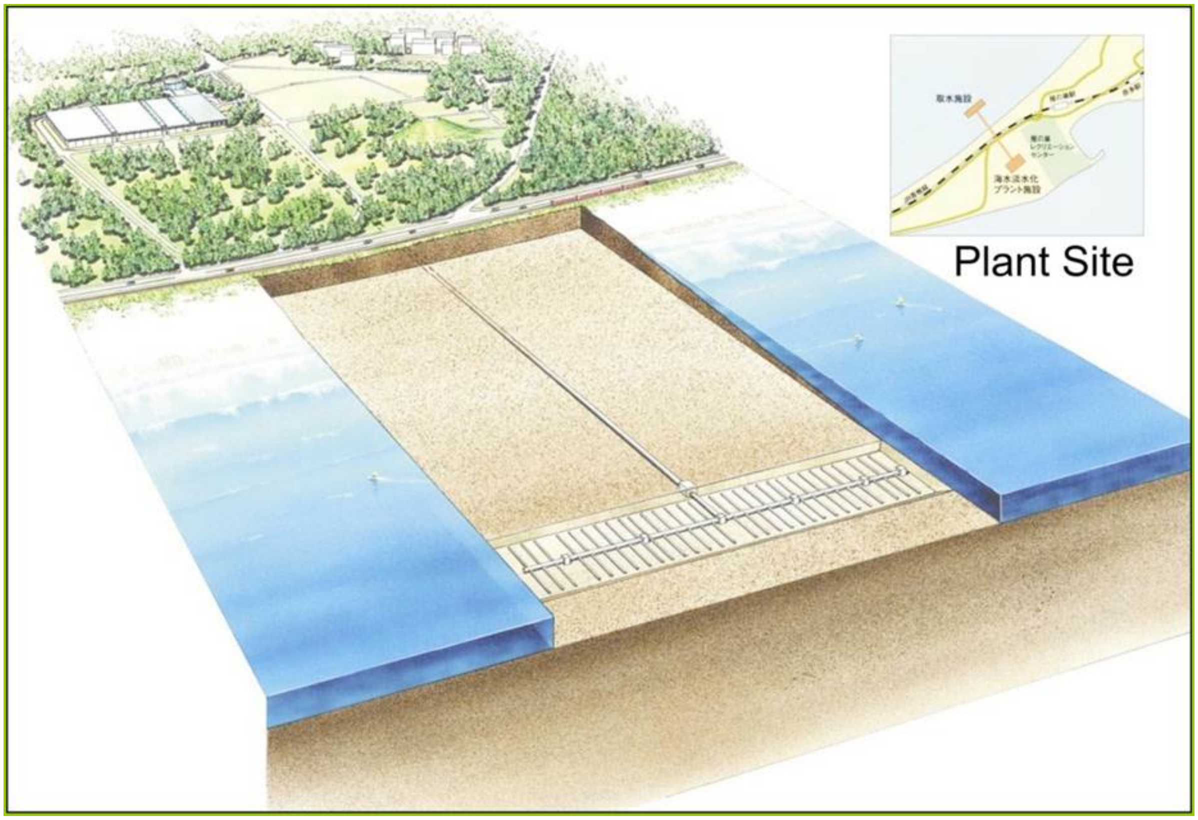


Figure 3.7. Fukuoka, Japan SIG conceptual diagram (from Pankratz, 2006).

An important issue in the siting, design, and construction of a SIG is the bottom stability and the robustness of the design to withstand any extreme natural events, such as earthquakes and harmful algal blooms. The Fukuoka SIG operated without interruption through a 6.5 earthquake on the Richter scale in 2005. The SIG showed only a short-duration increase in the silt density index, but continued to provide high quality seawater to the SWRO plant.

To further increase reliability, SIGs can be constructed as modular systems using a series of gallery cells, each equipped with a pump. This allows shorter distance collection systems to be used to improve flow balance within the gallery and allows a high percentage of the SWRO facility to operate in the event of a pump failure or some clogging of a cell. An example of a SIG design with multiple cells is shown in Figure 3.8. Note that this preliminary design was for a very large capacity SWRO facility (140 MGD) in Saudi Arabia.

The engineered filter used in a SIG contains multiple layers with an upper active layer and several layers used that gradually reduce the grain size to transition into a basal, high permeability collection layer (Figure 3.8). Similar to a beach gallery system, most of the water treatment occurs in the upper layer.

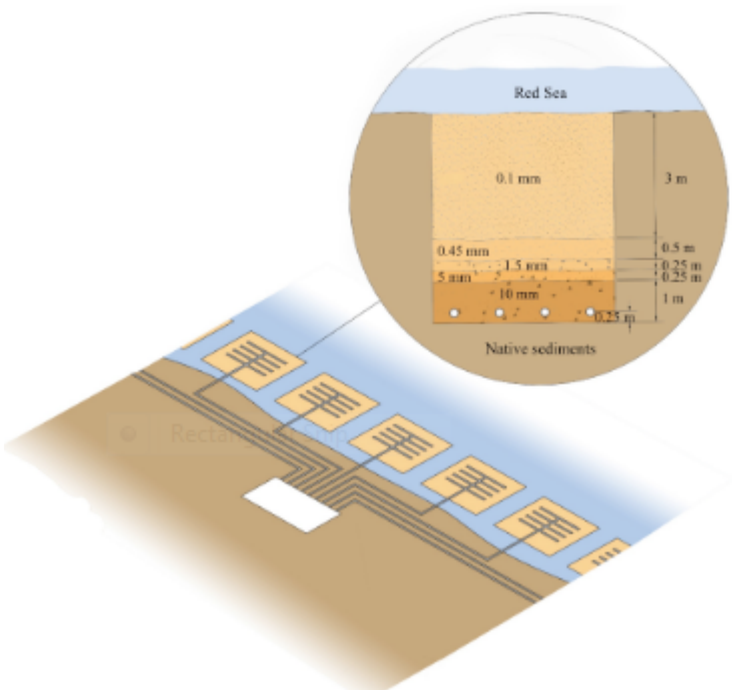


Figure 3.8. Conceptual design of a SIG for the Shuqaiq SWRO plant, Red Sea, Saudi Arabia (from Mantilla and Missimer, 2014).

3.5 Water tunnels

A tunnel intake was recently constructed to provide some or all of the 34.3 MGD of feedwater required to operate the Alicante II SWRO plant in Spain (Rachman et al., 2014). This system contains a tunnel underlying the beach area. The tunnel contains a series of collectors, commonly drilled upward into the overlying aquifer (Figure 3.9). The laterals contain screens that are open to the aquifer and yield water to the tunnel as it is pumped. It operates in a manner similar to a vertical Ranney collector system.

The tunnel system lies fully beneath the surface and would have no significant environmental impact during operations. The induced vertical flow of seawater would produce water with a quality essentially identical to seawater and without inducing impacts to the shallow aquifer landward of the beach. No information was provided by Poseidon on this option.

