ATTACHMENT C

June 25, 2015

Laura Horton
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601 Gateway Blvd., Suite 1000
South San Francisco, CA 94080

Subject: Comments on the Draft Environmental Impact Report Prepared for the Monterey Peninsula Water Supply Project

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Dear Ms. Horton:

This letter contains my comments on the Draft Environmental Impact Report (DEIR) for the Monterey Peninsula Water Supply Project (Project or Proposed Project) prepared by San Diego County (County) under the California Environmental Quality Act (CEQA).

I am a conservation biologist with professional experience in wildlife ecology and natural resource management, and since 1994 have maintained U.S. Fish and Wildlife (USFWS) Recovery permits for listed species under the Endangered Species Act (ESA). I have served as a biological resources expert on well over a hundred projects on private, public, and military lands, primarily in California. The scope of work I have conducted both independently and as a supervisor has included enabling clients to evaluate and pursue environmental compliance, restoration, mitigation, and research as related to biological resources; as well as submitting written reports for such types of work. This work often included assessing and reviewing actions pursuant to CEQA and the National Environmental Policy Act (NEPA), along with surveying, preparing, and contributing to Biological Reports, Assessments, and related documents.

My research on highly endangered and rare reptile, mammal, and bird species in Latin America has received various awards, including the National Geographic Research and Exploration Award and the National Commission for Scientific and Technological Research Award for the Novel Researcher. I have also served as an on- and off-camera technical consultant for wildlife documentaries filmed by National Geographic Television, Discovery Channel, and BBC.

I have gained particular knowledge of the biological resource issues associated with the Project through my work on numerous other projects in California, including several years of surveys on coastal development projects pre-, during, and post-construction activities. My comments are based upon first-hand observations, on my review of the environmental documents prepared for the Project, a review of scientific literature pertaining to biological resources known to occur in and near the Project area, consultation with other biological resource experts, and the knowledge and experience I have acquired throughout my 22 years of working in the field of natural resources management.

Project Scope

The California-American Water Company (CalAm) is proposing the Monterey Peninsula Water Supply Project with the intention of developing "up to" 9,752 acre-feet per year (afy) of water supplies to help meet a DEIR predicted future average annual demand of 15,296 afy in CalAm's Monterey District service area. The Project is highly ambitious in that it purports to provide sufficient supplies of water for the multiple regional demands associated with "existing legal lots of record, 'payback' to the Seaside Groundwater Basin, water entitlements held by the Pebble Beach Company and other Del Monte Forest property owners, and tourism demand under a recovered economy".[1]

According to the DIER, the project area extends over 14 miles from the northern site of the proposed desalination plant to the western end of the associated proposed pipeline, and east approximately eight miles to the community of Hidden Hills. In addition to the construction of a desalination plant located on the Salinas River, the Project's massive scope is exemplified by the fact that development also includes drilling of "up to" ten subsurface slant wells roughly west of the desalination plant, approximately 30 miles of pipelines, two pump stations, and water storage tanks the exact numbers of which are unspecified by the DEIR. The project also includes improvements to the existing Seaside Groundwater Basin (SGB) aquifer storage and recovery system facilities (ASR); including a new ASR injection/extraction well.

The DEIR Fails to Present the High Degree of Importance of the Project Area to Regional Conservation of Biodiversity.

The area proposed for the Project is incredibly rich in biological terms. The DEIR only vaguely alludes to the overall biological importance by stating that Monterey County has some of the most diverse flora in California. More than that, the area has been identified as an important conservation "hot spot" due in part to its high endemism of species, and it has been described as one of the most essential coastal regions in the world in terms of conservation of biodiversity of plants and wildlife.[2,3,4] Biologists recognize the importance of thorough and enlightened

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[1] DEIR 3-1, 3-3

[2] Davis, E. B., Koo, M. S., Conroy, C., Patton, J. L., & Moritz, C. 2008. The California hotspots project: Identifying regions of rapid diversification of mammals. *Molecular Ecology, 17*(1), 120-138. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1111/j.1365-294X.2007.03469.x

management conservation strategies in the region, especially where coastal development pressures are increasing, stating that for this area's rare habitats

> "Habitat conversion will clearly outpace expansion of formal protected-area networks, and conservationists must augment this traditional strategy with new approaches to sustain the Mediterranean biota."[5]

This statement emphasizes the importance of protections prescribed and implemented in areas exactly such as those proposed for development by this Project.

Historical and recent data reflect the biological sensitivity of this area for both aquatic and terrestrial habitats and species. The U.S. Fish and Wildlife Service (2013)[6] reports no less than 35 listed threatened or endangered species that "occur within or may be affected by projects in the area". In terms of terrestrial species only, the California Natural Diversity Database (CNDDB) denotes within the Project area quads the occurrence of 17 Endangered Species Act (ESA) listed species, 10 California Endangered Species Act (CESA) listed species, and twenty-four Species of Special Concern, including one currently under petition review for federal endangered status (the tricolored blackbird).

The DEIR Failed to Adequately Survey and Analyze the Potential for Sensitive Species To Occur

In light of the uniquely high biodiversity and sensitivity of the area, combined with the broad geographic scope of the project, and in consideration of the large number of proposed projects next to and near this Project site contributing to cumulative impacts on sensitive species, it is a serious oversight that the DEIR fails to present current, ground-truthed data for the many sensitive wildlife species for which there is the potential to occur on-site or in nearby habitat, or have historically been present.

The DEIR does at least recognize the difference between generic habitat assessments and focused surveys where it mentions in a footnote,

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[3] Keledjian, A. J., & Mesnick, S. 2013. The impacts of El Niño conditions on California sea lion (*Zalophus californianus*) fisheries interactions: Predicting spatial and temporal hotspots along the California coast. *Aquatic Mammals*, *39*(3), 221-232. Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/1439262501?accountid=14068

[4] Maxwell, S. M. 2010. *Effectiveness of marine protected areas for top predators along the central west African and US west coasts* (Order No. 3421299). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (751629118). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/751629118?accountid=14068

[5] Cox, R. L., & Underwood, E. C. 2011. The importance of conserving biodiversity outside of protected areas in Mediterranean ecosystems. *PLoS One*, *6*(1) doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1371/journal.pone.0014508

[6] USFWS. 2013. Endangered Species Division, Letter to Michelle Giolli. (Document Number 130408113454). 8 April. TS.

"Reconnaissance-level field surveys are conducted for the purpose of **generally** describing the vegetation communities present within a project area and assessing the potential for special-status species to occur within the project area. Focused surveys are conducted to determine the presence or absence of a certain species or habitat type. Protocol-level surveys are a type of focused survey utilizing specific survey protocol as defined by a regulatory agency[emphasis added]".[7]

The DEIR states that impact analysis described for terrestrial biological resources are "based on special-status species observations available to Environmental Science Associates (ESA) as of May 9, 2014".[8] However, the 'observations' reported as such are far from sufficient for such impact analysis. According to the DEIR, all terrestrial Project site surveys conducted were "reconnaissance-level" surveys, the sum total of which comprised 9 days spread over the course of four years, specifically, on May 17, June 5, and September 20, 2012; on March 6, 7, and 26, 2013; May 9, 2013; April 24, 2014; and June 25, 2014. Even these basic surveys were not conducted comprehensively for the entire site, as the DEIR notes that their consultant's biologists did not survey a segment of the proposed pipeline that traverses the Presidio of Monterey and the Terminal Reservoir/ASR Pump Station site "due to access restrictions." Additionally, necessary details regarding survey methodology and the biologists who conducted each survey are lacking as well.

Studies in the Monterey Bay area show not only abundance but presence of coastal species of various taxa can be highly variable based from year to year based upon factors such as drought, El Niño conditions, and related prey-predator cycles.[9] And yet, instead of conducting project-level, protocol (focused) surveys for any of the many sensitive wildlife species potentially present onsite as should have occurred at the least for several federally ESA listed species, the DEIR relies largely on databases, including the CNDDB, not only to predict presence/absence of species, but the degree to which such a predicted species' status may be mitigated if and when Project impacts to the species are deemed significant based upon this prediction. Such predictions are not supported by actual, formal scientific observations made on the ground by biologists who specialize in detecting the species for which protocol surveys have been required due to their protected status and resultant sensitivity to harassment.

For federally endangered and threatened species, protocol surveys are conducted by permitted biologists as they have the proven experience (as verified by USFWS, the permitting agency) to be able to detect the species and other essential characteristics important to individual and

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[7] DEIR 4.6-3

[8] *Ibid.*

[9] Benson, S. R. 2002. *Ecosystem studies of marine mammals and seabirds in Monterey bay, California, 1996--1999* (Order No. 1408777). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (230788013). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview

subpopulations assessments, including density, behavioral factors, breeding status, etc. Permitted biologists not only have the responsibility of formally reporting all such observations to USFWS, but also to ensure harassment of species during surveys is minimized by default of their knowledge and training for the species in question.

The DEIR, however, does not recognize this important and widely accepted aspect of protected species surveys, and made little attempt to use permitted biologists to determine the most current site-specific status threatened or endangered wildlife species on or near the site. It instead referred to biologists conducting plant and habitat assessments to indicate, via anecdotal observations (as opposed to protocol surveys), or inferences from habitat onsite, to make protected species status determinations in respect to field observations. This is a clear oversight in the DEIR, as species presence/ absence, and indications of 'likelihood to occur" are guidelines intended to assist consultants in determining where site-specific, protocol level surveys are warranted in order to determine essential details like current species density, nesting or breeding status, species richness, and all of the other components that are part of a protocol survey and cannot be completely derived from any given database.

Using databases is a standard part of gathering site-specific data, but it cannot replace protocol surveys in its specificity or accuracy. For example, the CNDDB is relied upon heavily by the DEIR to make species impact determinations. However, the CNDDB is limited in its ability to predict species currently present at any given locale; instead it presents at best a conservative description of what may or may not be present on site. Many species sightings are not actually reported on the public CNDDB. For instance, according to the California Department of Fish and Wildlife CNDDB coordinator, for most birds the CNDDB keeps track of and maps only those occurrences that can be associated with "evidence of nesting". Observations of flyovers or foraging are generally not mapped into CNDDB as an 'Element Occurrence', the standard mapping unit, based on NatureServe natural heritage program methodology.[10] The CNDDB biologists stated that the database represents summaries of species occurrences; not individual detections. "Given limited resources to map submissions, the CNDDB tries to map occurrences that relate to an important aspect of life history." (*pers. comm*, P. McIntyre, June 6, 2015).

As importantly, CNDDB records are voluntarily reported and only exist for locations that have been surveyed to varying degrees. As a result, the lack of CNDDB records, or records from any other database, does not mean a species is absent. To help get this message across, the California Department of Fish and Wildlife posts a disclaimer on its California Natural Diversity Data Base web site:

> "We work very hard to keep the CNDDB and the Spotted Owl Database as current and up-to-date as possible given our capabilities and resources. However, we cannot and do not portray the CNDDB as an exhaustive and comprehensive inventory of all rare species and natural communities statewide. Field verification for the presence or

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[10] http://www.natureserve.org/conservation-tools/standards-methods. Retrieved June 18, 2015.

absence of sensitive species will always be an important obligation of our customers."[11]

Similarly, the California Native Plant Society's Inventory of Rare and Endangered Species states the following: "A reminder: Species not recorded for a given area may nonetheless be present, especially where favorable conditions occur."[12]

As the DEIR acknowledges, several protected (special-status) terrestrial wildlife species have the potential to occur in the Project area, and have the potential to be significantly impacted (Table 4.6-4). These include the Smith's blue butterfly, California tiger salamander, California red-legged frog, Western snowy plover, Western pond turtle, black legless lizard, silvery legless lizard, coast horned lizard, tricolored blackbird, Western burrowing owl, red-shouldered hawk, red-tailed hawk, white-tailed kite, American peregrine falcon, American kestrel, loggerhead shrike, pallid bat, Western red bat, Monterey dusky-footed woodrat, Monterey shrew, American badger (among other species).

Because focused surveys have not been conducted for any of these species, the DEIR lacks the data needed to analyze Project impacts and formulate appropriate and adequate mitigation measures.

The DEIR assumes some of these special status species *may* be encountered, and proposes to mitigate impacts by various measures. However, without knowledge of the actual breeding status, specific locations, density, etc. of these species, along with details regarding the survey methodology made available for review, it is impossible to analyze or verify the degree to which any given mitigation measures will be sufficient to reduce impacts, nor can one assess the adequacy of any given success criteria for mitigation measures. Simply put, impacts cannot be adequately analyzed when data from recent, comprehensive focused surveys are almost completely lacking. These should be conducted and made available for public review in a Project-wide Biological Assessment, which at present does not exist.

Concurrently, all conclusions that impacts would be less than significant due to the lack of documented occurrences are invalid.

Some Impacts Dismissed or Considered Mitigated with Poor Justification

<u>Wildlife Corridors</u>

The DEIR asserts that there would be no impacts to established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites because "the proposed project does not include the placement of structures within creeks, rivers, or other waterways and there are no established native resident or migratory wildlife corridors or wildlife nurseries within the project area. The terrestrial wildlife habitat in the project area is fragmented by agricultural fields, residential developments, commercial / industrial developments, and roads

[11] http://www.dfg.ca.gov/biogeodata/cnddb/cnddb_info.asp (Retrieved June 18, 2015)
[12] https://archive.is/northcoastcnps.org (Retrieved June 20, 2015)

and does not serve as wildlife movement corridors."[13] Wildlife corridors and nurseries certainly can and do occur in agricultural and industrial areas. For instance, research on peregrine falcons - a sensitive species known to have occurred recently within or near the Project area according to the CNDDB - have been observed to utilize non-forested and agricultural habitat as important post-fledgling corridors.[14] Snakes have been found to use agricultural habitats as important corridors, particularly in urbanized landscapes.[15] Movement corridors for various taxa often occur along watercourses, or follow the cover of shrubs or trees. Corridors and nursery areas vary by species, and include movement to and from, for example, nesting areas to foraging areas, feeding areas to hilltopping areas, one part of range to another part of range, allowing genetic exchange and viability.[16, 17] Therefore the conclusion that the project does not significantly impact corridors is not supported by adequate evidence. Existing corridors within and next to the project, including those incorporating agricultural, partly developed, and disturbed habitat, must be assessed with greater detail and supporting documentation.