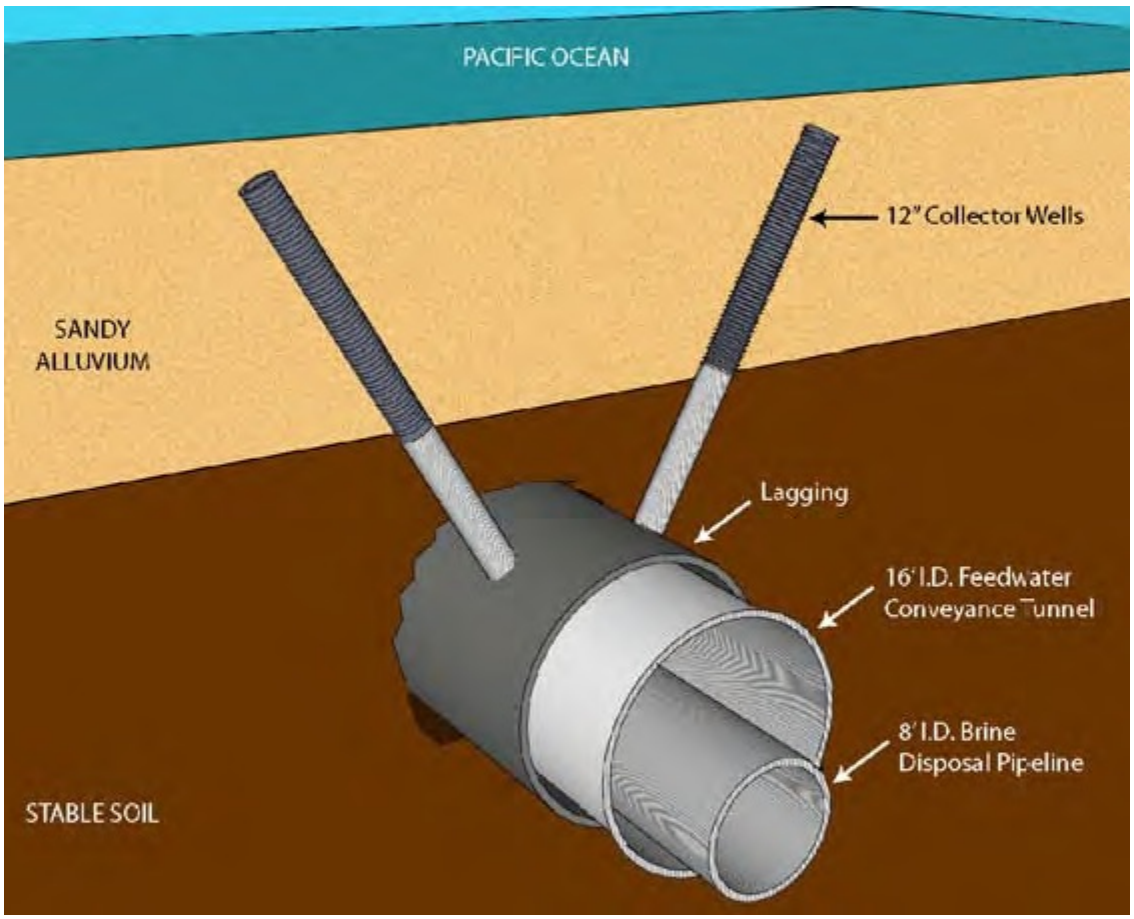


Figure 3.9. Conceptual diagram of a tunnel intake system proposed for another southern California SWRO plant.

3.6 Discussion

The ISTAP considered various subsurface intake systems for use at the proposed 50 MGD capacity SWRO system at the City of Huntington Beach, California. Most subsurface intake systems used at various global locations were reviewed. A common theme throughout the world supporting the use of subsurface intake systems include: (1) reduced environmental impacts, (2) production of feedwater of a higher quality compared to a conventional open-ocean intake, (3) reduced potential for membrane biofouling, and (4) reduced operating costs.

At a very high infiltration rate (10 m/d) the water entrance velocity at the seawater/sea bottom interface would be 0.0045 in/s. Therefore, no significant entrainment of marine organisms would occur. No operational environmental impacts would, therefore, occur.

Subsurface intake systems tend to greatly improve feed water quality by reduction of SDI and removal within the aquifer system or constructed filter of virtually all of the algae, up to 98% of the bacteria, up to 50% of the natural organic matter with a higher percentage of organic polymers removed, and a reduction of significant quantities of transparent exopolymer particles (TEP) (Schwartz, 2003; Choules et al., 2007; Laparc et al., 2007; Rachman et al., 2014; Dehwah et al., 2014). TEP is created by self-assembly of acidic polysaccharides secreted by algae and bacteria (Passow, 2000). Organic biopolymers and TEP in the raw seawater conditions the SWRO membranes and leads to membrane biofouling (Passou and Alldredge, 1994; Berman, 2012; Berman et al., 2011). Significant reduction in concentrations of biopolymers and TEP in the feed water decreases the risk of membrane biofouling and tends to increase the time between required membrane cleanings and allows longer operating life for the membranes (Vesa et al., 2008). Thus, a subsurface intake may eliminate or significantly reduce the need for a pretreatment system that would be needed to produce an equivalent RO feed water quality if a surface intake were used with a standard water pretreatment system.

Use of higher feed water quality in a SWRO reduces the complexity of in-plant pretreatment systems, thereby decreasing the usage of chemical, such as chlorine and coagulants, reduces capital costs of constructing these systems, and reduces electric power consumption. These factors tend to decrease the operating cost of SWRO water treatment (Wright et al., 1997; Missimer et al., 2010) for subsurface intake systems.

Chapter IV. DISCUSSION OF FEASIBILITY CRITERIA

4.1 Introduction

The technical feasibility of a subsurface intake type depends on a variety of hydrogeological, design, oceanographic, and geochemical constraints. In addition, consideration needs to be given to the historical experiences of the various intake types, and particularly whether precedent exists for the investigated subsurface intake type, meaning that this type has been constructed and successfully operated at a comparable scale and in a similar setting as the studied Huntington Beach site. In order for a subsurface intake type to be considered technically feasible at the Huntington Beach site, there must not be any fatal flaws, which are defined as conditions that would either not allow a full-scale system to be successfully constructed and operated or would result in a high risk of failure or unacceptable performance of Poseidon's full-scale target minimum hydraulic capacity of 100 MGD.

Following is a discussion of the feasibility criteria developed by the ISTAP to evaluate the subsurface intake options described above at the Huntington Beach site. The application of these criteria to the Huntington Beach site is presented in Section VII. Some criteria might not lead to a fatal flaw from a purely technical perspective, but could impact feasibility from an economic, regulatory, or environment perspective, whose consideration is not part of Phase 1 of the ISTAP assessment. For example, low vertical well yields could require an uneconomically large number of wells to obtain 100 or 127 MGD of seawater, and thus be economically infeasible, whereas the option might still be technically possible.

Evaluation of the technical feasibility of the considered subsurface intake options involved the collective professional judgment of the Panel as to whether or not the option could be built and reliably operated using currently available methods. The application of professional judgment involved consideration of the available data on the hydrogeology, oceanography, and water quality of the Huntington Beach area and construction and operational experiences at other sites.

4.2 Hydrogeological Feasibility Factor

4.2.1 Impacts on freshwater aquifers

Groundwater pumping on the seaward site of the Talbert Gap could induce seaward flow of water from the Orange County Groundwater Basin. The pumping of saline water could have beneficial impacts as adding an extractive component to the Talbert Gap Salinity Barrier. The pumping would tend to draw the saline-water interface seawards. However, large-scale groundwater pumping seaward of the Talbert Gap may also result in abstraction of freshwater from the basin, adversely impacting its water budget and causing additional drawdowns. Subsurface intake options that would be expected to produce large volumes of water from the Orange County Groundwater Basin would be considered fatally flawed.

4.2.2 Potential yields per installation

Potential yields per installation are best estimates of unit yield per well, acre of gallery subsurface area, and per foot of HDD well or water tunnel. In the absence of site-specific data, these values were estimated based on local hydrogeology and the performance of similar systems constructed elsewhere.

4.3 Design Constraints

4.3.1 Units required for 127 MGD

The number of units (e.g., wells, gallery acres, feet of HDD wells) was obtained by dividing the maximum hydraulic capacity of 127 MGD by the potential yield per installation. A 20% back-up (redundancy) factor was applied, which allows for system capacity to be maintained during operation and maintenance activities and unexpected breakdowns of system components, and some decline in performance over time.

4.3.2 Linear beachfront required

Linear beachfront requirement gives an indication of how spread out a system will be and is an important cost and logistical factor. The requirements were determined by multiplying the number of units by anticipated minimum spacing. For example, a spacing of 100 feet was used for vertical wells completed above the confining unit. Actual spacing requirements would be determined through groundwater modeling to evaluate well interference. A 10-foot separation of surf zone gallery cells is assumed.