Mitigation Measures Proposed for Terrestrial Biological Resources are Inadequate

There are various incidences where impacts proposed as significant are considered mitigated to below significance with the following measures, even though the specifics of these measures are not identified, and at times deferred to the biologist or another agency:

Mitigation Measure 4.6-1a. Biologist oversight of construction:[18] In the case of a potential sensitive species take or harassment, the biologist will not have direct stop work authority, but may report to the site supervisor who does have this authority. I have witnessed this scenario many times in my experience as an environmental consultant, where the onsite lead biologist is not given the authority to cease any actions that threaten or are in the process of causing impact to sensitive species or their habitats, or any other related environmental violations. This in itself is a serious problem on these construction sites, due largely to the delays inherent

[13] DEIR 4.6-97

[14] Dzialak, M. R. (2003). *Peregrine falcon, Falco peregrinus, reintroduction in cliff habitat in Kentucky* (Order No. 3117498). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (305319211). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/305319211?accountid=14068

[15] Andrus, W. (2011). *Ecology and conservation of prairie rattlesnakes (Crotalus viridis viridis) in relation to movement in a fragmented urban environment* (Order No. MR80171). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (895976697). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/895976697?accountid=14068

[16] Nabe-Nielsen, J., Sibly, R. M., Forchhammer, M. C., Forbes, V. E., & Topping, C. J. (2010). The effects of landscape modifications on the long-term persistence of animal populations. *PLoS One, 5*(1) doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1371/journal.pone.0008932

[17] Sales, J. (2007). *Determining the suitability of functional landscapes and wildlife corridors utilizing conservation GIS methods in Denton County, Texas* (Order No. 1449625). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (304827551). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/304827551?accountid=14068

[18] DEIR 4.6-125

within the process, and the conflicts inherent when relying on "construction or operational site supervisors" to stop work on projects for which their primary responsibility, reinforced by their employer, is ensuring work proceeds with little to no interruption or delays. This scenario is ripe for conflict, and more often than not results in the impacts to species and habitats going unreported, under-reported, or the situation being settled in a manner that does not comply with the spirit or intent of the mitigation measure or protocol(s).

According to this mitigation measure it appears that the lead biologist is expected to relocate any special status species that are 'at risk'. The DEIR does not specify what 'at risk' entails, nor any protocol for relocation methodology, nor even which species or taxa are being referred to in the first place. Confusingly, Mitigation Measure 4.6-1c(j) says that if special status species are found on site during construction, construction activities shall cease (under whose authority it does not say) while everyone waits for the animal to move "on its own outside of the project area (if possible)". If it is a plant species to be relocated, the DEIR does not identify to where the plant species shall be relocated, or with what methodology, despite the fact that areas of the Project site are occupied by threatened and endangered plants species for which the risk of impacts on site could arise frequently. Apparently consideration of where to relocate to has been deferred and delegated to the field biologist, and goes undescribed. "Violations shall be thoroughly documented as part of compliance monitoring." There is no consideration that it might not be possible to easily locate certain species, nor any discussion of what measures would be undertaken to reduce impacts if such is the case.

Mitigation Measure 4.6-1b. Crew training:[19] The training will include information on species and "the measures CalAm and/or its contractors have committed to implementing to protect species status species." What these measures are these? They are not specified, and therefore cannot be assessed for adequacy.

Mitigation measure 4.6-1e Avoidance of special plants:[20] The DEIR states that sensitive plants will be flagged and avoided where possible, or salvaged, or otherwise impacts will be mitigated as a result of a consult with USFWS and/or CDFW, the details for which are not provided. Because this is a deferral to the future, mitigation actions to be taken are indeterminate and unspecified, and thus inadequate to determine efficacy of the mitigation. The DEIR also states that "compensation for temporary or permanent loss of special status plant occurrences, in the form of land purchase or restoration [on or off site], shall be provided to a level acceptable to the resource agencies with jurisdiction over those species." This is also deferment of mitigation prescriptions, it also provides no information for the reviewer to determine if and how impacts will be adequately reduced below significant, nor does it make any mention of what success criteria will be used to determine impacts have been adequately reduced.

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[19] DEIR 4.6-126
[20] DEIR 4.6-130

Mitigation measure 4.6-1f Avoidance of Smith's blue butterfly:[21] The DEIR states that the Applicant will conduct a section 7 consultation implement all measures required by USFWS. Once again this amounts to mitigation measures being deferred, unspecified, and thus impossible to assess for efficacy.

Mitigation measure 4.6-1g Avoidance of black legless lizard, silvery legless lizard, and coast horned lizard:[22] The lead biologist is presumed to prepare a relocation plan, and use relocation as a primary mitigation measure. The DEIR states that "only relocation sites that are not over-populated and have suitable habitat conditions shall be used", however provides no basis for determining such a status of any given relocation destination. There is no information provided about the existence of such sites anywhere, nor is there data on likelihood of survival. The biologist shall survey for lizards by raking under bushes and walking "appropriately spaced transects" 24 hours before construction. These mitigation descriptions and methods are inadequate, poorly supported, and poorly described, and result in the reviewer being unable to reasonably determine their efficacy. Each species has different natural histories, different bias in respect to detectability during any given time and method of surveying. To assume the same protocol (as of yet undescribed) will work in detecting, not to mention relocating, these species will be adequate is unfounded. In my experience the taxa most susceptible to incidental mortality on construction sites are snakes, due to difficulty of detection by biologists and ease of hidden movements on the part of the animal. I have caught, documented, and released over 800 snakes in the course of my natural history and consulting research, and to say these animals are highly susceptible to anthropogenic impacts would be an understatement. Such realities must be taken into consideration when reviewing mitigation measures, something the reviewing public cannot do in this case because no necessary details are provided.

Impacts to Coastal Dunes: Coastal dune habitat has been virtually extirpated from most parts of southern California. As such, in California it is one of our most impacted, most rare, and most fragile habitats. Yet because it is critical as a barrier to the sea, it is also one of our most important habitats.[23] Part of the project site is considered mostly "primary" habitat according to the City of Marina's Local Coastal Plan, with some "secondary" habitat (habitat adjacent to primary), and constitutes a an Environmentally Sensitive Habitat Area pursuant to the Coastal Act.[24] The habitat should thus by definition be protected against habitat losses; where "only uses dependent on coastal resources shall be permitted in such areas".[25] The DEIR's proposed actions appear to conflict with their own description of this Environmentally Sensitive Habitat Area required management.

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[21] DEIR 4.6-131

[22] DEIR 4.6-132

[23] Martinez, M. L. and Psuty, N.P. (eds.) 2004. Coastal Dunes: Ecology and Conservation. Ecological Studies Vol. 171, Springer-Verlag Berlin.

[24] DEIR 4.6-68

[25] *Ibid.*

The hydrology of sand systems such as those found in dune habitats in complicated.[26] In a coastal setting such as this, the dune plants are typically neither xerophytic nor halophytic.[27] They typically germinate during a rain event and rapidly send down a fine root through wet sand until it reaches the water table. Fresh water "floats" on the salt. The ground water is drawn toward the surface, and if the dune gets built higher, complicated physics results in the water being drawn up so that the freshwater lens used by the plants stays a relatively stable distance from the surface of the dune, whether the dune is being built higher, or eroded lower.[28] In short, the effect and resultant impacts of imposing the construction of ten extraction wells through this intricate and sensitive hydrological system, and providing a strong pull toward the ocean, is not addressed but should be for adequate impact analysis.

Impacts to critical habitats and sensitive habitats: Acreages of habitat loss for these types of Project related habitats are not estimated in the DEIR's analysis. Instead of providing a ratio of mitigation for loss of habitat, most of the impacts are considered temporary with little further discussion, unless they are actually within a structural footprint. Even that kind of impact is not quantified for purposes of compensatory mitigation. Instead, the measures (including those listed above) are erroneously considered to mitigate habitat loss to below a level of significance, despite their inadequacy of detail, or are simply being deferred for future actions that may or may not occur, and are not detailed. Similarly wetlands and jurisdictional waters are not delineated or quantified, but are considered mitigated with the above listed measures.

THE DEIR FAILS TO PROVIDE ADEQUATE DATA, IMPACT ANALYSIS, AND MITIGATION MEASURES FOR THE WESTERN SNOWY PLOVER (*Charadrius alexandrinus nivosus*)

Status of The Snowy Plover Regionally And On The Project Site

Historically, thousands of snowy plovers nested along the California coast, however by the late 1970s the snowy plover had disappeared from significant parts of its coastal California breeding range, and biologists estimate the breeding population along the coast has now dwindled to

[26] Zarnetske, P. L. 2011. *The influence of biophysical feedbacks and species interactions on grass invasions and coastal dune morphology in the Pacific northwest, USA* (Order No. 3492886). Available From ProQuest Dissertations & Theses Full Text; ProQuest Dissertations & Theses Global. (918818070). Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/918818070?accountid=14068

[27] Martinez, M. L. and Psuty, N.P. (eds.) 2004. Coastal Dunes: Ecology and Conservation. Ecological Studies Vol. 171, Springer-Verlag Berlin.

[28] *Ibid.*

less than 1,500 birds.[29, 30, 31] The Pacific Coast population of the western snowy plover (*Charadrius nivosus nivosus*) was federally listed as Threatened in 1993,[32] and is a Bird Species of Special Concern in California. A Recovery Plan for the species was finally published in 2007, and a Final Rule for the revised designation of critical habitat was published in June 2012.[33]

Threats and Types of Impacts to the Species

The primary threats to Pacific coast population of the western snowy plover are decreased habitat availability and anthropogenic disturbances to habitat.[34] Specific causes and effects vary geographically, but include fragmentation, degradation, and loss of habitat due to encroachment, habitat erosion, expansion of urban development and increased recreational beach use.[35] Increasingly, the impacts of climate change and resultant sea level rise are contributing to the cumulative impacts on populations. These adverse effects often are exacerbated by various anthropogenic influences that benefit or attract predators of the snowy plover.[36]

The Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (Recovery Plan) specifically identifies habitat degradation caused by human disturbance, urban development, introduced species such as beachgrass, and expanding predator populations as resulting in significant decline in active nesting areas and in the size of the breeding and wintering populations, while contributing to poorly analyzed, cumulative type of habitat loss for western snowy plovers.[37]

In addition to causing direct loss of habitat, urban development causes a suite of other direct

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[29] WesternSnowyPlover.org. n.d. Western Snowy Plover Natural History and Population Trends. *Adapted from U.S. Fish and Wildlife Western Snowy Plover Pacific Coast Population Draft Recovery Plan*, May 2001. Available at: <http://www.westernsnowyplover.org/pdfs/plover_natural_history.pdf> Retrieved June 20 2015. *See also* Thomas SM, JE Lyons, BA Andres, EE T-Smith, E Palacios, JF Cavitt, JA Royle, SD Fellows, K Maty, WH Howe, E Mellink, S Melvin, T Zimmerman. 2012. Population Size of Snowy Plovers Breeding in North America. *Waterbirds* 35(1):1-14.

[30] *Ibid.*

[31] Morrison RIG, BJ McCaffery, RE Gill, SK Skagen, SL Jones, GW Page, CL Gratto-Trevor, BA Andres. 2006. Population estimates of North American shorebirds. *Wader Study Group Bulletin* 111:66-84.

[32] http://www.fws.gov/arcata/es/birds/WSP/documents/1993Mar5%20Determination%20of%20Threatened%20Status%20for%20WSP%2058%20FR%2012864.pdf (Retrieved June 20, 2015).

[33] http://www.fws.gov/arcata/es/birds/WSP/documents/WSPCH_June2012/6-19-2012_FR_rule.pdf (Retrieved June 21, 2015)

[34] MacDonald B, Longcore, T Dark, S. 2010. Habitat suitability modeling for Western Snowy Plover in Central California. The Urban Wildlands Group, Los Angeles, California, 129 pp. *See also* United States Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751.

[35] United States Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751.

[36] *Ibid.*

[37] *Ibid.*

and indirect impacts that adversely affect plovers. For example, increased development increases human use of the beach, thereby increasing disturbance to plovers.[38] In addition, the value of breeding and wintering habitat is diminished by increased levels of illumination at night (e.g., for parking, construction activities); increased sound and vibration levels; increased attraction of predators due to increased sources of garbage and other anthropogenic food attractants, and pollution drift.[39] Finally, activities such as beach raking and debris (e.g., driftwood) collection remove habitat features for both plovers and their prey, and precludes nests from being established.[40]

The Pacific coast population of the western snowy plover has continued to decline despite its listed status protections and development of the Recovery Plan. Point Blue Conservation Science (Point Blue), in collaboration with the USFWS and California Department of Parks and Recreation, has been monitoring the status of nesting snowy plovers along the coast of Monterey Bay and for the past 30 years, and in northern Santa Cruz County since 1988.[41] At the end of 2012 they issued a report of the snowy plover's nesting status in these areas, including an assessment of the species' response to management agencies efforts to enhance breeding success and population size.[42] According to the report the plovers experienced a 10% decrease from the previous year, with no plovers in detected in Santa Cruz beaches for the third year, thus reinforcing the elevated importance of the nearby population in Monterey Bay area where the Project site is located. Specifically, the report stated

> "The plovers experienced subpar breeding success in 2012. Their clutch-hatching rate was 51.0 % on Monterey Bay beaches. These rates were well below their respective averages from 1999-2011. The hatching rate on the beaches was 21% below the 64% average of the previous 13 years."

They also reported that only 28-30% of the chicks that hatched on the beaches fledged; a rate about 32% below the average of 42.4% from 1999-2011. Fledging rates were below 10% at one survey site (Martin Property) that is in close proximity to the Project's proposed slant well site.

It is important to have detailed information regarding just how close this particular nesting site is to the Project, especially in consideration of the fact that that is suffering such severely reduced breeding success. However due to the DEIR's:

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38 *Ibid.*

39 *Ibid.*

40 *Ibid.*

41 Point Blue Conservation Science. 2014. Nesting of the Snowy Plover in the Monterey Bay Area, California in 2013. Point Blue Conservation Science, Petaluma (CA). 32 pp.

42 Page G. W, Neuman K. K., Warriner J. C., Warriner J. S., Eyster C., Erbes, Dixon D., and Palkovic A., (December 2012). Nesting of the Snowy Plover in the Monterey, California in 2012. PRBO Conservation Science Publication # 1898.

(a) Complete lack of focused, protocol surveys for snowy plovers, or

(b) Lack of provisioning of data for public review regarding nest monitoring by other research agencies, including specific nesting grounds locations and numbers of breeding pairs over the past 5 plus years by other researchers, and

(c) Poor map detail and quality regarding adequate location details of Project components and proximity of current breeding pairs,

it is impossible to make such a determination, thus making it impossible for the public to thoroughly and accurately assess the impact of the Project's activities in this area to this segment of the plover population, and thus the regional population as a whole. This same argument can be made project-wide, since within the DEIR no such recent, detailed data regarding the specific subpopulation status of breeding pairs were provided for review, nor were protocol surveys conducted, or directly reported and mapped in detail for any segment of the Project, including Project development sites in close proximity to snowy plover critical habitat (as delineated by DEIR map 4.6-3).