4.3.3 Onshore footprint

Onshore footprint is the area permanently required for the number of units. For vertical wells, a 50-ft by 50-ft easement at the wellhead with a 10-ft by 200-ft pipeline easement are assumed to be required. The estimated onshore footprints do not include temporary construction easements. The offshore footprint of seafloor and surf zone infiltration galleries is determined by the number of units required (Section 7.3.1).

4.3.4 Scalability

Scalability refers to the ability to increase the capacity of the system. Subsurface intakes inherently have a modular design, and capacity can be adjusted by changing the number of units. Wells have estimated per well yields, and a specified project demand can be matched to the required number of wells. Likewise, infiltration galleries have yields per unit area. Again, the required demand for a project can be matched to the area required to supply that demand. Not addressed are economies of scale, which is not in the TOR for Phase 1. In general, galleries, and perhaps also water tunnels, tend to have relatively high economies of scale (i.e., there are unit cost savings associated with constructing larger systems), whereas wells have a relatively low economy of scale.

4.3.5 Complexity of construction

Complexity of construction refers to the potential for difficulties to occur during construction. It also ties into the local availability of contractors who are qualified to perform the work and that have the specialty equipment and experience with this specific type of work. Options that have a complex construction would be expected to be relatively expensive, of long duration, and risky in terms of difficulties encountered during construction. Complexity of construction, as considered herein, also includes consideration of factors that may impede or delay construction including: uncertainties and extended duration for obtaining construction permits, seasonal restrictions on beach construction due to public use, seasonal restrictions of offshore operations due to sea conditions, and environmental impacts from construction.

4.3.6 Performance risk

Performance risk is essentially the potential for the intake system to not meet project performance expectations in terms of water yield and quality. It is one of the most important factors in evaluating the technical feasibility of an intake option, as there must be confidence that a constructed intake can satisfactorily perform over the 30-year planned minimum life of the desalination plant. A high degree of uncertainty with regard to the likelihood of successful implementation (i.e., a high potential for system failure or underperformance) is considered a fatal flaw. Performance risk also relates to the opportunities to pilot test an intake option or accurately estimate system performance using other means or data, including the operational history of comparable systems constructed in similar geologies to Huntington Beach. For example, vertical well intakes have a low performance risk because they can be readily pilot-tested.

4.3.7 Reliability of intake system

The reliability of an intake system considers whether or not, or the degree to which, an intake option is expected to maintain acceptable performance over the planned lifespan of the desalination plant. Typically, that lifespan for planning purposes is defined as 30 years, but longer lifespan can be considered. The reliability of intake system factor allows for normal operation and maintenance activities, provided that they can be readily performed and would restore system performance. For example, vertical wells are expected to require periodic rehabilitation using standard methods and replacement of pumps. Evaluation of the reliability of some intake options is complicated by the absence of long-term operation data from precedent systems. The absence of a precedent is of particular concern for system types that do not have precedence for use in freshwater supply. For example, data are not available on the long-term performance of HDD and slant wells, and whether or not they can be rehabilitated to close to original conditions.

4.3.8 Frequency of maintenance

Frequency of maintenance is the relatively frequency at which an intake option is expected to require operation and maintenance activities to either address breakdowns (e.g., pump failure) or restore system performance (e.g., well rehabilitation).

4.3.9 Complexity of maintenance

Subsurface intake systems are generally expected to require some maintenance over their operational lives. Complexity of maintenance addresses both technical difficulties associated with potential maintenance activities and logistical issues that may make maintenance more complex. For example, rehabilitation of slant and HDD wells is much more complex than that of vertical wells. Although potential maintenance of seafloor infiltration galleries is technically simple (e.g., raking the surface), it has a relatively high complexity because it is performed offshore.

4.3.10 Material constraints

Material constraints address construction materials requirements for intake types. In general, seawater intakes should be constructed of corrosion resistant materials.

4.4 Oceanographic constraints

Oceanographic constraints address coastal sedimentological and environmental constraints. Sea level change (rise) is of importance because it effects the position of the beach.

4.4.1 Sensitivity of sea level rise

Sensitivity to sea level rise relates to the effects of changes in water depth and landwards beach migration on constructed intakes. The location of intake structures needs to consider the projected rise of seawater and beach migration over their operational lives. Intakes using wells are designed and located with the intent of producing infiltrated seawater, with their optimal location being as close to the shoreline (subtidal zone) as safely possible. Locating them further inland to avoid the impacts of future sea level rise would place them now in a sub-optimal setting. Intakes that require inundation (e.g., galleries and off-shore water tunnels) would not be sensitive to a rise in sea level.

4.4.2 Sensitivity to Huntington Beach sedimentation rate

Under normal conditions, Huntington Beach would be retreating due to erosion. However, the beach is being maintained through artificial renourishment by the U.S. Army Corps of Engineers. Sedimentation rate, whether natural or anthropogenically influenced, may impact subsurface intakes by either burying or exhuming them. It is assumed that a SIG would be installed in a sedimentologically stable area. The sensitivity of intake design option was evaluated based on the projected Huntington Beach sedimentation rates and likely intake locations and designs. Sedimentation rate is not applicable to vertical, slant, and radial collector wells.

4.4.3 Sensitivity to Huntington Beach bathymetry

Sensitivity to Huntington Beach bathymetry addresses both current and potential post-sea level rise future conditions. This factor is not applicable to vertical, slant, and radial collector wells.

4.4.4 Suitability of bottom environment conditions

Suitability of bottom environmental conditions is applicable to only seabed and surf zone infiltration galleries. Unsuitable conditions would be a rocky bottom or the presence of sensitive environments (e.g., kelp beds). The latter would constitute a fatal flaw.

4.5 Geochemical constraints

Seawater desalination facilities using reverse osmosis technology require feed water with a low suspended solids concentration, low concentrations of clogging organic compounds, and stable water chemistry. Chemical conditions within the subsurface intake should also not be conducive for biogeochemical clogging and associated loss of performance. The most stable systems are those that produce only seawater from vertical infiltration. Mixing of waters with different chemistries can result in a variety of adverse inorganic chemical reactions, such as elemental sulfur and iron oxyhydroxide precipitation.

4.5.1 Risk of adverse fluid mixing

The risks of adverse fluid mixing are greatest where waters from different directions within an aquifer (landwards vs. seawards), aquifers, or aquifer depths enter an intake (or enter different intakes and later mixing within piping system). Systems with the lowest risk of adverse fluid mixing are constructed subsea and produce water largely by vertical infiltration.

4.5.2 Risk of clogging

Loss of intake capacity by clogging (also referred to as plugging) can be caused by a variety of chemical, biological, and physical processes. The greatest risk of clogging occurs where there is mixing of dissimilar waters or a change in water chemistry (e.g., introduction of dissolved oxygen). Clogging is of greatest concern where rehabilitation is complex and expensive (Section 7.3.9).

4.5.3 Risk of changes on inorganic water chemistry

Seawater desalination facilities are designed to treat water with a specific envelope of chemical conditions. Long-term changes in water chemistry caused, for example, by different fractions of landward derived freshwater could interfere with the reverse-osmosis process. The risk is lowest where intakes produce water predominantly by vertical infiltration of seawater (e.g., subsea galleries).

4.6 Precedents

Confidence in the feasibility of an intake option type is greatest where there is a track record of successful implementation of the type at other sites with geological conditions similar to Huntington Beach and ideally also of a comparable hydraulic capacity. Inasmuch as subsurface intakes have a high scalability, the absence of precedents for the proposed 127 MGD system is not considered to be a fatal flaw. However, problems (under-performance) at precedent systems is an important consideration for evaluation of the technical feasibility of the intake option at Huntington Beach, especially if there is no documentation of the cause and resolution of the problem.