The Point Blue researchers concluded that the consequence of the low number of fledglings in 2012 will likely be a smaller breeding population in the Monterey Bay area in 2013, and their prediction was correct. The authors released a monitoring update for the 2013 breeding season, where once again breeding success was reported as declining compared to previous years:

> "Plovers experienced another year of subpar breeding success in the Monterey Bay area in 2013. Clutch hatching rate was 54% and chick fledging rate 31% below the prior 14-year average. As a result, the total of 116 fledges was 51% lower than the average of the prior 14 years. The consequence of the low number of fledglings produced in 2013 will likely be a smaller breeding population in the Monterey Bay area in 2014. One fledged young per male is necessary to sustain a population experiencing average mortality levels but only 0.6 chicks per male fledged in 2013."[43]

Poor reproductive success has contributed to the decline and low population size of the western snowy plover, especially where it breeds on coastal beaches used by humans for recreation.[44] Due to increasingly low reproductive success, the Pacific coast population of the western snowy plover has become a management-dependent species. **To sustain the breeding population requires provision of undisturbed nesting areas and wintering habitat,** **as well** as

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[43] *Ibid.*

[44] Colwell MA, CB Millett, JJ Meyer, JN Hall, SJ Hurley, SE McAllister, AN Transou, RR LeValley. 2005. Snowy Plover reproductive success in beach and river habitats. Journal of Field Ornithology 76(4):373-382.

protection from predators.[45]

The DEIR Fails To Adequately Analyze Impacts To Snowy Plovers

The DEIR summarizes direct and indirect impacts and resultant proposed mitigation to snowy plovers at the slant well active mining as follows:

> "Western snowy plover may also use the entire subsurface slant well construction area for wintering. Construction of the slant wells in the CEMEX active mining area could occur year-round. The construction footprint for the northernmost well cluster is located within potential nesting habitat and construction of the northernmost well cluster during the breeding season would result in the temporary loss of potential nesting habitat. Construction during the snowy plover wintering season (October 1 through February 28) could directly or indirectly impact individual birds if present within or adjacent to the construction area. This would be a significant impact. With respect to wintering habitat, construction activities would be temporary, occurring in 6-month increments for a total of 18 months...There is abundant wintering habitat along the Monterey Bay shoreline north and south of the subsurface slant wells site. Any displaced birds would only be temporarily displaced to these areas. Therefore, installation of the subsurface slant wells would have less than significant impacts on wintering habitat."[46]

This is a spurious and circular argument. First, it states that construction could occur year-round. This would obviously result in significant impacts to breeding birds, however this is not addressed here. The DEIR then concedes that development during wintering season could also cause significant impacts, followed by the illogical determination that because wintering season construction would be temporary, that is, would have a limited time construct of approximately three years, that impacts would somehow be rendered insignificant. Exactly from what scientific evidence do they draw the conclusion that direct impacts to non-breeding birds in federally designated critical habitat will have no impact due to an arbitrary time duration of three years?

The Applicant also makes the argument that harassed birds can simply move elsewhere due to there being "abundant" wintering habitat nearby. This argument is biologically flawed and should be summarily dismissed. If impacts to species could be avoided simply by default of the

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[45] Colwell M, NS Burrell, MA. Hardy, K Kayano, JJ Muir, WJ Pearson, SA Peterson, KA Sesser. 2010. Arrival times, laying dates, and reproductive success of Snowy Plovers in two habitats in coastal northern California. Journal of Field Ornithology 81(4):349-360. *See also* Point Blue Conservation Science. 2014. Nesting of the Snowy Plover in the Monterey Bay Area, California in 2013. Point Blue Conservation Science, Petaluma (CA). 32 pp.

[46] DEIR 4.6-104

existence of the presence of similar habitat nearby, much of the impacts of any given development on a given species could be ignored by default.

There is abundant evidence demonstrating how erroneous the DEIR's assumption here is. Nearby habitat may or may not be as adequate for an individual's needs as habitat already occupied. There is no way for the Applicant to determine to what degree 'nearby' habitat destinations for displaced birds may be occupied by conspecifics that may defend resources, or to what density predators may occur, or if, for instance, whether nearby habitat may or may not have adequate microsites or other resources for optimal foraging, thus potentially impacting foraging success and fecundity.[47] Research demonstrates that when birds and other vertebrates emigrate to a new location, risk of mortality increases due to factors such as increased visibility, decreased familiarity with a new area relative to competitors, predators, and resources.[48] Mortality for passerine juveniles during their first year, including during non-breeding season, is typically very high and based on many factors that can be compromised by anthropogenic influences. [49, 50, 51, 52] The Applicant provides no way of determining the degree to which direct and indirect impacts from harassment will reduce survival of first year juveniles, especially given the DEIR makes little attempt to discuss actual site population details such as number of breeding pairs, local breeding success in terms of chicks fledged in a given area/year, etc.

For these reasons, and other discussed below, the argument that harassed wintering birds can simply go somewhere else over the course of three years, with minimal impact, during construction of their winter grounds is unacceptable. This impact analysis conclusion is fatally flawed and must be revisited with additional measures to mitigate significant impacts that will be a result of 18 months of construction in occupied, critical snowy plover habitat during non-

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[47] Nol, E., MacCulloch, K., Pollock, L., & McKinnon, L. 2014. Foraging ecology and time budgets of non-breeding shorebirds in coastal Cuba. *Journal of Tropical Ecology, 30*(4), 347-357. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1017/S0266467414000182

[48] Guy Morrison, R.I., R, K. R., & Niles, L. J. 2004. Declines In Wintering Populations Of Red Knots In Southern South America. *The Condor, 106*(1), 60-70. Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/211249469?accountid=14068

[49] Vitz, A. C., & Rodewald, A. D. 2011. Influence of condition and habitat use on survival of post-fledging songbirds. *The Condor, 113*(2), 400-411. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1525/cond.2011.100023

[50] Cano, L. S., Franco, C., Doval, G., Torés, A., Carbonell, I., & Telleräa, J. L. 2013. Conservation of iberian black storks (*Ciconia nigra*) outside breeding areas: Distribution, movements and mortality. *Bird Conservation International*, 23(4), 463-468. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1017/S0959270912000482

[51] Tökölyi, J., Mcnamara, J. M., Houston, A. I., & Barta, Z. 2012. Timing of avian reproduction in unpredictable environments. *Evolutionary Ecology, 26*(1), 25-42. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1007/s10682-011-9496-4

[52] Sandercock, B. K., Székely, T., & Kosztolányi, A. 2005. The Effects Of Age And Sex On The Apparent Survival Of Kentish Plovers Breeding In Southern Turkey. *The Condor, 107*(3), 583-596. Retrieved from http://search.proquest.com.jerome.stjohns.edu:81/docview/211305157?accountid=14068

breeding season. As the USFWS Recovery Plan indicates, snowy plover population recovery requires undisturbed wintering as well as breeding habitat; this fact must be taken into consideration for impact analysis. (See below for additional supporting evidence regarding wintering habitat, cumulative impacts, and resultant inadequacy of snowy plover impact analysis.)

The DEIR summarizes impacts to the roughly 9 miles of year-round occupied, snowy plover critical habitat that coincides the Source Water Pipeline footprint as follows,

> "Western snowy plover are known to use the western portion of the Source Water Pipeline alignment year-round. Construction noise or activity during the wintering season could directly or indirectly impact individual birds, a significant impact. There is abundant wintering habitat along the Monterey Bay shoreline north and south of the Source Water Pipeline and birds would only be temporarily displaced to these areas. Therefore, installation of the pipeline would have less than significant impacts to wintering habitat. Construction noise or activity associated with installation of the Source Water Pipeline during the western snowy plover breeding season could impact plovers by causing temporary flight of breeding birds and nest abandonment or failure, which would be significant. Construction work within the western end of the proposed Source Water Pipeline would result in the temporary loss of potential nesting habitat, a significant impact."

Mitigation Measure 4.6-1d, and 4.6-1n are referred to as mitigation for these impacts.[53] These measures are inadequate for the following reasons, and for reasons detailed further below:

1. Measure 4.6-1d defers aspects of mitigation to consultation with USFWS. This prohibits the reviewer to analyze the efficacy of details of mitigation protocols (or success criteria for such), as they cannot be provided when they are as of yet to be determined. Deferment of mitigation measures and relevant details to some point in the future does not allow for adequate impact analysis as required under CEQA, and provides no guarantee such measures will even be undertaken.

2. For construction *during the breeding season*, visual barriers are proposed to reduce impacts. In light of the complex causes and results of anthropogenic disturbances to breeding pairs and chicks, such barriers will not serve to significantly reduce the direct and indirect impacts of noise on breeding birds. Based upon the abundant evidence regarding the negative impact of human proximity to nesting birds, all construction during breeding season should simply be avoided, as impacts will be inevitable and unavoidable despite construction of a barrier, or the presence of a biologist on-site to detect breeding birds. The Applicant should be reminded that detection, imperfect avoidance mechanisms, and reporting cannot and will not serve to restore the impacts that will inevitably occur to birds in the form of harassment, injury, and possibly

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[53] DEIR 4.6-129

mortality if construction occurs within their nesting area during breeding season.

The DEIR states that impacts during breeding season will be minimized, under Measure 4.6-1d, by having an onsite biologist survey for nests and then "consult with USFWS to determine any additional avoidance or minimization measures should be implemented prior to initiating construction activities." Once again mitigation is deferred to a future consult / plan, thus making it impossible for the public to review the efficacy proposed mitigation.

Adequate details for analysis are not only preferable, but essential. For instance, the snowy plover management plans for the proposed Monterey Bay Shores Resort – to be constructed in snowy plover occupied habitat in proximity to the Project's western Source Water pipeline - prescribed establishing exclosures around the nesting area "during fledging" (the interval between hatching and flight) as a method to reduce breeding season construction impacts.[54] However, this has little value as a take avoidance measure because snowy plovers have precocial chicks that leave the nest within hours after hatching.[55] Snowy plover chicks coming from nests on the project site or adjacent areas would be susceptible to direct (e.g., crushing) and indirect (heightened vigilance that precludes normal foraging activities) impacts from Project construction activities.[56]

Additionally, Muir and Colwell (2010) studied the response of incubating plovers to an observer approaching the nests. Incubating plovers ceased incubation and left nests when an observer approached to within a mean distance of 80 ± 33 meters,[57] thus further demonstrating the ease at which harassment to plovers can occur with the presence of humans in the general area. This is just one example of where a thorough analysis of mitigation protocols is essential for determining adequacy of mitigation measures; without such an accurate assessment of impact reduction is impossible. Ultimately, **the only reliable way to prevent such impacts is to prohibit construction activities during the entire snowy plover breeding season.**

3. The Applicant proposes to develop a Habitat Mitigation and Monitoring Plan (HMMP) to complete its obligation to reduce impacts to below significant for sensitive species including the snowy plover. Once again the description of adequate impact reduction is deferred, and as a result the reviewer is unable to determine the adequacy of the measures given that no site-specific or species-specific details or methodology have been provided for a plan that has yet to be created. This prohibits adequate review by the public to determine if impacts will satisfactorily reduced to below significant as required by CEQA. Not only does it prohibit thorough analysis, it provides no guarantee that the HMMP will actually be developed and

[54] http://www.landwatch.org/pages/issuesactions/gm-ecoresort.html Retrieved June 22, 2015.
[55] Precocial chicks are well developed, feed themselves, run about, and regulate their body temperature.
[56] Muir JT, MA Cowell. 2010. Snowy Plovers Select Open Habitats for Courtship Scrapes and Nests. *Condor* 112(3):507-510.
[57] *Ibid.*

function as promised to reduce impacts as proposed, nor are any success criteria for such presented. The DEIR states the HMMP will be given to the appropriate agencies for approval, but it does not discuss what, if any, actions will be taken if any of the "appropriate" agencies (such as USFWS, or CDFW, or a local jurisdiction) do not all approve the final HMMP, nor how such an impasse would affect impact mitigation as the DEIR asserts will occur be default of the mention of a Plan that has yet to be created.

4. As discussed above, the DEIR erroneously asserts that construction during non-breeding season will have no impact, and thus impacts to critical habitat and breeding pairs can be made insignificant simply by avoiding - "where feasible" – construction during breeding season. However, the USFWS Recovery Plan specifically states,

> "A portion of the Pacific coast population of western snowy plovers do not migrate up or down the coast and are year round residents. Additionally, the majority of western snowy plovers that do migrate are site-faithful, returning to the same breeding areas in subsequent breeding seasons (Warriner et al. 1986, Stenzel et al. 1994). Western snowy plovers occasionally nest in exactly the same location as the previous year (Warriner et al. 1986)."[58]

The USFWS Snowy Plover Recovery Plan concludes that to bring the snowy plover population back to numbers above threatened status, it is essential to

> "prevent disturbance of breeding **and wintering** western snowy plovers by people and domestic animals. **Disturbance by humans and domestic animals causes significant adverse impacts to breeding and wintering western snowy plovers**. Because human disturbance is a primary factor affecting western snowy plover reproductive success, land managers should give the highest priority to implementation of management techniques to prevent disturbance of breeding birds. Management plans (Actions 3.3.1, 3.3.2, and 3.4) should include appropriate human/domestic animal access restrictions to prevent disturbance of western snowy plovers [emphasis added]".

The DEIR Fails to Adequately Mitigate Impacts to Snowy Plover Critical Habitat

The Project site not only supports snowy plovers, but as mentioned above is also located adjacent to federally designated critical habitat for the species. Critical habitat is defined as "a specific geographic area that is essential for the conservation of a threatened or endangered

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[58] USFWS. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751. *See also* Brindock KM, MA Colwell. 2011. Habitat Selection by Western Snowy Plovers During the Nonbreeding Season. Journal of Wildlife Management 75(4):786-793. (p. 138).

species and that may require special management and protection."[59] Within designated critical habitat, the USFWS protects areas that provide primary constituent elements (PCEs), which are the physical and biological features of a landscape that a species needs to survive and reproduce.[60] PCEs of critical habitat for the western snowy plover include:

1. Areas that are below heavily vegetated areas or developed areas and above the daily high tides;
2. Shoreline habitat areas for feeding, with no or very sparse vegetation, that are between the annual low tide or low-water flow and annual high tide or high-water flow, subject to inundation but not constantly under water, that support small invertebrates, such as crabs, worms, flies, beetles, spiders, sand hoppers, clams, and ostracods, that are essential food sources;
3. Surf- or water-deposited organic debris, such as seaweed (including kelp and eelgrass) or driftwood located on open substrates that supports and attracts small invertebrates described in PCE 2 for food, and provides cover or shelter from predators and weather, and assists in avoidance of detection (crypsis) for nests, chicks, and incubating adults; and
4. **Minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators, which provide relatively undisturbed areas for individual and population growth and for normal behavior.**[61] (Emphasis added).

Snowy plover critical habitat is within close proximity to the Project site, which currently provides these PCEs. It is difficult to assess with accuracy how close the critical habitat is to the construction footprint due to the poor quality of the Project's maps, specifically in terms of lack appropriate scale regarding critical habitat and detailed boundaries of the proposed Project maps. It is also important to note that construction sites consistently create impacts that extend beyond the footprint boundaries in the form of temporary roads, parking areas, poorly contained construction vehicles, noise, erosion, dust and other pollutants that can markedly diminish the minimally disturbed quality of critical habitat as described above. It is therefore possible that the Project site could significantly reduce the quality of snowy plover critical habitat as defined by these PCEs.[62] Additionally, without better, detailed maps it is impossible to completely assess impacts to critical habitat in multiple sections of the Project site.

According to Figure 4.6-3 of the DEIR, the Project proposes construction within critical habitat:

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[59] USFWS. 2002. Critical Habitat: What is it? Publication 703/358 2105. http://endangered.fws.gov. (Retrieved Jun 14, 2015).

[60] *Ibid.*

[61] Federal Register. 2012 Jun 19. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Pacific Coast Population of the Western Snowy Plover; Final Rule. Federal Register 77(118):36728-36869.

[62] USFWS. 2014 Apr 7. Letter to the California Coastal Commission. Attachment to Staff Report Addendum for April 8, 2014 for April 9, 2014 Hearing.

(a) At the proposed slant well site,

(b) At the west end of the proposed seawater intake system, and

In close proximity to critical habitat along approximately **9 miles of coastal snowy plover critical habitat** from the northern slant well proposed site to Monterey State Beach, at times within less than 400 feet off the development footprint, with virtually no major visual, structural, or auditory barriers (from existing development or geographic topography) between the proposed construction footprint and critical habitat.

The majority of this critical habitat has historically been occupied by nesting plovers, and was recorded as having active nesting during breeding season 2012 and 2013 by Point Blue researchers. Also, the site of the proposed seawater intake system pipeline where it runs west from the shoreline is historic nesting habitat for the snowy plover, according to Point Blue studies (*pers. comm.* Kriss Neuman June 23, 2015; Figure 1).[63,64]

The Importance of Avoiding Impacts to Non-breeding Season Snowy Plover Habitat is Seriously Underestimated

It is important to note that critical habitat provision #4 above does not distinguish between breeding and non-breeding season; in other words minimization of disturbance to critical habitat is important regardless of the time of year. Western snowy plovers are non-migratory residents along the Monterey coast, studies of banded birds demonstrate that many individuals occupy the same general habitat with little to no migration to other locales; researchers have discovered that banded plovers exhibited high site faithfulness, occupying small linear stretches of beach (752 +/- +/- 626 m).[65]

Successful management of highly sensitive, reduced populations such as those found along the Monterey coast require equal attention paid to avoiding significant impacts to occupied nesting habitat year-round, since the specific habitat, foraging, and predation factors continue to play a key role in population size and viability despite the time of year or breeding status of the individuals. In their Final Recovery Plan, the USFWS state that species' social factors play a role in attracting plovers to nest in any given area, and that the management of wintering flocks can be important relative to plover nesting sites.[66] In response to comments of their Final Recovery

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[63] Point Blue Conservation Science. 2014. Nesting of the Snowy Plover in the Monterey Bay Area, California in 2013. Point Blue Conservation Science, Petaluma (CA). 32 pp.

[64] Page G. W, Neuman K. K., Warriner J. C., Warriner J. S., Eyster C., Erbes, Dixon D., and Palkovic A., (December 2012). Nesting of the Snowy Plover in the Monterey, California in 2012. PRBO Conservation Science Publication # 1898.

[65] Brindock, K. M., & Colwell, M. A. 2011. Habitat selection by western snowy plovers during the nonbreeding season. Journal of Wildlife Management, 75(4), 786-793. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1002/jwmg.106

[66] USFWS. 2007. Western snowy plover (*Charadrius alexandrinus nivosas*). Pacific coast population Recovery Plan, Portland, Oregon, USA.

Plan, USFWS states that "Our designation of critical habitat recognizes the importance of both wintering and breeding areas."[67]

Western snowy plover research emphasizes the importance of careful management of habitat and nest sites during both breeding and non-breeding season, and how mitigation for impacts is not nearly as straightforward as avoiding major impacts during breeding season only, or relying on implementing avoidance measures for impact mitigation during breeding season only, such as fencing, nest exclosures, or 'educating' on-site workers about the presence of plovers.

Some snowy plover management scenarios have demonstrated that lethal predator removal and reducing human disturbance facilitate population recovery and may partially alleviate the reliance upon immigration of birds from other areas, a necessary function to maintain a viable subpopulation. However, in some cases the use of nest exclosures reduced population growth because they were found to compromise *adult* survival, thus highlighting the importance of maintaining viable source populations and re-evaluating the recovery objectives for plovers during both breeding and non-breeding seasons.[68]

It has been demonstrated that conservation of snowy plover populations in California, characterized by those located near and within the Project site, "requires managing habitat throughout the year, especially during winter when northern populations may be limited by food and predation".[69] Specific, often seemingly minor attributes of wintering sites can make a significant difference in survival and fecundity of individuals. Northern coastal sites occupied by plovers had more brown algae (e.g., *Macrocystis, Nereocystis, Postelsia*, and *Fucus*) and associated invertebrates (e.g., amphipods and flies), were wider, and had less vegetation than unoccupied sites, suggesting that wintering plovers select habitats with more food and where they could more easily detect predators.[70] Maintaining habitat year-round with attributes that support abundant food and reduce predation risk (i.e., wide beaches, limited obstructive cover) is important to individual survival and maintaining the Pacific Coast population of snowy plovers. Specifically, researchers concluded that,

> "Protecting occupied sites from human disturbance, which adversely alters nonbreeding habitat and directly causes mortality, may be essential for conserving the Pacific coast population of the snowy plover, and it may benefit other shorebirds."[71]

For these highly sensitive nesting populations that occur near and on the Project site, within

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[67] *Ibid.*

[68] Eberhart-Phillips, L., & Colwell, M. A. 2014. Conservation challenges of a sink: The viability of an isolated population of the snowy plover. *Bird Conservation International*, 24(3), 327-341. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1017/S0959270913000506

[69] Brindock, K. M., & Colwell, M. A. 2011. Habitat selection by western snowy plovers during the nonbreeding season. Journal of Wildlife Management, 75(4), 786-793. doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1002/jwmg.106

[70] *Ibid.*

[71] *Ibid.*

critical habitat, mitigation of the significant temporary, indirect, direct, and cumulative impacts of the Proposed Project requires more than is prescribed by the DEIR to reduce impacts below significant.

Plover Mortality Will Increase Due to Increase in Human Disturbance Despite Proposed Mitigation Measures

Disturbance by humans is a key factor in reducing or eliminating snowy plover nesting habitat.[72] Humans negatively impact plovers by causing: (1) destruction of nests and chicks; (2) increased disturbance leading to reduced incubation or brooding constancy; and (3) decreased foraging opportunities by adults and chicks.[73]

Direct mortality can occur when humans inadvertently step on chicks or them with mechanized vehicles.[74] Neither is mortality to birds due to nearby construction activities limited to chicks. As a professional environmental consultant specializing (in part) in wildlife monitoring for over 20 years, I have personally witnessed, as have other biologist construction monitors I have communicated with over time, that for various types of development - including pipeline installation - despite a myriad of mitigation protocols and best management approved and imposed under standard multi-agency permitting processes, mortalities of ground nesting and foraging birds, along with reptiles and rodents, are an inevitable result of construction traffic on any given construction site that occurs in a species habitat (*pers. comm*, Patrick Hord, Jan 2014; Jane Higginson June 2015; Dr. Kelly Smith May 2015). These mortalities occur despite imposed speed reductions, fencing, signage, right-of-way-restrictions, imposed nest 'buffers', educational trainings for workers, pre-construction nest surveys, and other typical mitigation measures that purport to reduce impacts during both breeding and non-breeding season development. For instance, on one construction site for a solar industrial complex, within the span of one month along one dirt road designated for construction traffic, over 30 flat-tailed horned lizards (a protected species) were inadvertently run over and killed due to their cryptic nature and attraction to the moisture provided by erosion control water trucks. The degree to which this phenomenon occurred was partly due to the construction site occurring near occupied critical habitat for the species, and had little to do with breeding season or status of the individuals.

Although it can be argued whether or not such inevitable mortalities are significant based on the numbers of individuals injured or killed, it cannot be denied that when the mortalities occur

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[72] MacDonald B, T Longcore, S Dark. 2010. Habitat suitability modeling for Western Snowy Plover in Central California. The Urban Wildlands Group, Los Angeles, California, 129 pp.

[73] Colwell MA, CB Millett, JJ Meyer, JN Hall, SJ Hurley, SE McAllister, AN Transou, RR LeValley. 2005. Snowy Plover reproductive success in beach and river habitats. *Journal of Field Ornithology* 76(4):373-382. *See also* United States Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751.

[74] *Ibid.*

among individuals of endangered or threatened species such as the Western snowy plover, it must be concluded that each breeding individual loss results to some degree in reduced viability of the population.

As significantly, indirect mortality occurs because high levels of human activity hinder normal brooding, foraging, and sheltering activities. As mentioned above, snowy plover chicks are precocial. After hatching, the male bird cares for the chicks for approximately 28 days.[75] However, the chicks quickly must learn how to feed themselves, balance thermoregulatory needs, and avoid predators without assistance. Human activities can be especially detrimental to survivorship during this critical period in the species' life cycle. When a brooding adult is disturbed, it often leaves chicks exposed, and hence vulnerable to predation, inclement weather, and reduced foraging time.[76] Human activity may also cause brood movement, resulting in the separation of one or more chicks from the rest of the brood.[77] In addition, movement into adjacent territories can result in attacks on the young by other adult plovers, resulting in chick death and abandonment.[78]

Predation, by both native and nonnative species, has also been identified as a cause of mortality to plovers even in the presence of applied certain mitigation measures to reduce impacts of development projects, and is a major factor limiting western snowy plover reproductive success at many Pacific coast sites.[79]

While predominantly a natural phenomenon, predation is enhanced through the introduction of nonnative predators and unintentional human encouragement of larger populations of native predators (e.g., by providing supplemental food, water, and nest sites). Elevated predation pressures result from both temporary and permanent landscape-level alterations in coastal dune habitats that, in turn, now support increased predator populations within the immediate vicinity of nesting habitat for western snowy plovers.[80]

Because anthropogenic disturbance is the primary threat to the western snowy plover, numerous biologists have concluded that protecting occupied sites from human disturbance during both breeding and non-breeding season may be essential to the conservation and

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[75] Colwell MA, SJ Hurley, JN Hall, SJ Dinsmore. 2007. Age-Related Survival and Behavior of Snowy Plover Chicks. *Condor* 109(3):638-647.

[76] *Ibid.*

[77] Ruhlen TD, S Abbott, LE Stenzel, GW Page. 2003. Evidence that human disturbance reduces snowy plover chick survival. *Journal of Field Ornithology* 74(3):300-304.

[78] *Ibid.*

[79] *Ibid.*

[80] *Ibid.*

recovery of the species.[81]

Relevant Case Studies Substantiating the Effects of Disturbance

Numerous studies have demonstrated that human activities are affecting the survivorship, numbers, and activity patterns of western snowy plovers. Escofet and Espejel (1999) concluded that human encroachment has caused nesting snowy plovers to completely disappear from many coastal breeding locations in California. Habitat that is opened to human disturbance, such as the Project construction proposed over a minimum of a six month period in occupied plover nesting habitat, even while temporary and possibly during non-breeding season may have permanent impacts on snowy plovers. Lafferty (2001) reported that snowy plovers immediately stopped breeding at the Reserve when it was opened to recreation, and ultimately permanently abandoned the site for wintering.[82]

Page et al. (1977) observed western snowy plovers' response to human disturbance at two coastal beaches where normal beach use ranged from light to heavy.[83] When humans approached western snowy plovers, adults left their nests 78% of the time when people were within 50 meters and 34% of the time when people were over 100 meters away.

Ruhlen et al. (2003) examined the effects of human disturbance on snowy plover chick survival at Point Reyes National Seashore, California.[84] Chick loss on weekends and holidays was 72% greater than expected in 1999 and 69% greater than expected in 2000. This suggested that increased human recreation on Point Reyes beaches over weekends and holidays negatively affected snowy plover chick survival, even though humans were not observed to cause direct impacts to chicks. Rather, results suggest that the increased associated potential for anthropogenic disturbance (noise, predator attraction) was primarily responsible for chick mortality.

CUMULATIVE IMPACTS TO SNOWY PLOVERS ARE NOT ADEQUATELY ANALYZED

Three other projects have been proposed for the coastal zone in the vicinity of the Project site,

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[81] USFWS. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751. *See also* Brindock KM, MA Colwell. 2011. Habitat Selection by Western Snowy Plovers During the Nonbreeding Season. Journal of Wildlife Management 75(4):786-793.

[82] Lafferty KD. 2001. Human disturbance to wintering western snowy plovers at a southern California beach. *Biological Conservation* 10:1-14. *See also* University of California, Santa Barbara Natural Reserve System. 2001. Snowy Plover Management Plan (SPMP) – 2001. <http://coaloilpoint.ucnrs.org/SnowyPloverProgram.html>. (Retrieved Jun 19, 2015).

[83] Page GW, JS Warriner, JC Warriner, RM Halbeisen. 1977. Status of the snowy plover on the northern California coast. Part I: Reproductive timing and success. California Department of Fish and Game Nongame Wildlife Investigations, Sacramento, CA. 6 pp.

[84] Ruhlen TD, S Abbott, LE Stenzel, GW Page. 2003. Evidence that human disturbance reduces snowy plover chick survival. *Journal of Field Ornithology* 74(3):300-304.

and proximal to snowy plover critical habitat. **However, the DEIR fails o list these projects in their description of cumulative impacts** (Table 5-1 Cumulative Projects).[85]

1. The Collection at Monterey Bay Project (development of a 342-room coastal resort on a 26.46-acre site located west of State Route 1 in Sand City).
2. A new campground at Fort Ord Dunes State Park (development of 100 campsites, parking areas, an internal trail network with beach access, and various other infrastructures).
3. The Monterey Bay Shores Resort Project (development of a 40 acre parcel in Sand City, including approximately 680,000 cubic yards of grading)

The Fort Ord coastal HCP includes the creation of a new campground at Fort Ord beach and will greatly increase human use in plover habitat, causing significant impacts to wintering and breeding birds and habitat within the general region of this Proposed Project's pipeline development.

The Monterey Bay Shores Resort, an exceedingly large coastal hotel to be constructed at the southern boundary of Fort Ord, will preclude nesting and wintering of plovers within and adjacent to the Project footprint, thus causing permanent direct and long term impacts to nesting to the regional population. The California Coastal Commission, amazingly, did not require any sort of concurrence with USFWS when it issued its conditional development permit, and as a result impacts to snowy plovers (and other resident sensitive species) remain inadequately mitigated, thus contributing further to local impacts to plovers in close proximity to the Project proposal. The Collections is another hotel proposed slightly south of the Monterey Bay shores Resort, and is also in Sand City, with similar significant impacts to snowy plovers.