Chapter V. Evaluation of Subsurface Intake Types

5.1 Evaluation matrix

An evaluation of the considered subsurface intake types with respect to the feasibility criteria is provided as a coarse screening matrix in Table 5-1. Table 5-1 is based on the collective professional judgment of the Independent Scientific and Technical Advisory Panel. The values of the parameters used are best, ballpark estimates based on available local or general intake-type information in the absence of site-specific actual data. It is important to stress that feasibility issues did not closely depend upon the specific values used. For example, an increase or decrease of well or gallery yields by a factor of two would not impact technical feasibility. However, well or gallery yields are an important economic issue. The technical feasibility of each design option is further discussed in Section 5.2. As noted elsewhere in this Report, the ISTAP stresses that the evaluation was based on the hydrogeologic and oceanographic conditions specific to the Huntington Beach AES site and proximate areas. The infeasibility of a particular intake type at this location should not be generalized to feasibility assessments of any specific intake type in a different setting or location.

5.2 Subsurface intake type feasibility at Huntington Beach

5.2.1 Vertical wells completed above upper confining unit

Vertical wells have the lowest performance risk because their performance can be readily determined through a test well program. The available information on the geology of the Huntington Beach area indicates that the shallow aquifer is moderately transmissive (permeable), which would limit well yields and increase the number of wells required to produce 127 MGD. Assuming a well yield of 0.72 MGD/well, 212 wells would be required. A subsurface intake system that requires such a large number of wells is technically challenging but not infeasible (not taking cost into consideration), provided that well sites can be obtained. The 0.72 MGD (500 gpm) yield may be optimistic in terms of long-term pumping rates, and a lower well yield would result in an even greater number of wells required. A more fundamental limitation is that a production rate of 127 MGD is well beyond what is likely sustainable from the shallow aquifer. As was noted by Mr. Roy Herndon of the OCWD during the public meeting, the proposed groundwater pumping would be about 45% of the total Orange County Groundwater Basin pumping. Pumping would result in very large drawdowns, which would pull freshwater from the landward direction resulting in a high water quality risk. Vertical wells completed in the shallow aquifer above the confining unit above the Talbert aquifer are thus considered to be infeasible.

5.2.2 Vertical wells completed below confining unit

Large-scale water production from the Talbert aquifer would draw large volumes of water from the landward direction, from the Orange County Groundwater Basin, which is considered a fatal flaw rendering the option infeasible. Additional considerations are impacts to the Talbert Gap salinity barrier, which could be net beneficial, and a geochemical risk from the mixing of waters.

5.2.3 Vertical wells completed above and below confining unit

Dual-zone aquifer would have the benefit of greater well yields, but would still have the fatal flaw of a large component of the flow being derived from the Orange County Groundwater Basin. Geochemical incompatibility would also be a major concern due to the mixing of waters from two aquifers within the wells or piping system if paired wells were used.

5.2.4 Radial collector in shallow aquifer

Radial (Ranney) collector wells have the advantage that large volumes of water (equivalent to multiple vertical wells) may be produced from a single well site. Radial collector wells are typically installed in hydrogeological settings where (a) high transmissivity interval(s) is(are) present (e.g., gravel bed) in which laterals can be installed, rather than in sandy strata such as present at the project site. Radial collectors are considered to have a medium performance risk due to the very high cost of testing the option. A full-scale system would have to be constructed. There are also practical limitations on the lengths of laterals. The driller does not recommend/warranty laterals greater than 250 ft., which would mean the laterals would be installed largely above the shoreline (rather than subsea), as caissons would have to be constructed back from current high-tide line. Radial collector wells are considered technically infeasible at the Huntington Beach site due to an inappropriate geology and because the excessively high production rates from the shallow aquifer would not be viable.

5.2.5 Slant wells completed in Talbert aquifer

Slant wells completed in the Talbert aquifer would draw large volumes of water from the Orange County Groundwater Basin, which in itself is considered a fatal flaw. Recent public comments have suggested that pumping seawards of the Talbert Salinity Barrier could have beneficial impacts in managing seawater intrusion. In the Panel's opinion, however, this benefit is too uncertain to overcome the ISTAP conclusion about the fatal flaw of this technology as applied to the proposed Huntington Beach site. The advantage of having a subsea completion is largely lost in confined aquifers. The performance risk is considered medium, as the dual-rotary drilling method used to construct the wells is a long-established technology, but there is very little data on the long-term reliability of the wells. Maintainability is also a critical unknown issue.

5.2.6 Engineered seafloor infiltration galleries (SIGs)

The results of the investigations by Scott Jenkins (as presented to the Panel) and others indicate that an area with a stable seafloor is present off the Huntington Beach site that has a relatively low environmental sensitivity. Inasmuch as the overlying sand materials can be engineered to provide the target infiltration rate, and desired filtration performance and hydraulic retention time, construction of an engineered seafloor infiltration gallery is considered to be technically feasible. The limited precedence for this type of system (Fukuoka, Japan system) is favorable as far as systems maintaining their capacity over time. However, the experiences at

Fukuoka are not necessarily transferable to Huntington Beach. The key consideration for a seafloor infiltration gallery is construction complexity due to its construction offshore at depth. Maintenance would also be complex, but not a fatal flaw. An engineered seafloor infiltration gallery is thus considered to be technically feasible.

5.2.7 Surf zone infiltration galleries

A surf zone infiltration gallery has the dual advantages of (a) construction near shore and potential greater yields (per unit area) than a seafloor system due to a coarser grain size (and greater hydraulic conductivity) and (b) the self-cleaning nature of the beach. However, the construction complexity is high due to the high-energy breaking wave conditions in the surf zone. In order to provide a safe work environment above the waves for equipment and crews constructing the surf-zone infiltration gallery, all construction of the gallery would have to performed from the top of a pile supported steel access trestle (temporary bridge) that would be built over-the-top and elevated above the breaking waves.

The installation and advancement of such a trestle system is time-consuming and expensive in that all work must be performed in a series of activities rather than concurrently as performed in most normal marine construction operations. Work from the top of the trestle would include construction of the trestle, installation of steel sheetpiles, dredging, installation of the intake piping system, backfilling, extraction of sheetpiles, and finally removal of the trestle. These operations could involve local beach closure of approximately 1500 feet of beach at a time over a time period of approximately four to five years. In addition, the trestle and sheetpiles could not be easily removed to allow timely public use of beach areas during summer seasons. Such disruption to the environment and public use of extensive beach areas would create a very difficult condition for obtaining construction permits from state and Federal regulatory agencies within a reasonable and predictable time. Potential restrictions on the time of year in which construction would be allowed would extend the construction period beyond that feasible for the project. The combination of the above factors is considered to make a surf zone infiltration gallery construction very challenging at the Huntington Beach site.

The length of construction along the beach would also impact littoral sand movement, causing temporary local deposition and erosion as the gallery construction advances. However, this impact on construction could be minimized by advancing construction of the gallery in a down-coast or southward direction. A surf zone infiltration gallery would also be impacted by periodic beach renourishment activities. Construction of a surf zone infiltration gallery is considered to be technically feasible in that it is technically possible to construct such a system. However, great constructability challenges would be expected, which would impact the ability to meet project schedules and costs.

5.2.8 Horizontal directionally drilled (HDD) wells underneath the sea floor

Horizontal directionally drilled (HDD) wells can technically be installed at the Huntington Beach site, as the underlying technology is well established. The performance of the HDD systems will be suboptimal in granular materials (sands) as opposed to lithified strata (limestone) and thus a greater (undetermined) number of drains would be required. There is inadequate data on the long-term reliability and maintainability of the HDD wells/drains at this time. This subsurface intake design option is considered technically infeasible at the Huntington Beach site because of a high performance risk. There is too great uncertainty that a system could be constructed that would reliably provide the required water volume over the operational life of the desalination facility.

5.2.9 Water tunnel

A water tunnel constructed subsea would have the advantages of high water quality stability and minimal impacts to the beach area. Water tunnels have severe construction complexity as ground freezing may be required. Water tunnels are considered to be infeasible due to a high performance risk. There is an unacceptable degree of uncertainty in the performance of these systems, which cannot be practicably pilot-tested.

Table 5-1 Subsurface Intake Summary Matrix

	Subfactor	Vertical wells completed above confining unit	Vertical wells completed below confining unit	Vertical wells completed above and below confining unit	Radial collector in shallow aquifer	Slant Wells completed in Talbert aquifer	Engineered seafloor infiltration gallery	Surf zone infiltration gallery	HDD wells in shallow aquifer	Water tunnel
Hydrogeology										
	Impact on fresh water aquifers	Yes	Yes	Yes	No	Yes	No	No	No	No
	Potential Yield per installation (MGD)	0.72	2.2	3	5	12.9 MGD per 3-well cluster[3]	5 MGD/acre	10 MGD / acre	0.67 to 2.2 MGD/drain[1]	2,600 GD/ft[2]
Design Constraints										
	Units required for 127 MGD with 20% safety factor	212	70	51	31	12 (3-well clusters)	30.48 acres	15.24 acres	227 to 69 drains	9 miles
	Linear beachfront	4 miles	2 miles	1.4 miles	2 miles	1.3 miles		1.0 miles[4]	1.8 to 2.8 miles	
	Area	2.2 acres[5]	0.7 acres	0.5 acres	0.3 acres	1.4 acres[6]	30.48 acres	15.24 acres	2.4 acres[7]	0.5 acres
	Scalability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Complexity of construction	Low	Low	Low	Medium	Medium	High	High	Medium	Very High
	Performance risk - degree of uncertainty of outcome	Low	Low	Low	Medium	Medium	Medium	Medium	High	Unknown
	Reliability of intake system	High	High	High	Medium	Medium/unknown	Medium	Medium/ unknown	Unknown	High
	Frequency of maintenance	High	High	High	Medium	High	Medium/Unknown	Medium/ unknown	High	Low
	Complexity of maintenance	Low	Low	Low	Medium	Medium	High	Medium	High	High
	Material constraints	Non-metallic, sea water resistant. Duplex stainless steel pumps	Non-metallic, sea water resistant. Duplex stainless steel pumps	Non-metallic, sea water resistant. Duplex stainless steel pumps	Non-metallic, sea water resistant. Duplex stainless steel pumps	Non-metallic, sea water resistant. Duplex stainless steel pumps	HDPE/PVC	HDPE/PVC	Non-metallic, sea water resistant. Duplex stainless steel pumps	Pre-cast concrete/ss reinforcing. Laterals non-metallic
Oceanographic										
	Sensitivity to sea level rise	High	High	High	High	Medium	Low	Low	Low	Low
	Sensitivity to HB sedimentation rate	N/A	N/A	N/A	N/A	N/A	Low	Low	Low	Low
	Suitability of HB Bathymetry	N/A	N/A	N/A	N/A	High	High	High	High	High
	Suitability of bottom environmental conditions	N/A	N/A	N/A	N/A	N/A	High	High	N/A	N/A

Table 5-1 Subsurface Intake Summary Matrix (Continued)

	Subfactor	Vertical wells completed above confining unit	Vertical wells completed below confining unit	Vertical wells completed above and below confining unit	Radial collector in shallow aquifer	Slant Wells completed in Talbert aquifer	Engineered seafloor infiltration gallery	Surf zone infiltration gallery	HDD wells in shallow aquifer	Water tunnel
Geochemistry										
	Risk of adverse fluid mixing	Low	High	High	Low	High	Low	Low	Unknown	Low
	Risk of clogging	Low	Medium	High	Low	Medium	Low	Low	Medium	Low
	Risk of significant change in inorganic chemistry of water quality over the long term?	High	High	High	High	High	Low	Low	Medium	Low
Precedent in use		Worldwide. Largest systems use (e.g., Sur, Oman) use carbonate aquifers. Sand City - 0.3 MGD is largest in sand.	Numerous brackish RO well fields	No precedent	Ocean Beach, SF (Aquarium)	One test well (Dana Point). None in operation	Monterey Aquarium (small). Long Beach (small test).	Small scale systems	Eight systems installed mostly in Spain	Alicante, Spain
Precedent on large scale in similar geological conditions		Jeddah, Saudi Arabia; 5 MGD from 10 wells	No precedent	No precedent	Pemex system in Mexico, 3 collectors with total capacity of 12 Mgd	No precedent	Fukuoka, Japan. 27 MGD intake capacity	No precedent	Alicante, Spain; designed for 34 MGD, operating at 17 MGD	Alicante, Spain, 17 MGD
Key considerations / fatal flaw(s)		Performance risk: inadequate aquifer capacity and great drawdowns. Low yields would require extremely high number of wells, major water quality risk	Complications with seawater intrusion management and production from Orange Groundwater Basin	Complications with seawater intrusion management and production from Orange Groundwater Basin	High performance risk due to inappropriate geologic conditions	Complications with seawater intrusion management and production from Orange Groundwater Basin; geochemical impacts	Construction complexity	Construction complexity in high energy environment, potential restrictions on allowable construction times/beach closure, impacts of beach renourishment	Performance risk concerns over granular materials and maintenance of well performance	Complex construction involving ground freezing. High performance risk - no precedence for project scale. Cost likely prohibitive
Technically Feasible? Y or N		**N**	**N**	**N**	**N**	**N**	**Y**	**Y**	**N**	**N**

Table 5-1 Notes:

[1]2.7 MGD average rage per drain for Alicante, Spain system, corrected for lower hydraulic conductivity at Huntington Beach
[2]Average rate for Alicante, Spain system
[3]Based on Dana Point test slant well
[4]Based on 150 ft. width by 300 ft. length cells and 30 ft. separation
[5]Assumed 250 ft. 2 per well; does not include construction easement
[6]Assumed 100 ft. by 50 ft. easement plus pipe line easement; does not include construction easement
[7]Assumed 300 ft. by 50 ft. easement plus pipe line easement; does not include construction easement, and seven clusters

The judgments included in this Table are in response to the hydrogeologic and oceanographic conditions specific to the proposed HB AES site and proximate areas. The technical infeasibility of a particular intake technology at this location should not be generalized to feasibility considerations of any intake type in different settings or locations.

Chapter VI. Summary, Conclusions, and Recommendations for Phase 2

The ISTAP evaluated nine types of subsurface intakes for technical feasibility at the Huntington Beach site. The subsurface feasibility options included: (1) vertical wells completed in the shallow aquifer above the Talbert aquifer, (2) vertical deep wells completed within the Talbert aquifer, (3) vertical wells open to both the shallow and Talbert aquifer, (4) radial collector wells tapping the shallow aquifer, (5) slant wells tapping the Talbert aquifer, (6) seabed infiltration gallery (SIG), (7) beach gallery (surf zone infiltration gallery), (8) horizontal directional drilled wells, and (9) a water tunnel.

The hydraulic design capacity for these subsurface intake types ranged from 127 MGD for the combined requirement of the proposed SWRO plant and RO concentrate discharge dilution, and 100 MGD, if the concentrate discharge dilution was unneeded (diffuser system used to reduce environmental impacts from the concentrate discharge).

The ISTAP used a standard definition of technical feasibility as defined in the California Coastal Act and carefully evaluated fatal flaws of each subsurface intake type considered for application at the proposed Huntington Beach site. Only the seabed infiltration gallery and the beach gallery survived the fatal flaw analysis and both are deemed to be technically feasible at this site. The design of both types of galleries is well understood, but construction challenges would be expected for both due to their subsea/subtidal construction. The surf zone (beach) gallery, in particular, was judged to have some potentially difficult constructability challenges (and thus a lesser degree of technical feasibility) related to construction in the high-energy surf zone. The ISTAP does not consider the existing scale of use of any particular subsurface intake compared to the capacity requirement at Huntington Beach to be a fatal flaw for technical feasibility (e.g. the only existing seabed infiltration gallery has an hydraulic capacity of 27 MGD versus the 100 MGD proposed at the Huntington Beach site, and no large scale implementation of the beach gallery has been constructed and operated to date).