The Project, in conjunction with these other projects, would result in significant cumulative impacts to the western snowy plover and its critical habitat. It is important to note that a comprehensive strategy for the conservation of western snowy plover breeding and wintering locations has not been incorporated into the Sand City General Plan, Local Coastal Program, or their implementing ordinances. The USFWS has expressed concern about the aforementioned projects being addressed in a piecemeal fashion, which does not allow an adequate assessment of their cumulative effects.[86] As a result, the USFWS and others have recommended the preparation of a habitat conservation plan (HCP) to adequately address cumulative effects.[87] The City of Sand City, City of Marina, and the Monterey Bay Shores Resort developers each committed to preparing an HCP for the western snowy plover. None of these entities have fulfilled their commitment. To date, there exists no definitive habitat plan by any of these

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[85] DEIR p. 5-4

[86] USFWS. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover *(Charadrius alexandrinus nivosus)*. Sacramento, California. xiv + 751.

[87] *Ibid.*

entities that addresses cumulative impacts to the plover, or proposes a strategy for conserving snowy plovers in the specific region.

In short, the DEIR lacks fundamental details necessary for the public to evaluate the relative status of this snowy plover breeding and wintering population, recent breeding success (or lack thereof), and resultant impact of any and all development within and near their occupied habitat with any reasonable level of certainty. Simply stating that some estimated numbers of plovers have been present over time in the general area is not adequate for analysis needed to develop appropriate, site-specific mitigation measures.

THE DEIR FAILS TO PROVIDE ADEQUATE DATA TO ASSESS IMPACTS TO SNOWY PLOVERS

The DEIR's lack of site-specific data and detailed maps based upon snowy plover protocol surveys as should have been conducted by the Applicant's consultant. The lack of such recent, specific data result in insufficient information necessary to analyze the degree to which the Project may impact the local populations.

Even the DEIR itself points out that protocol surveys should be conducted within specific regions of the Monterey coast that are proximal to the site footprint, and include sensitive is dune habitats as well as snowy plover critical habitat. Specifically, in Table 4.6-2,[88] it states

> "For any proposed development in the environmentally sensitive habitat areas of the Del Monte Beach area... a resource survey shall be conducted, according to established protocols, for all sensitive species, including dune plants, snowy plover, black legless lizard, and marine mammals known to occur in the vicinity."

The same language is repeated in the DEIR on Table 4.6-2 for the areas of the Harbor LUP. Clearly, protocol surveys are not only important but a necessary part of the species impact analysis for this site. Some of this data could have been provided within the DEIR by presenting details from reports from 2014 back to 2002, as all such reports is available on USFWS species' specific website. Why was such information not made available and mapped within the DEIR so that the public could make a more thorough and complete analysis of the snowy plover status and resultant mitigation requirements relevant to the Project, especially considering the large scale of this Project?

As discussed above, this is clearly an oversight not just for the snowy plover, but other sensitive species that may occur within the Project site but have not been adequately observed or discussed for impact analysis. Even the available recent survey reports by Point Blue do not cover all the potential snowy plover habitat within and near the Project site. For instance, according to Point Blue biologists, Western snowy plovers have nested at the inland dune area,

[88] DEIR 4.6-77

south of the main Cemex plant operations, including part of the Project footprint. They state that is it difficult to assess what the use of this site by plovers has been in recent years, because this area hasn't been surveyed by Point Blue (*pers. comm.* Kriss Neuman, June 23, 2015)(Figure 1).

Considering that the Point Blue Conservation Science biologists have been monitoring plovers in the area for the past 30 years, and that they were cited briefly in the DEIR so their existence is at least know the applicant, why has there been no coordination with them to analyze impacts or develop adequate mitigation measures?

COMPENSATORY MITIGATION IS NECESSARY TO FULLY ADEQUATELY REDUCE PROJECT IMACTS TO SNOWY PLOVERS.

Under Mitigation Measure 4.6-1n (discussed above) the DEIR does state that the HMMP would include a "Description of any compensation in the form of land purchase or restoration". As discussed above, simply deferring creation of such a plan to a future time is an inadequate presentation of details necessary for complete impact mitigation analysis.

In light of

(1) The numerous direct, indirect, and cumulative significant impacts that this project will cause to Western snowy plovers for a minimum of at least three years during construction alone, and

(2) The significant impacts to critical habitat (that also happens to be rare and sensitive coastal dune habitat),

(3) The significant degree to which regional snowy plover nesting success within the region and the vicinity of the Project has been on the decline, as reported by Point Blue biologists (discussed above), and

(4) The broad geographic scope of this project that is within and near snowy plover breeding pairs and critical habitat,

it follows that impact mitigation should go beyond deferment of consideration of "a land purchase or restoration" to include a conservation fund (see below). According to Point Blue snowy plover biologist Kriss Neuman (*pes. comm.* June 23, 2015),

> "There is currently no dedicated funding to support the monitoring and conservation activities that are conducted to support this regional plover population and in particular at this site. The landowner [of the Cemex site] gladly allows Point Blue, California State Parks, and USFWS refuge staff to access habitat, and we jointly install protective fencing, manage habitat and predators, and monitor nesting. A dedicated conservation fund supporting these activities on the site and possibly in the region as well would help to ensure population stability in the region."

Given that the Point Blue, in coordination with California State Parks, and the local USFWS

Wildlife Refuge have been working to monitor and conserve snowy plovers for the past 30 years, it would appear that two of the most effective measures that could be taken to truly reduce the cumulative impacts to this sensitive species would be for the applicant to

(1) Create a conservation fund, to be overseen by the appropriate oversight agency, that will be used for monitoring, habitat restoration, and other conservation actions that are key to the populations' viability over time, and

(2) Contribute to a region-wide Snowy plover Habitat Management Plan that incorporates all of the relevant municipalities and agencies that are stakeholders for this regional plover population's habitat and conservation. Any such Plan should coordinate and consult with the Point Blue, California State Parks, and USFWS biologists who have been researching this region's snowy plovers for decades.

CONCLUSION

Based on the issues described in this letter, it is my professional opinion that the obligations of CEQA have not been met, and that the Project would result in significant and unmitigated impacts to several sensitive biological resources.

Sincerely,

Renée Owens, M.S.

Senior Biologist

Figure 1. Historic Western Snowy Plover nesting habitat, CEMEX Property, Marina, CA. (Point Blue Conservation Science, June 23, 2015)

ATTACHMENT D

RBF CONSULTING
A Baker Company

July 2, 2013

City of Marina
Attention: Ms. Theresa Szymanis, AICP
211 Hillcrest Avenue
Marina, CA 93933

Subject: Application Package for the Temporary Slant Test Well Project, Marina, CA

Dear Ms. Szymanis:

On behalf of California American Water (CalAm), RBF Consulting (RBF) is submitting this application to the City of Marina. The Temporary Slant Test Well, herein referred to as the "Project", is located in the northwest portion of the City of Marina, CA, located on Assessor Parcel Number 203-011-019-000. This parcel is owned by CEMEX, Inc. This application replaces and supersedes our prior Test Well application, which we hereby officially withdraw. The Project would be located in a disturbed portion of the active CEMEX mining area, east of the beach and adjacent to the unimproved roadway currently used by CEMEX. The temporary slant test well will extend west, underground, approximately 1,000 linear feet.

The temporary test well Project will provide field data concerning geologic, hydrogeologic, and water quality characteristics of the Sand Dunes Aquifer, Salinas Valley Aquitard, and 180-foot Aquifer. Furthermore, the information obtained from this temporary test well Project will be utilized in the design and permitting of a separate potential future desalination project – the Monterey Peninsula Water Supply Project (MPWSP). The MPWSP is being processed separately by the California Public Utilities Commission. The temporary slant test well is functionally independent from and could not be used for the MPWSP without substantial additional infrastructure and associated CEQA, NEPA and regulatory permitting compliance.

The revised location avoids virtually all the issues noted for the prior "North CEMEX" test well site. Although the test well site is in an active portion of the CEMEX site, in a disturbed area, CalAm is proposing various avoidance/minimization measures to further ensure no effect on sensitive resources, based on consultation with the U.S. Fish and Wildlife Service and Point Blue Conservation Science.

We have attached biological resources reports (Attachment "F") for the temporary test well and the geotechnical boreholes for your information, as borehole CB-1 is in the same location as the test well and the boreholes report addresses species of state concern. A cultural resources assessment is attached as Attachment "G". Based on this and previously provided information at the June 10th CalAm Agency Update meeting, we request that the City consider the project's eligibility for a "Categorical Exemption" CEQA determination pursuant to CEQA Guidelines Section 15306, as well as an Administrative Coastal Development Permit. The attached materials indicate that:

1. The test well is located in an active mining area, along disturbed portions of the CEMEX access road;
2. Prior biological and cultural resource studies for this access road indicated a lack of sensitive resources, with the exception of Monterey spineflower which would be avoided during construction (we have also attached an updated biological resources memo by Mike Zander that specifically focuses on boreholes 1, 2 and 4, which covers the test well location, as borehole 1 and the test well location are the same);
5. The Project has been designed (with avoidance and minimization measures), based upon input from Michael Zander, Jacob Martin and PRBO.

Please direct all communications regarding this application to Richard Svindland at California American Water, 4701 Beloit Drive, Sacramento, CA, 95838, (916) 568-4296, richard.svindland@amwater.com and copy Kevin Thomas at RBF Consulting, 40810 County Center Drive, Suite 100, Temecula, CA, 92591, (951) 506-2074, kthomas@rbf.com. If there is any way we can assist with your review and processing of this permit application, or should you require additional information, please contact Richard Svindland at your earliest convenience.

I thank you in advance for your diligence in processing the application for the Project, which is an important research project for the region. We would be happy to arrange an in-person meeting at your office or a site visit if this would facilitate your review.

Sincerely,

Kevin Thomas, CEP
Environmental Services Manager

Cc: Richard Svindland, P.E., California American Water

Attachments:

A – City of Marina Cover Page
B – City of Marina Project Description Form
C – City of Marina Environmental Information Form
D – City of Marina Affidavit Form
E – MPWSP Temporary Slant Test Well Project Description (June 25, 2013)
F – Biological Technical Memo for Temporary Slant Test Well Project (July 2013)
Biological Technical Memo for Exploratory Borings Program (June 2013)
G – Cultural Resources Assessment (June 25, 2013)
H – Test Well Facilities Map

Attachment A – City of Marina Cover Page

City of Marina

City of Marina
211 HILLCREST AVENUE
MARINA, CA 93933
831- 884-1278; FAX 831- 384-9148
www.ci.marina.ca.us

PLANNING APPLICATION COVER PAGE

TYPE OF APPLICATION (check all that apply):

- ☐ Appeal
- x Coastal Development Permit/LCP amendment
- ☐ Conditional Use Permit
- ☐ General Plan/Zoning Map orText Amendment
- ☐ Home Occupation Agreement
- ☐ Lot Line Adjustment
- ☐ Sign Review/Master sign program
- ☐ Site & Architectural Design Review
- ☐ Specific Plan
- ☐ Temporary/Special Use Permit
- ☐ Tentative Parcel Map
- ☐ Tentative Map
- ☐ Tree Removal Permit
- ☐ Variance/ Subdivision Exception
- ☐ Time Extension
  Identify Permit ______________

Applicant(s):

Name: California American Water - Richard Svindland, P.E.

Mailing Address: 4701 Beloit Drive, Sacramento, CA 95838

Phone (Business): (916) 568-4296 Phone (Home): (916) 204-2190 cell

Property/Land Owner(s):

Name: CEMEX - Ronald D. Wilson

Mailing Address: 5180 Golden Foothills Parkway, El Dorado Hills, CA 95762

Phone (Business): (916) 941-2852 Phone (Home): (916) 337-2420 cell

Name and mailing address of property owner's or applicant's duly authorized agent who is to be furnished with notice of hearing. (Section 65091-California Government Code):

Name: RBF Consulting - Kevin Thomas, CEP

Mailing Address: 40810 County Center Drive, Suite 100, Temecula, CA 92591

Phone (Business): (951) 506-2074 Phone (Home): (714) 269-7427 cell

Project Address/Location: 100 Lapis Road, Marina, CA 93933

Most Current Assessor's Parcel Number: 203-011-019-000

FOR OFFICE USE ONLY:
DATE APPLICATION SUBMITTED ______________________ FEE COLLECTED $______________
DATE APPLICATION COMPLETE ______________________ RECEIPT NUMBER ______________
FILE NUMBER(S) ____
PLANNER INITIALS:__________ ASSOCIATED PERMITS: ______________________________

<u>Attachment B</u> – City of Marina Project Description Form

City of Marina
AT MONTEREY BAY

PROJECT DESCRIPTION

Name of Project Applicant:

California American Water – Richard Svindland, P.E.

Mailing Address:

4701 Beloit Drive, Sacramento, CA 95838

Phone:

(916) 568-4296

Name of the project:

Temporary Slant Test Well, Marina, CA

Project location (address and/or Assessor's Parcel Number(s):

CEMEX property west of Lapis Road & Highway 1. Parcel # 203-011-019-000, Marina, CA 93933

Size of project site (acreage):

Approx. 0.12 acres of temporary construction footprint (See Attachment "E")

Existing General Plan Land Use Designation:

Habitat Preserve and Open Space

Existing Zoning Designation:

C-D (Coastal Conservation and Development District) and C-P (Coastal Development Permit Combining District)

Describe the existing land use(s) of the site:

Refer to Attachment "E" - The proposed test well location is shown on **Figure 1**, *USGS Location Map* and **Figure 2**, *Test Well Facilities Map*. The slant test well site, shown in **Figure 2**, would be located in a disturbed portion of the active CEMEX mining area, east of the beach and adjacent to the unimproved roadway currently used by CEMEX. The facilities are located on CEMEX property (APN 203-011-019-000). The existing onsite CEMEX activities involve truck traffic and the use of a dredge to extract sand for building material production.

Describe the existing land use of properties surrounding the site:

Existing land uses surrounding the CEMEX property include the Marina Dunes Preserve to the south, the Pacific Ocean to the west, vacant open space to the north, and agricultural/open space land uses to the east.

Describe the proposed land use(s)/Project:

The slant well test facilities will include the slant well, submersible well pump, and well-head vault; vertical monitoring wells; test water disposal facilities; test water disposal connection to the outfall; electrical facilities; and temporary flow measurement/sampling equipment. The slant test well will be operated continuously for a period of up to 24 months. Discharge from the well of up to 2500 gallons per minute will be routed directly into the MRPWCA outfall. The existing CEMEX facility will continue operational activities. Refer to Attachment "E", *Temporary Slant Test Well Project Description*.

For residential uses, indicate the number, type, and size of the units, and the estimated range of the sale and rental prices:

N/A – No residential use proposed.