It is the collective opinion of the ISTAP that each of the other seven subsurface intake options for the desired hydraulic capacity range (100-127 MGD) had at least one technical fatal flaw that eliminated it from further technical consideration. The shallow vertical wells would create unacceptable water level drawdowns landward of the shoreline and could impact wetlands and cause movement of potential contaminants seaward. The deep vertical wells would have a significant impact on the Talbert aquifer that would interfere with the management of the salinity barrier and the management of the interior freshwater basin. The combined shallow and deep-water wells would adversely impact both the shallow aquifer and Talbert aquifer, and in addition, would produce waters with differing inorganic chemistry, which would adversely affect SWRO plant operation. Radial collector wells constructed into the shallow aquifer would have to be located very close to the surf zone which would make them susceptible to damage during storms and would be impacted by the projected sea level rise. Slant wells tapping the Talbert aquifer would interfere with the management of the salinity barrier and the management of the freshwater basin, and further, would likely have geochemical issues with the water produced from the aquifer (e.g., oxidation states of mixing waters). The recently-collected offshore hydraulic conductively data shows that the use of HDD wells is technically questionable and the largest capacity system in Spain is currently not operating at its original design capacity. The water tunnel constructed in the unlithified sediment at Huntington Beach would have overwhelming constructability issues.

The ISTAP recommends in Phase 2, further consideration be given solely to seabed infiltration galleries (SIG) and beach gallery intake systems. For clarification, the ISTAP believes that the remaining subsurface intake system deemed to be technically feasible could meet the seawater extraction goals of either 100 or 127 MGD.

It is important to stress that the ISTAP interpreted its Phase 1 charge relative to the Terms of Reference to be the evaluation of the technical feasibility of subsurface intake technology linked to a proposal. Consistent with that approach, the Phase 1 Panel considered nine technologies keyed to a potential project in the range 100 to 127 mgd. The Panel did address the broad issue of downward scalability where they saw relevance, but did not consider a full or parsed range of scale options for any of the nine technologies as this task exceeded the agreed upon scope defined in the TOR. Scalability issues could be addressed in subsequent assessments of other feasibility factors at the mutual agreement of the conveners.

Further, it was not the charge of the Phase 1 ISTAP to evaluate the economic considerations of using a subsurface intake versus a conventional open-ocean intake in this phase. The ISTAP recommends that the Phase 2 Panel give considerable analysis to the constructability of the seabed infiltration and beach gallery intake systems, because this greatly affects the economic viability of their potential use. However, the ISTAP recommends that in the Phase 2 evaluation of the subsurface intake options that a detailed lifecycle cost analysis should be provided to the succeeding committee. This lifecycle cost analysis should contain at least four scenarios, including: (1) the lifecycle cost using the appropriate operating period duration obtaining the 127 MGD of feed water from a conventional open-ocean intake without considering the cost of potential environmental impacts of impingement and entrainment, (2) the lifecycle cost using the appropriate duration of an operating period obtaining the 127 MGD of feed water from a conventional open-ocean intake and considering the cost of potential environmental impacts of impingement and entrainment, (3) the lifecycle cost using the appropriate duration of an operating period obtaining the 127 MGD of feed water from a seabed gallery intake system (or beach gallery intake system) using the same pretreatment design as used in treating open-ocean seawater, and (4) the lifecycle cost using the appropriate duration of an operating period obtaining the 127 MGD of feed water from a seabed gallery intake system (or beach gallery intake system) using a reduced degree of pretreatment, such as mixed media filtration followed by cartridge filters.

In each of these scenarios, the ISTAP recommends that the selected design hydraulic capacity match both the minimum and maximum flow rates consistent with the desired production rate of a 50 MGD desalination facility using the SWRO technology. The definition of an “appropriate” operating period should follow accepted industry standards for such lifecycle cost analyses. Typically, a period of 30 years is used, but given concerns on the potential for sea level rise impacts, analysis over a longer operating period (e.g. 50 years) may be desirable. In addition, the ISTAP questions the need for the use of seawater to dilute the concentrate discharge given the well-known use of diffuser outfalls to meet ocean discharge requirements.

The ISTAP also recommends that “Technical Feasibility” should continue to be defined by generally recognized factors as documented in the California Coastal Act of 1976. *(Section 30108 of the California Public Resources Code)*

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Chapter VIII. APPENDICES

8.1 APPENDIX A: Biographies of Panelists

Robert Bittner, P.E.

Mr. Robert Bittner is a professional engineer and President of Bittner-Shen Consulting Engineers, Inc., a firm specializing in the design of innovative marine structures including bridge foundations, marine terminals, offshore GBS structures, locks and dams. He has 40 years experience in construction engineering and project management on major marine structures worldwide, including the Itaipu Dam in Brazil and the Oresund Tunnel connecting Denmark and Sweden. One focus of his work has been minimizing construction cost of major marine structures through the design and development of innovative construction methods and equipment.

Prior to starting his own firm in 2009, Mr. Bittner was President of Ben C. Gerwick, Inc. While at Gerwick, he provided construction-consulting services worldwide and managed the design of several marine structures, including an innovative float-in dam on the Monongahela River in Pennsylvania for the US Army Corps of Engineers. Additionally, he led the Gerwick team that developed a new float-in cofferdam system that has been successfully used on the foundations for the New Carquinez Straits Bridge in the San Francisco Bay Area, the New Bath-Woolwich Bridge in Maine, the new Port Mann Bridge in Canada, and three major bridges in Asia. Mr. Bittner was Chairman of the Marine Foundations Committee for the Deep Foundations Institute (DFI) for 6 years from 2003 to 2008, and is currently President of DFI.

Mr. Bittner holds a B.S. in Civil Engineering and an M.S. in Construction Management, both from Stanford University.

Martin Feeney, PG CEG CHg

Martin Feeney is an independent consultant providing hydrogeologic support services to municipalities, water agencies and water utility companies. Mr. Feeney is a California Professional Geologist with specialty certifications in engineering geology (CEG) and hydrogeology (CHg) and has more than 30 years experience in groundwater consulting. Mr. Feeney was a founding Principal of Staal, Gardner and Dunne, Inc. (later becoming Fugro West, Inc.) and managed this firm's Monterey County office for nine years. He was later was a member of the firm, Balance Hydrologics, Inc. Mr. Feeney's experience in groundwater supply issues includes basin analysis, well siting and design, groundwater modeling (both flow and solute-transport), perennial yield analysis, water quality assessments, and regulatory compliance.

During his career, Mr. Feeney has designed and managed the construction of over 120 municipal wells with depths to 2,500 feet, diameters to 24-inches and discharge rates of up to 6,000 gpm. He has significant experience in drilling and well construction technology as well of the assessment and rehabilitation of existing wells. Mr. Feeney also has significant experience in groundwater issues associated with desalination facilities. He has worked in the Caribbean on numerous subsurface feedwater supply systems and was instrumental in the development of the feedwater and reject disposal systems utilized in the desalination facilities in Marina and Sand City, CA. Mr. Feeney has been involved in the evaluation of subsurface feedwater supply feasibility on beaches of Ventura, Monterey and San Diego Counties. These evaluations include alternative subsurface feedwater supply approaches including vertical wells, Ranney Collectors, horizontal wells and slant wells.

Mr. Feeney has participated in several peer review advisory panels. Currently, he is a member of the so-called "Hydrogeologic Working Group" evaluating the feasibility and potential water rights impacts of the installation of a 24 MGD capacity slant well array on the edge of Monterey Bay to support a regional desalination facility. Mr. Feeney is also currently is a member of the DPH-mandated Independent Advisory Panel for the Monterey Regional Water Quality Control Agency's Groundwater Replenishment project utilizing highly treated wastewater for groundwater recharge. He has previously served on advisory panels focusing on the overdraft issues in the Salinas and Pajaro Valleys, the sewer system in Los Osos and groundwater management plan development in the Carpenteria Basin. He has a BS in geology (UCSC) and a MA in Environmental Planning -Groundwater Emphasis (UCD, CSUN).

Michael C. Kavanaugh PhD, P.E., BCEE

Dr. Michael Kavanaugh is a professional engineer and Senior Principal with Geosyntec Consultants, Inc. He is a registered professional engineer in California, a Board Certified Environmental Engineer (BCEE), and an elected Fellow of the Water Environment Federation. Dr. Kavanaugh has over 40 years of consulting experience advising private and public sector clients on water quality, water and wastewater treatment, and groundwater restoration issues.

In addition to his consulting practice, Dr. Kavanaugh has broad experience in science advising for policy. He completed several assignments with the National Research Council including chair of the Water Science and Technology Board and the Board on Radioactive Waste Management. He also chaired the NRC committee on alternatives for ground water cleanup (1994) and recently chaired a NRC study on the future of subsurface remediation efforts in the U.S. with a report released 2013. For the past ten years, he has been a regular contributor to the Princeton Groundwater professional courses offered in the U.S. and Brazil. Dr. Kavanaugh was elected into the National Academy of Engineering (NAE) in 1998.

He has a B.S. and M.S. degrees in Chemical Engineering from Stanford and the University of California, Berkeley, respectively and a PhD in Civil/Environmental Engineering from UC Berkeley.

Robert G. Maliva, Ph.D.

Dr. Robert Maliva is a hydrogeologist and is currently a Principal Hydrogeologist with Schlumberger Water Services USA, Inc. based in Fort Myers, Florida. Dr. Maliva specializes in alternative water supply projects including managed aquifer recharge, alternative intakes for desalination systems, and injection well systems used for the disposal of desalination concentrate and other liquid wastes. He has been a consulting hydrogeologist since 1992.

Dr. Maliva has managed or taken the technical lead on numerous water resources and hydrologic investigations including water supply investigations, wellfield designs, aquifer storage and recovery (ASR) projects, contamination assessments, and environmental site assessments. He has designed raw water supply wellfields for brackish water desalination systems, alternative intakes for seawater desalination systems, and injection well systems for concentrate disposal.

He is the senior author of two books, "*Aquifer Storage and Recovery and Managed Aquifer Recharge Using Wells: Planning, Hydrogeology, Design, and Operation"* (2010) and *"Arid Lands Water Evaluation and Management"* (2012), and has numerous peer-reviewed publications. Dr. Maliva has a Ph.D. from Harvard University and has held research positions in the Department of Earth Sciences at the University of Cambridge, England, and the Rosenstiel School of Marine and Atmospheric Science of the University of Miami, Florida. He also has an A.M. in Geology from Indiana University at Bloomington, Indiana and a B.S. in Geology from State University of New York at Binghamton, New York, USA.

Thomas M. Missimer, Ph.D.

Dr. Thomas Missimer is a hydrogeologist and president of Missimer Hydrological Services, Inc., a Florida-based consulting firm. He is licensed as a professional geologist in four states. Dr. Missimer is also a visiting professor of environmental science and engineering (specialty in hydrogeology) at the King Abdullah University of Science and Technology in Saudi Arabia and is currently a visiting professor at the U. A. Whitaker College of Engineering, Florida Gulf Coast University.

He has 41 years of experience as a hydrogeologist and has completed projects in groundwater development, water resources management, and the design and construction of various water projects. He has worked on a large number of artificial aquifer recharge projects used for storage and treatment of impaired waters (domestic wastewater and stormwater) and for seasonal and strategic storage of potable water (aquifer storage and recovery projects). He is the author of nine books and more than 350 technical papers of which about 80 are published in peer-reviewed journals.

Dr. Missimer has specialized in the design, permitting, and construction of intake systems for brackish-water and seawater reverse osmosis desalination systems. His book entitled "Water supply development, aquifer storage, and concentrate disposal for membrane water treatment systems" (Schlumberger, 2009) is a widely used reference in this field and has won two publishers awards in technical communication. His first wellfield project used to supply feed water for an RO system was completed in 1977, and he has worked on over 80 other systems worldwide. He and his students have completed and published 6 technical feasibility investigations over the last three years along the shorelines of the Red Sea and Arabian Gulf to assess the use of seabed gallery intake systems. In 1991, he won the best paper presentation award from the International Desalination Association for his paper on use of subsurface intake systems to supply large-capacity seawater desalination systems.

He has a BA in geology from Franklin & Marshall College, an MS in geology from Florida State University, and a PhD in marine geology and geophysics from the University of Miami.

Terms of Reference
for an Independent Scientific and Technical Advisory Panel (ISTAP)
to Examine the Feasibility of Subsurface Intakes
and Advise the California Coastal Commission on Poseidon Water's Proposed Huntington Beach Desalination Project
April 18, 2014

Headings Included Here

A. Background

As part of its review of a permit application from Poseidon Resources to construct and operate a desalination facility in Huntington Beach, the California Coastal Commission directed the applicant to undertake a more complete independent analysis of intake alternatives. Due to concerns over impacts on the coastal environment and marine ecosystems [Coastal Act Sections 30230 and 30231 in particular], the Commission recommended that Poseidon examine in more detail the feasibility of subsurface intakes.

In order to establish a review process that is responsive to the Commission's guidance and appropriately engages Poseidon, both parties have agreed to undertake an independent scientific review. To help implement this guidance, Poseidon has agreed to contract with CONCUR, Inc., a firm specializing in analysis and resolution of complex environmental issues and in structuring independent review processes. While the Commission is not contracting with CONCUR, the agency staff agrees on the choice of CONCUR as the facilitator and convener of this independent review.

This Terms of Reference document (TOR) sets the structure and operating procedures of the scientific review and sets the specific charge to the Panelists. The intention of this Terms of Reference is that, while Poseidon and the agency staff may have some divergent interests, they will collaborate and strive to reach agreement on these elements of the review process.[1]

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[1] In this TOR, Poseidon Resources (Surfside) LLC will be referred to simply as "Poseidon", the term "Commission" refers to the agency and its governing board, and the staff of the Coastal Commission will be referred to as "agency staff". The term "both parties" means Poseidon and agency staff.

CONCUR will convene a panel of scientific experts—the Independent Scientific and Technical Advisory Panel—to review the issues at hand and make recommendations to bolster the scientific underpinning of the permit application and review process.

Both parties agree that this "joint fact-finding process" is a credible and effective way to respond to the guidance provided by the Commission. The Panel will consider a defined set of questions, deliberate, and prepare reports that will be delivered to both parties. These reports will provide evidence for the Commission and agency staff to consider when staff prepares its recommendation to the Commission regarding the proposed project. The Panel's final reports will be part of the Commission's record for Poseidon's permit application.

B. Mission Statement and Purpose
The broad goal of the Independent Scientific and Technical Review Panel is to provide credible, legitimate and independent scientific advice and guidance to support permit review.

The Panel's specific and limited purpose is to investigate whether alternative intakes would be a feasible method to provide source water to Poseidon's proposed desalination facility. It will focus on the extant site at Huntington Beach, but may investigate alternate sites on the Orange County coast. If subsequent phases of work are initiated, the expectations are that the Panel will compare the relative degree of feasibility of alternative intakes as described below.

Poseidon will fund the Panel and CONCUR. To ensure the Panel's independence, it will be guided by CONCUR and will report directly to agency staff with input from but without alteration by Poseidon. To provide transparency, the public will be invited to participate in some Panel meetings (but not Panel work sessions) and to comment at intervals on the Panel's interim and final work products for each phase of work as may be undertaken.

C. Criteria to Guide the Panel's Assessment of Feasibility
Both parties will set forth criteria they find important to the consideration of "feasibility" as defined in the Coastal Act, which will be reviewed and considered by the Panel in determining the feasibility criteria to be used for each phase that is undertaken.

D. Initial Work Program
The scope of work may include one or more phases as set forth below.

After each phase, both parties will consider the results of the phase and advise on next steps.

Both parties agree that the intent of the review is to work through to a final product for each phase that is undertaken. Both parties commit to at least the first phase of work outlined. Both parties would need to concur to go beyond Phase 1 and involve the Panel in later phases. Both parties anticipate that the disciplines composing the Panel would need to be rethought between Phase 1 and Phase 2. The disciplinary composition of the Panel may be revised at each phase to provide the necessary expertise.

Both parties agree that multiple phases will be necessary to generate the information the Commission needs to proceed to a final decision.