For commercial uses, indicate the type (neighborhood, city, or regional orientation), the total square footage, the estimated number of employees, and the hours of operation:

N/A – No commercial use proposed.

For industrial uses, indicate the type, the total square footage, the estimated number of employees, and the hours of operation:

N/A – No industrial use proposed.

For other uses, indicate the major function, the total square footage, the estimated number of employees, and the hours of operation:

The temporary slant test well project's major function is to obtain field data concerning geologic, hydrogeologic, and water quality characteristics of the Sand Dunes Aquifer, Salinas Valley Aquitard, and 180 ft. Aquifer; To operate the test well year round for up to 24 months to acquire water quality data and predict the length of operation that will be required for the extracted water to reach stable salinity; to verify and refine construction means and methods, schedule requirements, and minimization and avoidance measures for implementation of the future potential MPWSP intake wells; to discharge the well product water into the existing Monterey Regional Water Pollution Control Authority's outfall, which generally runs beneath the access road. The temporary slant test well will be in operation year round for 24 months. The temporary slant test well would operate for 24 hours per day. During construction, the number of employees at the site each day is anticipated to be approximately seven to ten personnel. During operation, there would be periodic site visits for sampling that is anticipated to involve two to four employees per site visit. The temporary slant well vault and the associated facilities would occupy approximately 0.12 acre of temporary construction footprint.

List and describe any other permits or public approvals required for this project, including those required by city, regional, state, and federal agencies:

- City of Marina – Coastal Act Compliance
- California State Lands Commission - Surface Lease
- California Coastal Commission – Coastal Development Permit
- Central Coast Regional Water Quality Control Board – To Be Determined
- Monterey Bay National Marine Sanctuary - Authorization

Are there water, sewer, gas, electric, and telecommunication facilities available to the project site? (X) Yes ( ) No If no, are connections to these facilities proposed?

Electrical power for construction and pumping operations will be provided by a connection to either CEMEX or a new connection to PG&E at the CEMEX site. An electrical panel will be located at the well site. Water, sewer, gas, or telecommunication facilities are not proposed or required for the temporary slant test well project.

Please describe any odor, noise, smoke, or dust which will result from the proposed development or use:

The project anticipates temporary construction equipment noise, smoke, dust, and minimal amounts of construction equipment odor during the construction phase of the project. During the testing/operational phase, there will be minimal pump noise generated.

Will there be any potentially hazardous materials, toxic substances, or flammable materials used, stored, manufactured, or disposed of at the project site? (X) yes ( ) no If yes, please explain:

Vehicles and equipment machinery will require fuel/oil for power and lubrication and will be utilized in a manner acceptable to applicable regulatory agencies.

Please describe the proposed scheduling and phasing of the project's construction:

The anticipated sequence of construction for the construction and testing is as follows:

- Mobilize monitoring well drill rig;
- Drill and develop monitoring wells;
- Demobilize monitoring well drill rig;
- Excavate and place wellhead vault structure (pre-cast);
- Install test water discharge piping, meter, and sampling facilities, construct connection to the outfall and install temporary sedimentation tanks;
- Mobilize slant well drill rig;
- Drill and install slant test well (through openings provided in well head vault);
- Develop slant well and conduct initial testing, aquifer testing, and short term pumping program;
- Demobilize slant well drill rig and temporary sedimentation tanks;
- Install underground electrical conduit, cable and electrical panel, and telemetry;

- Remove upper section of well casing to terminate in wellhead vault.
- Install submersible well pump and make final electrical and piping connections;
- Backfill around well-head vault, grade remaining drill cuttings into existing access road;
- Demobilize all construction equipment.

The slant test well will be operated continuously using a submersible well pump for a period of up to 24 months. Discharge from the well of up to 2500 gpm will be routed directly into the MRPWCA outfall. Operators will travel to the site using the existing active CEMEX access road on a weekly basis for 30 to 60 minutes per visit to check that the pump, meter, and water quality measurement equipment is operating properly, and to collect water quality samples. Radio telemetry at the site will communicate alarms of any system malfunction. Controls will be used to shut down the well pump in the event of system malfunction.

Please provide any additional relevant information that can assist in the processing of this application:

Please refer to the attachments listed in the cover letter.

Attachment C – City of Marina Environmental Information Form

ENVIRONMENTAL INFORMATION

ENVIRONMENTAL SETTING

Please provide the following information on a separate piece of paper:

- Describe the project site as it exists before the project, including information on topography, soil stability, plants and animals, cultural and historic resources, and any scenic aspects of the sites. Describe any existing structures on the site and the uses of those structures. ***(PROVIDED IN THE CITY OF MARINA FORM – PROJECT DESCRIPTION)***

- Describe the surrounding properties, including information on topography, soil stability, plants and animals, cultural and historic resources, and any scenic aspects of the area. ***(PROVIDED IN THE ATTACHMENTS INDICATED ON THE COVER LETTER)***

- Indicate the type and intensity of land uses, and the scale of the development. ***(PROVIDED IN THE CITY OF MARINA FORM – PROJECT DESCRIPTION)***

ENVIRONMENTAL CHECKLIST:

Would the Project result in the following (provide a brief description for each item checked "yes"):

Change in existing features of any streams, creeks, lakes, or wetlands: ( ) Yes (X) No

Change in scenic views or vistas from existing residential areas or public land or roads: ( ) Yes (X) No

The temporary slant test well site is not visible from any existing residential areas or roadways. There are dunes between Highway 1 and the project site on the beach that block any views. There would be a temporary change in scenic views from vessels out in the Pacific Ocean looking east onto the beach and potentially from the distant northern beach and southern beach off of the CEMEX parcel. After construction, the test well facility will not be visible from any public area.

Use or disposal of hazardous, toxic or flammable materials or explosives: (X) Yes ( ) No

Electrical power for construction and pumping operations will be provided by a connection to either CEMEX or a new connection to PG&E at the CEMEX site. Water pumped from the test well will be discharged into the outfall via a new subsurface connection to the outfall at the temporary test well location. Also, vehicles/equipment that would be utilized at the site would use fuel and oil to power and lubricate the vehicles/equipment and will be required to comply with Federal and State regulations.

Change in ocean, bay, lake, stream, or ground water quality or quantity, or alteration of existing drainage patterns: **( ) Yes (X) No**

Change in pattern, scale, or character of surrounding area of project: **( ) Yes (X) No**

Significant amounts of solid waste or litter: **( ) Yes (X) No**

Substantial alteration to topography or ground contours: **( ) Yes (X) No**

Change in dust, ash, smoke, fumes, or odors in the vicinity of the project: **( ) Yes (X) No**

The project anticipates temporary construction smoke, dust, and minimal amounts of construction equipment fumes/odor during the construction phase of the project. These construction related issues are considered minimal, given the remote proximity of the project site in relation to areas where people may reside or visit.

Substantial change in existing noise or vibration levels in the vicinity: **(X) Yes ( ) No**

The contractor shall install noise blankets as directed by a biologist to provide visual and sound attenuation for any sensitive species on the beach. All work would be conducted in the snowy plover non-nesting period (October 1st – February 28th). The test well pump will be submersible, generation nominal noise, in an already active mining area.

Substantial change in demand for municipal services (police, fire, water, sewer, etc.): **( ) Yes (X) No**

Substantial increase in fossil fuel consumption (electricity, oil, natural gas, etc): **( ) Yes (X) No**

Relationship to a larger project or a series of projects: **(X) Yes ( ) No**

It should be noted that the temporary slant test well project will field data concerning geologic, hydrogeologic, and water quality characteristics of the Sand Dunes Aquifer, Salinas Valley Aquitard, and 180-Foot Aquifer. This information will then be used to finalize the number, capacity, location, and design criteria of the potential future Monterey Peninsula Water Supply Project (MPWSP) intake wells, and also to improve the precision of ground water modeling that is required to determine the fraction of the extracted water that will come from inland sources. Furthermore, the information obtained from this temporary slant test well project will be utilized in the design and permitting of the separate MPWSP. The MPWSP is being processed separately by the California Public Utilities Commission. The temporary slant test well is functionally independent from and could not be used for the MPWSP without substantial additional infrastructure and associated CEQA, NEPA and regulatory permitting compliance.

Substantial change or increase of traffic on surrounding roads and highways: **( ) Yes (X) No**

Attachment D – City of Marina Affidavit Form

City of Marina

City of Marina
211 HILLCREST AVENUE
MARINA, CA 93933
831-884-1278; FAX 831-384-9148
www.ci.marina.ca.us

AFFIDAVIT

Applicant(s):

Applicant's Name: John Kilpatrick, Engineering Manager - Project Delivery, California American Water

Applicant's Signature: [signature] Date: 8/21/12

Applicant's Name: ______

Applicant's Signature: ______ Date: ______

1. *I attest to the truth and correctness of all the facts, exhibits, maps, and attachments presented with and made a part of this application.*
2. *I understand that a planner will visit the subject site in connection with this application.*
3. *I agree to pay all required application fees and cost.*
4. *I have contacted the owner and he has given his permission to process this application, or I am the property owner.*

Property Owners: **(REQUIRED)**

Property Owner's Name: CEMEX Construction Materials Pacific, LLC

Property Owner's Signature: [signature] Date: 12-7-12

Property Owner's Name: ______

Property Owner's Signature: ______ Date: ______

Attachment E – Temporary Slant Test Well Project Description

MPWSP TEMPORARY SLANT TEST WELL

INTRODUCTION

This document describes the construction and operation of a proposed temporary Slant Test Well (Project) and associated monitoring wells and appurtenances. The temporary test well facility is being proposed to gather technical data related to the feasibility of a subsurface intake system and to facilitate design and intake siting for the separately proposed Monterey Peninsula Water Supply Project (MPWSP).

The goals and objectives of the slant test well program are to:

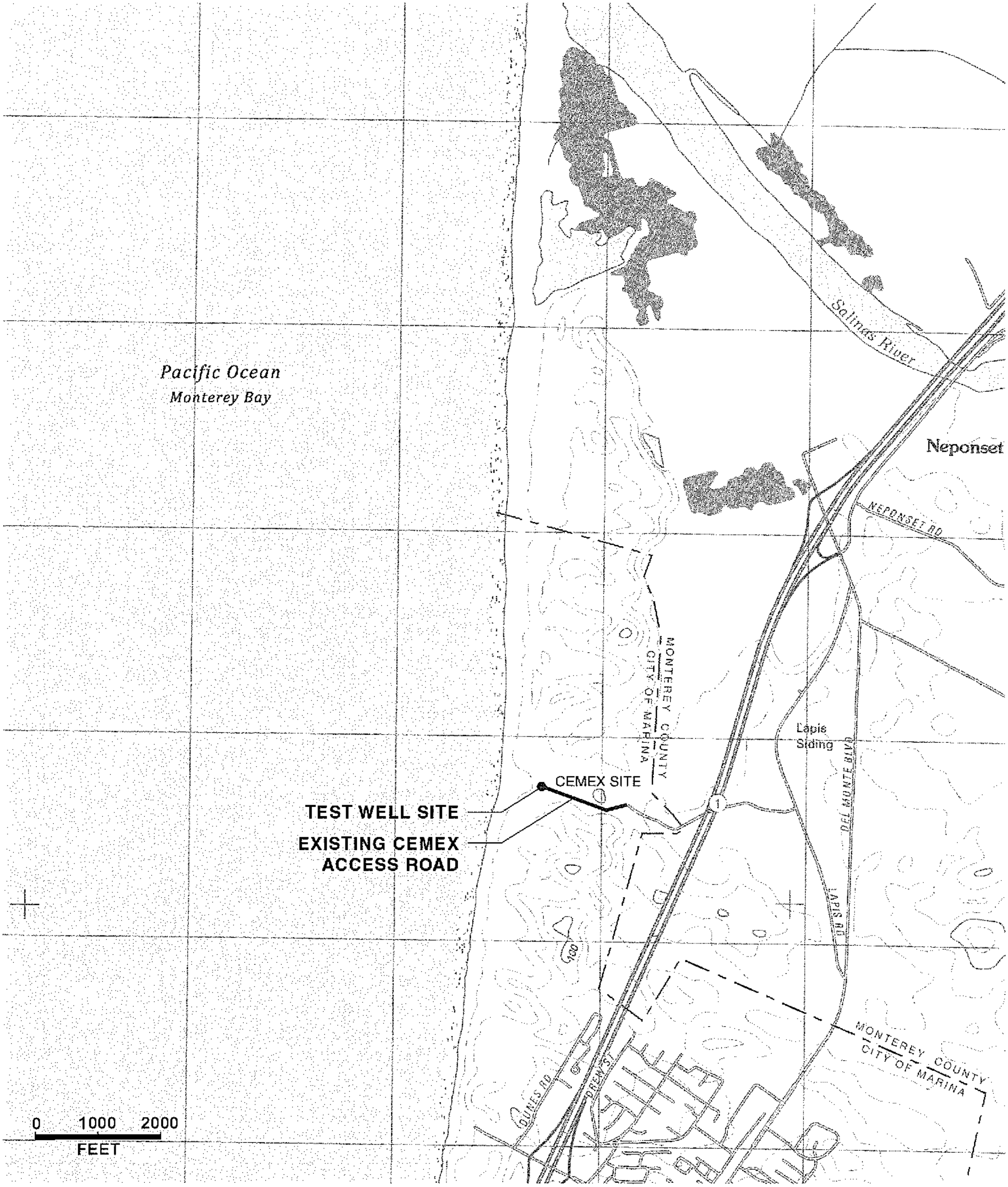
- Obtain current, site-specific field data concerning geologic, hydrogeologic, and water quality characteristics of the Sand Dunes Aquifer, Salinas Valley Aquitard, and 180-Foot Aquifer. This information will then be used to finalize the number, capacity, location, and design criteria of the MPWSP intake wells, and also to improve the precision of ground water modeling that is required to determine the fraction of the extracted water that will come from inland sources.

- Operate the test well year-round for up to 24 months to acquire water quality data and predict the length of operation that will be required for the extracted water to reach stable salinity. This information will be used to develop a start-up plan for the MPWSP desalination plant. Verify and refine information required to obtain permits for implementation of the MPWSP intake wells.

- Verify and refine construction means and methods, schedule requirements, and minimization and avoidance measures for implementation of the MPWSP intake wells.

- Discharge the well product water into the existing Monterey Regional Water Pollution Control Authority's outfall, which generally runs beneath the access road. This connection would be accomplished by a short subsurface pipeline to an existing manhole in the outfall.

The proposed test well location is shown on **Figure 1**, *USGS Location Map*, **Figure 2**, *Test Well Facilities Map*. The slant test well site, shown in **Figure 2**, would be located in a disturbed portion of the active CEMEX mining area, east of the beach and adjacent to the unimproved roadway currently used by CEMEX. The facilities are located on CEMEX property (APN 203-011-019-000). For the purposes of this application, the slant test well will be a temporary permitted facility until March of 2016. The MPWSP is a separate, potential future project, and its intake wells will be the subject of a separate permitting process. Conversion of the temporary slant test well to a permanent well would require considerable additional information such as conveyance, pumps and treatment, all of which would be addressed, if desired, as part of a separate CEQA and permitting process for the potential future MPWSP.