The Phase 1 scope of work is as follows:

Phase 1: Technical Feasibility at Huntington Beach.[2] Investigate whether alternative subsurface intake designs would be technically feasible at the proposed site at Huntington Beach. This assessment of technical feasibility will include a characterization of the geophysical, hydrogeological and geochemical features of the site and will identify the expected size and hydrogeological effects of the range of subsurface intakes that could be accommodated on the site, including those that could provide source water for the proposed 50 mgd facility. For Phase 1, both parties agree that the working definition of technically feasible is: able to be built and operated using currently available methods. This phase will include gaining command of the project and context, clarification of the goals and scope of this phase, review of published literature, case reports, and on-site studies. The Panel would prepare a report at the end of this phase that describes technically feasible alternative intake designs at or near the site and may also be asked to prepare interim informal reports.

At the end of Phase 1, both parties would consider the Panel report and the makeup of the Panel needed for the next Phase. Based upon the discussions to develop the Phase 1 scope of work, both parties have developed the following scope of work for Phase 2, if both parties decide to initiate a second phase.

Phase 2: Additional Review of Components of Feasibility at Huntington Beach. Still focused on the Huntington Beach site, the Panel would characterize the technically feasible subsurface intakes identified in Phase 1 relative to a broader range of evaluation criteria, as recommended by the parties and determined by the Panel, such as size, scale, cost, energy use, and characteristics related to site requirements and environmental concerns consistent with the Coastal Act's definition of feasible, and as compared to the proposed open intake. The Panel would prepare a report at the end of this Phase and may also be asked to prepare interim informal reports.

Both parties will decide after Phase 2 whether to conclude the ISTAP or whether to conduct additional studies and review. For instance, if initial review indicates that constructing a subsurface intake at the Huntington Beach site may not be feasible, a potential third phase could consider other locations on the Orange County Coast that might offer superior conditions for construction of subsurface intakes. The Panel could perform a reconnaissance-level review to identify alternative sites that should be the subject of a more in-depth analysis by the Panel or others and studied concurrently or at a later date. This reconnaissance level review should be considered a coarse screening. A fourth phase may entail a more in-depth analysis of alternate sites and if the ISTAP is involved may require additional expertise.

E. Qualifications and Recruitment Criteria for Panel Members

In Phase 1, the Panel is expected to include disciplines that as a whole should provide coverage of all of the following areas:

[2] The parties are aware that State Water Board staff is developing an amendment to the Ocean Plan that would address issues associated with desalinization facilities. The parties intend that the ISTAP process would be able to receive briefings on the progress and outputs of the SWRCB process (perhaps with State Board staff as technical advisors to this process).

- Subsurface intake design, construction, and/or operation
- Geophysical and/or hydrogeological study design and modeling
- Coastal processes and/or physical oceanography – hydrodynamics, sediment transport, sediment characterization, etc.
- Coastal engineering/construction methods/cost analysis
- Geophysical and/or hydrogeological characteristics of Orange County coastal areas
- Groundwater geochemistry

At each later phase both parties will work to define needed qualifications and disciplinary recruitment criteria. Other later phases of the Panel may include such disciplines as marine ecology or cost-benefit analysis.

Additional Recruitment Criteria
Panel members should possess demonstrated aptitude and capability in the following areas:

- Able to operate as an independent expert representing their professional discipline and experience in their participation in this ISTAP
- Experience providing scientific advice for developing public policy
- Ability to integrate multiple disciplinary perspectives
- Experience with highly contentious issues and high stakeholder interest
- Experience preparing reports for policy audiences
- Availability to work in a team setting
- Willingness to work with the expectation that the Panelists will author the report, accept attribution to the entire report, and sign the final report (Note: CONCUR will support the drafting and production of the report in all stages of work.)

Method of Panel Selection
Both parties, working with CONCUR, will jointly select the Panel. The credentials of potential members will be considered on their merits relative to the selection criteria listed above.

F. Technical Advisors
Individuals may also be considered for a potential Technical Advisor role. It is expected that a small number of Technical Advisors may be asked to make short presentations to contribute to the deliberations of the Panel and provide additional detail and context to support the Panel's work. It is understood that Technical Advisors are not expected to meet the Panelists' rigorous criteria for independence. Technical Advisors are not expected to participate in the entire duration of the Panel's work, but may be called in for specific topics. Technical Advisors will not participate in the internal Panel deliberations, nor will they be asked to co-author or co-sign the final Panel report.

G. Method of Panel Recruitment
Both parties will consider criteria for the recruitment of Panelists and will use their professional networks to identify and suggest potential candidates. CONCUR will also use its professional network and make suggestions for potential candidates. Together, all parties will form a pool of candidates, which the agency staff, Poseidon, and CONCUR will jointly review with the aim of reaching agreement on the full Panel.

H. Administrative Arrangements and Operating Procedures
Both parties agree to the following provisions to ensure proper administration of the independent Panel:

1. Poseidon will provide funds to CONCUR, Inc. in advance of convening the Panel in an amount outlined by the Scope of Work developed by the facilitator.

2. Panel members will be remunerated by CONCUR, with the panelist's client understood to be the ISTAP.

3. Poseidon and agency staff will work with the facilitator to draft and proceed jointly to agree to the Terms of Reference (TOR). By mutual agreement of all parties, supplemental Terms of Reference may be incorporated at a later time.

4. The Panel, once constituted, will be asked to verbally communicate with Poseidon or agency staff only with representatives of both parties participating via the facilitator *(or with cc's to CONCUR)*. Questions or comments (including requests for additional information, data, or documents) should be stated in writing, with copies to both parties.

5. The Panel's work products are to reflect its independent scientific and technical judgment. Both agency staff and Poseidon will contribute information and review, but neither agency staff nor Poseidon will alter the work products, and there will be clear identification as to their independent status. Both parties will not alter work products, but will have opportunities to comment on draft work products, as will members of the public.

6. Questions will be posed to the Panel via a written program of work and supplementary memoranda. The Panel will respond with written statements, which may be supplemented with briefings.

7. CONCUR shall designate Principal Scott McCreary as the facilitator for directing the activities of the Panel and as the point of administrative contact. The Poseidon point of contact is Stan Williams. The Coastal Commission point of contact is Tom Luster.

8. The Panel's formal contacts with agencies, stakeholders and the public will be via procedures established through the Terms of Reference in consultation with Poseidon, agency staff, and CONCUR to strike a balance between the Panel's independence and ensuring fair and open access to the Panel and its work products.

I. Meeting Formats
Meetings of the Panel will be of three types:

- **Panel meetings** with structured opportunities for observers, representatives of agencies, and Technical Advisors (as described in F. above) to hear and make presentations and public comments.
- **Work sessions**, where the Panel may interact with invited Technical Advisors
- **In person or by-telephone work sessions** of the Panel.

CONCUR will prepare summaries of deliberations of all meetings. Summaries will be made available to the public. CONCUR will be the primary point of contact for handling press inquiries. Agency staff and Poseidon may consider the use of short, joint statements at intervals.

Panel members will need to review critical Commission and other documents so that their comments and recommendations are based on:

- The best possible understanding of the physical requirements of desalination, local land use conditions and limitations, marine ecosystems in the region of the proposed project;
- An understanding of the policy and administrative context of Commission deliberations;
- The timelines and targets for Commission permit review and related actions;
- The timelines and targets for Poseidon's corporate planning.

J. Authorship, Attribution, Distribution and Dissemination of the Panel's Report
The expectation is that Panel members will author, accept attribution, and sign the final report in its entirety. The Panel will submit the results of its review to Poseidon and agency staff simultaneously. If requested, the Panel may present the findings of its report in a Workshop format or briefing to the Commission.

K. Final Report Becomes Part of the Public Record
Upon its presentation, this Report becomes part of the public record.

L. Statement of Concurrence
We hereby concur and agree to this Terms of Reference document and funding requirements as described in this document.

Coastal Commission:		Poseidon Resources (Surfside) LLC:	
Chief Deputy	Date: 4/30/2014		Date: 4/18/2014
	Date: 4/30/14		Date: 4/18/2014