Source: USGS 7.5-Minute Series, Marina Quadrangle

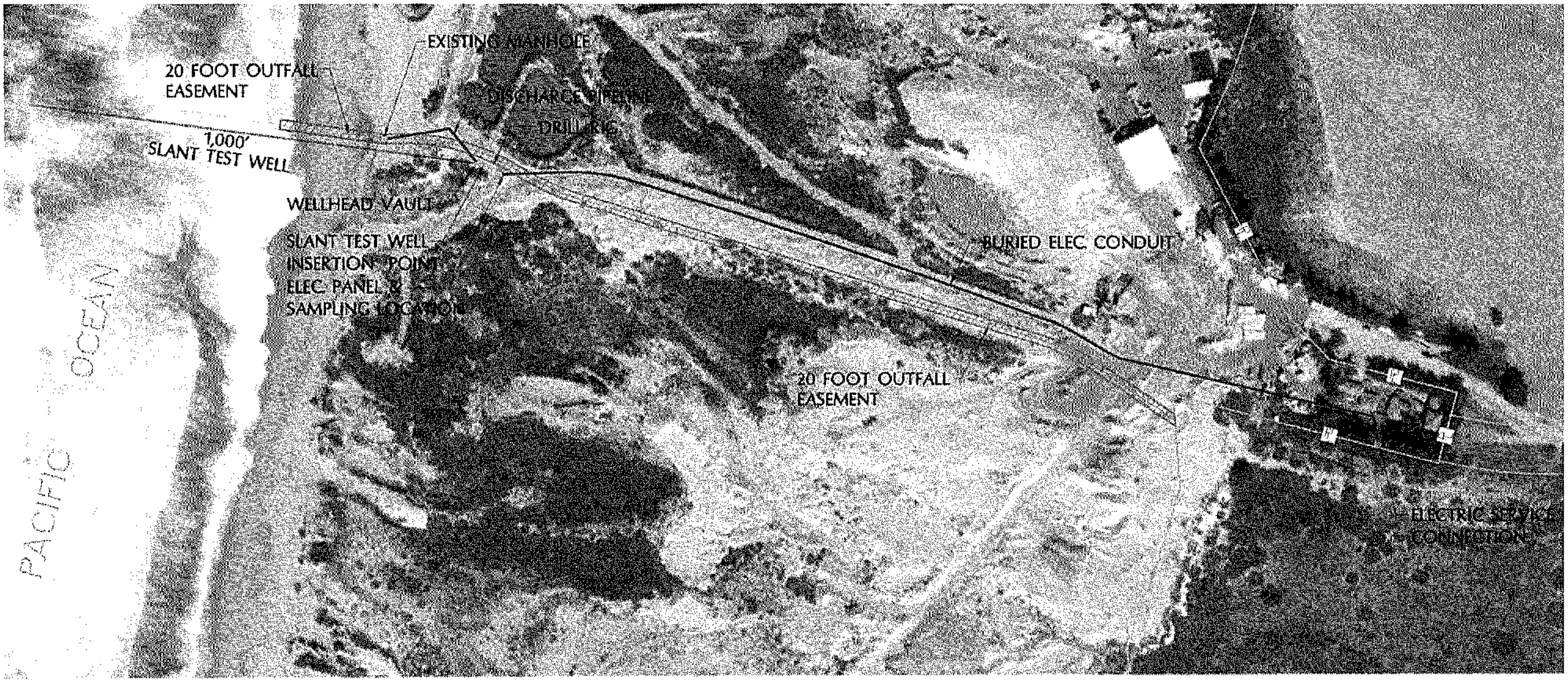
JN 130770 JUN 2013

RBF CONSULTING
A Baker Company

MONTEREY PENINSULA WATER SUPPLY PROJECT
TEMPORARY SLANT TEST WELL

U.S.G.S. Location Map

Figure 1



CALIFORNIA AMERICAN WATER

Note: Access path will be field verified by a qualified biologist to avoid sensitive locations.

MONTEREY PENINSULA WATER SUPPLY PROJECT
TEMPORARY SLANT TEST WELL

Test Well Facilities Map

RBF CONSULTING

JN 130770 JUN 2013

Figure 2

SITE ALTERNATIVES

Various alternative sites were considered for the temporary test well facilities, including two sites located at the southern extent of the CEMEX property (at the terminus of a Regional Park District beach access path), one site at the extreme north boundary of the CEMEX property within the beach "swash zone" (the previously submitted "North CEMEX" site), and one site located north of the CEMEX site entrance/facility area approximately 550 feet north of the CEMEX sand extraction pond, Also, a North CEMEX site option located higher on the beach was considered. Several southerly sites were considered including one at the State Parks parking lot at the terminus of Reservation Road. However, these sites are all less preferable than the proposed Project based on the results of investigations and discussions, including:

- Biological Assessment;
- Preliminary ground water modeling;
- Discussions with CEMEX concerning site acquisition, access and electrical power supply;
- Discussions with PG&E regarding electrical service;
- Discussions with City of Marina regarding Coastal Act permitting concerns;
- Discussions with stakeholders, including the California Public Utility Commission's technical advisory group on subsurface intake feasibility;
- Discussions with Monterey Peninsula Regional Parks District regarding access; and
- Discussions with California Department of Fish and Wildlife, Monterey Bay National Marine Sanctuary, U.S. Fish and Wildlife Service, and Point Reyes Bird Observatory.

FACILITIES

The slant well test facilities will include the slant well, submersible well pump, and well-head vault; vertical monitoring wells; test water disposal facilities; test water disposal connection to the outfall; electrical facilities; and temporary flow measurement/sampling equipment.

Slant Test Well and Well-head Facilities. The slant test well will be designed using similar materials, size and construction methodology as the proposed intake wells for the MPWSP. Cross-sectional views of the slant well and well-head facilities are shown in **Figures 3 and 4.** It should be noted that the configuration and geology presented in **Figure 3** are preliminary. The actual well configuration will be determined once the geology is confirmed during installation of the monitoring wells.

The slant test well will be drilled towards the ocean at 19-degrees from horizontal such that a 1,000 LF slant well will proceed to the bottom of the 180-Foot aquifer formation. The slant test well will be completed using up to 22-inch diameter casing and up to 12-inch diameter screen of "Super Duplex" Stainless Steel, a specialty metal designed for use in seawater environments. Well screen will be installed starting at elevation 30 feet BMSL through both the Dune Sands Aquifer and the 180-Foot Aquifers.

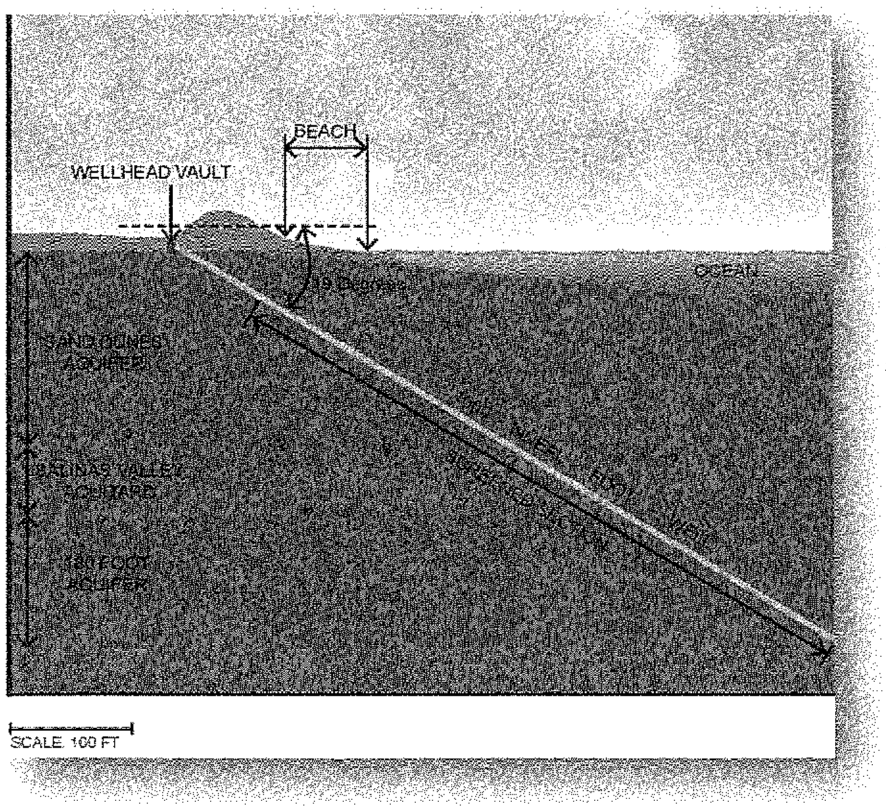


Figure 3
Cross Sectional View of Slant Test Well

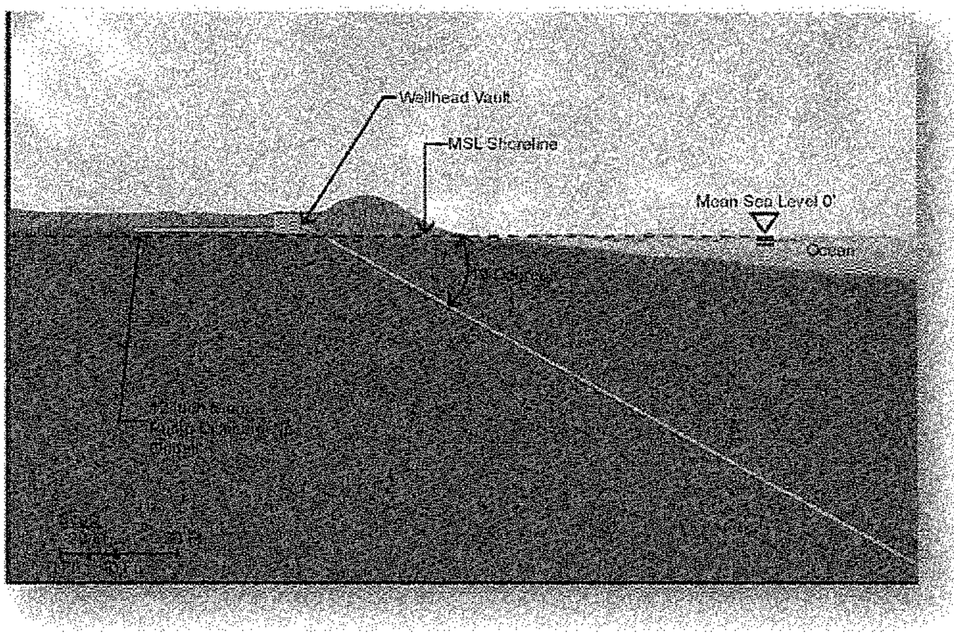


Figure 4
Cross Sectional View of Well-head Facilities

Monitoring Wells. Two individual vertical monitoring wells will be drilled prior to drilling the slant test well in order to measure changes in groundwater level during operation of the test well. One of the monitoring wells will be in the immediate vicinity of the slant test well and the second monitoring well will be approximately 1,200 ft inland on the side of the CEMEX service road.

The monitoring wells will be 2-inch diameter wells, drilled to a depth of approximately 300 feet BMSL. Boreholes for the monitoring wells will be approximately 6-inches in diameter, and will be drilled using a sonic drilling method. The monitoring wells will be constructed with a filter pack and surface seal in accordance with both County and State well standards for monitoring wells.

Electrical Power Supply. Electrical power for construction and pumping operations will be provided by a connection to either CEMEX or a new connection to PG&E at the CEMEX site. An electrical panel will be located at the well site.

Test Water Disposal Facilities. Water pumped from the test well will be discharged into the outfall via a new subsurface connection to the outfall at the temporary test well location.

ACCESS

Access to the well facility will be obtained by vehicles transporting personnel, construction equipment and construction materials to and from the site by using the CEMEX service road.

CONSTRUCTION

The temporary slant test well would be constructed within the area of the active CEMEX service road. The anticipated sequence of construction for the construction and testing is as follows:

- Mobilize monitoring well drill rig;
- Drill and develop monitoring wells;
- Demobilize monitoring well drill rig;
- Excavate and place wellhead vault structure (pre-cast);
- Install test water discharge piping, meter, and sampling facilities, construct connection to the outfall and install temporary sedimentation tanks;
- Mobilize slant well drill rig;
- Drill and install slant test well (through openings provided in well head vault);
- Develop slant well and conduct initial testing, aquifer testing, and short term pumping program;
- Demobilize slant well drill rig and temporary sedimentation tanks;
- Install underground electrical conduit, cable and electrical panel, and telemetry;
- Remove upper section of well casing to terminate in wellhead vault.
- Install submersible well pump and make final electrical and piping connections;
- Backfill around well-head vault, grade remaining drill cuttings into existing access road;
- Demobilize all construction equipment.

Figures 5, 6 and 7 are photographs of the drilling operation for a slant test well that was recently constructed on Doheny State Beach in Dana Point, California. **Figure 8** shows the Dana Point project site during the operational phase, after construction demolition.

Figure 5:
Slant Test Well Drilling Operation at Doheny State Beach, Dana Point, California
(Source: Geoscience Support Services, Inc.)

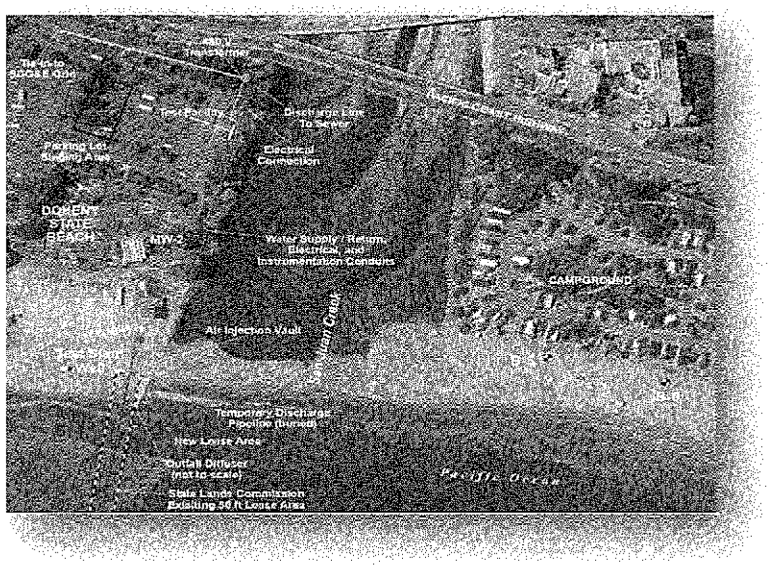


Figure 6
Slant Test Well Site Plan at Doheny State Beach, Dana Point, California
(Source: Geoscience Support Services, Inc.)

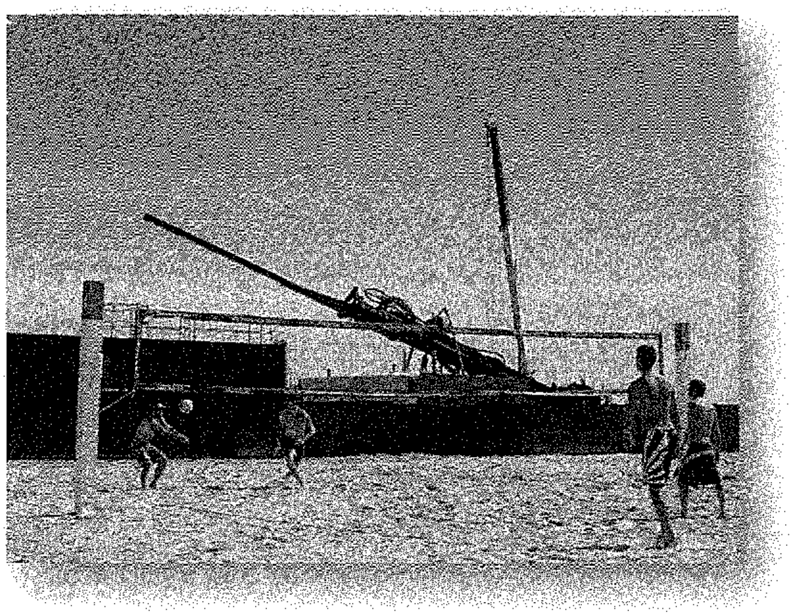


Figure 7
Slant Test Well Drilling Operation at Doheny State Beach, Dana Point, California
(Source: Geoscience)

Figure 8
Slant Test Well Site - Post Construction Operational Phase
Doheny State Beach, Dana Point, California
(Source: Geoscience Support Services, Inc.)

OPERATION AND SCHEDULE

The slant test well will be operated continuously using a submersible well pump for a period of up to 24 months. Discharge from the well of up to 2500 gpm will be routed directly into the MRPWCA outfall. Operators will travel to the site using the existing active CEMEX access road on a weekly basis for 30 to 60 minutes per visit to check that the pump, meter, and water quality measurement equipment is operating properly, and to collect water quality samples. Radio telemetry at the site will communicate alarms of any system malfunction. Controls will be used to shut down the well pump in the event of system malfunction.

ENVIRONMENTAL CONSIDERATIONS

Snowy Plover Protection. Construction activities will occur during the Plover non-nesting season, October 1st through February 28th, and in a disturbed area not expected to be used as a nesting area during the nesting season (i.e., in or on the shoulder of the active CEMEX access road).

Management of Drill Cuttings. Cuttings generated during the drilling process will be drained in a separation unit, with the drainage discharged to the tailings ponds adjacent to the test well site. The dewatered cuttings (estimated at less than 200 cubic yards) will be used to re-grade the CEMEX access road during and following construction of the test well.

Emissions. Air quality permits may be required for temporary emissions from diesel-fueled equipment that is necessary for construction operations.

Stormwater Pollution Prevention Plan. It is anticipated that a SWPP will not be required because the disturbed area for the project is less than 1 acre, and is located off the beach on existing disturbed CEMEX property.

AVOIDANCE AND MINIMIZATION MEASURES (PROJECT DESIGN FEATURES)

The following summarizes the avoidance measures proposed by the project, in order to address the environmental issues outlined above:

1) **Facility Siting.** As noted above, over the last nine months CAW has been working with regulatory agencies and other stakeholders in the environmentally sensitive siting and design of the temporary test well facility. After extensive discussions and preliminary studies, including several "all hands on" regulatory agency strategy meetings, CAW has relocated the proposed Project to the current location, in the active CEMEX access road area. The proposed site avoids the prior beach construction traffic, periodic beach access, and temporary disruption to recreational activity, beach habitat, noise and visual impacts that were associated with the North CEMEX site.

2) **Facility Design.** The test well construction footprint is as compact and oriented as sensitively as possible so as to create the smallest reasonable working area, allowing for adequate worker safety and access. The beach diffuser component of the prior North CEMEX site has been replaced with an environmentally preferable direct connection to the PCA outfall. The subsurface HDD electrical and water quality testing pipe associated with the earlier North CEMEX concept is no

longer needed due to siting in close proximity to existing electrical service along an active access road. Following construction, the facility will not be visible from any public area. The test well pump will be a submersible pump and will not generate noise or vibration that is detectable from any public area or from any snowy plover nesting area.

3) **Construction Limits.** CAW will restrict construction activities to the proposed construction area and access route, in order to minimize access impacts to CEMEX operations. All construction activities shall be in non-native or disturbed areas on or adjacent to the active CEMEX access road. No construction equipment, materials, or activity will occur outside the specified areas. The property owner will be consulted, prior to commencement of construction, in order to schedule construction activities during non-peak hours and provide advance notice of construction activities.

4) **Timing of Construction Activities (Biological Resources).** To avoid potential adverse impacts on the snowy plover, construction and demobilization activities will be limited to the plover's non-nesting season (October 1st through February 28th).

5) **Sensitive Habitat and Species.**

    a. A biologist will conduct pre-construction surveys for snowy plover to confirm absence of active nests within 100 feet of the drill rig or safe distance as determined by USFWS;

    b. A biologist will be present during drill rig setup to stake off the drilling work area to ensure that drilling activities avoid any state or federally listed species;

    c. The contractor shall install noise blankets as directed by the biologist to provide visual and sound attenuation for any sensitive species on the beach, such as snowy plover. Due to the limited duration of the drilling, and use of noise blankets, considering the access road is an active road traveled by heavy equipment, the proposed drilling operation is not expected to generate a substantial increase in noise or otherwise represent any significant environmental impact.

6) **Biological Education and Monitoring.** Prior to initiation of access or construction activities, a designated biologist will conduct an educational session with all construction personnel. An appropriately trained biologist will be designated to monitor equipment access in order to avoid disturbance to sensitive habitat.

ATTACHMENT E

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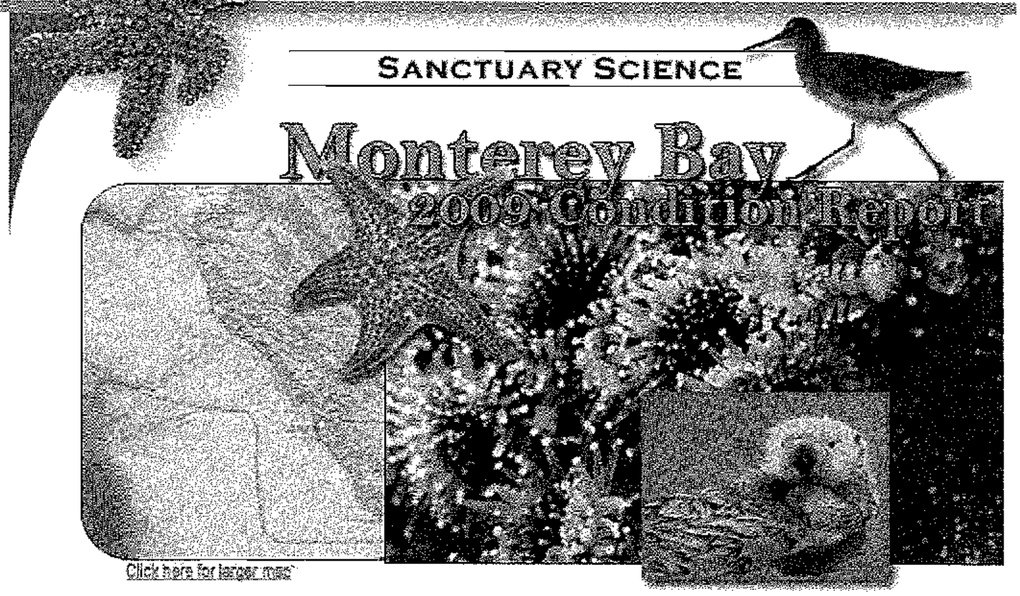

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State of Sanctuary Resources: Offshore Environment

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Offshore Environment Water Quality

The following information provides an assessment of the status and trends pertaining to water quality in the offshore environment.

1. Are specific or multiple stressors, including changing oceanographic and atmospheric conditions, affecting water quality and how are they changing?

Stressors on water quality in the offshore environment, specifically persistent organic pollutants (POPs), fluctuations in nutrient levels, and changing ocean conditions, may inhibit the development of assemblages and may cause measurable declines in living resources and habitats. For this reason the rating for this question is "fair" with a "declining" trend. Offshore waters have shown elevated levels of contaminants (CCLEAN 2007), ocean temperature and chemistry changes (MBARI 2006), some of which have been linked to changes in the offshore ecosystem (Tanner 2006).

Certain POPs, including polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), have exceeded California Ocean Plan objectives (CCLEAN 2007). Monitoring data indicates the majority of POP and some nutrient (nitrate and urea) loading are mostly due to inputs from large rivers such as the Salinas, Pajaro, San Lorenzo, and Carmel and that orthophosphate and urea loads from these

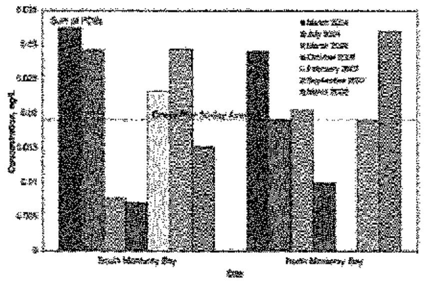


Figure 28. Concentrations of PCBs in water samples collected between 2004 and 2008 at two marine water quality background sites located five miles offshore in Monterey Bay. Some samples exceed the water quality standards for PCBs set forth in the California Ocean Plan. Click here for a larger image. *(Source: modified from CCLEAN 2009)*

rivers have been increasing during recent years (CCLEAN 2007). Hartwell (2008) analyzed sediment samples and concluded that Monterey Bay watersheds are the primary source of DDT for an expanse of the Central California continental shelf that includes San Francisco Bay. Water samples collected by the CCLEAN program show that sites approximately five miles offshore in northern and southern Monterey Bay exceed the Ocean Plan water quality standards for polychlorinated biphenyls (PCBs) (Figure 28) and dieldrin (a persistent, bioaccumulative, toxic insecticide that was used from 1950 to 1974). Contaminants in sediment samples (which may indicate potential problems in the water column) do not exceed NOAA persistent organic pollutant (POP) alert levels. However, concentrations of the legacy pesticides DDT and dieldrin frequently exceed the NOAA Effect Range Low (ERL) guideline at which amphipod toxicity is typically measured in 10% of laboratory bioassays (CCLEAN 2007, 2009). Moreover, DDT concentrations are relatively higher in these offshore locations than the average concentrations measured in San Francisco Bay and have not declined at most locations since the 1970s (CCLEAN 2007). Concentrations of dieldrin exceeded the ERL in 22 out of 40 samples collected from 2005 to 2006 (CCLEAN 2007).

While the overall ecological effects of stressors are difficult to measure because they are the result of complex interactions among biological and environmental factors, there is recent evidence of the deleterious effects of POPs in the marine environment. CCLEAN (2007) has found that suspended sediment from rivers, primarily the Pajaro River, may have negative effects on benthic organisms along the 80-meter contour. Moreover, the cumulative concentrations of POPs were associated with decreased abundance of some benthic infauna. Preliminary work from Miller et al. (2007) showed that southern sea otters with moderate or high exposure to freshwater flows had significantly higher concentrations of certain POPs (DDDs, DDE, HCH delta, dibenzothiophene C2 and PBDE 017) compared to those that came from areas with low exposure to freshwater flows. This study also suggests that some POPs may contribute to the risk of sea otter death due to infectious agents and trauma.

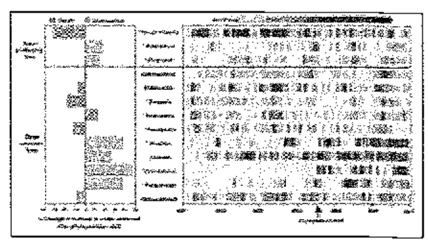


Figure 29. Relative abundance of diatoms and dinoflagellates common to Monterey Bay, California: (A) Change in the % of samples in which a given genus was observed after the floral shift (asterisks indicate a statistically significant difference ($p<0.05$); (B) Time series showing the relative abundance of diatom and dinoflagellate genera. Each row represents the change in relative abundance over time for the genus indicated on the y-axis; intensity of color increases with dominance and the arrow indicates the phytoplankton shift. Relative abundance ranges from not present to dominant, as shown in the overlying arrow bar Click here for a larger image. *(Source: Jester 2008)*

Oceanographic monitoring data collected by the Monterey Bay Aquarium Research Institute (MBARI) shows that since 1999 there has been a regime shift from warmer to cooler water conditions and that nitrate levels at 60 meters have been above normal (MBARI 2006). The taxonomic structure of the offshore phytoplankton community in Monterey Bay shifted during the summer of 2004 from the typically diatom-dominated community to a red-tide, dinoflagellate-dominated community and was associated with the presence of toxins in higher trophic level species (Jester 2008) (Figure 29). Since the taxonomic structure of the phytoplankton community affects how these toxins move through local food webs, the shift in this community is likely to have affected fish and higher trophic level organisms in ways that are important for the ecosystem both ecologically and commercially (MBARI 2006). The shift is possibly related to changes in water mass, nutrient levels, water column structure, or other environmental phenomena (Tanner 2006).

2. What is the eutrophic condition of sanctuary waters and how is it changing?

The offshore environment is rated "good/fair" relative to this question because monitoring data suggests that selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines. A "declining" trend is supported by evidence of nutrient enrichment, increasing nutrient loading, and increasing frequency and intensity of harmful algal blooms in selected areas of the offshore environment. In this context, eutrophication refers to the human accelerated process of organic enrichment of water bodies that can lead to hypoxia and anoxia, habitat degradation, alteration of food-web structure, loss of biodiversity, and alteration of harmful algal bloom (HAB) dynamics (Howarth 2008). Humans could be influencing algal blooms by increasing nutrient availability via runoff, causing climate change, or by assisting in the transport of new species into an area (Gilbert et al. 2005, CIMT 2006). Human-derived runoff, sewage, and fertilizers may be interacting with increased sea surface temperatures to alter the natural pattern of algal blooms.

HAB dynamics in California appear to be dominated by large-scale oceanographic forcing of nutrient dynamics (Anderson et al. 2008, Kudela et al., 2005, Kudela et al., 2004), however, there is growing evidence to suggest that the spatial extent, duration, and toxicity of events can be influenced by anthropogenic nutrient inputs. While evidence for direct causative links between HABs and coastal runoff and/ or eutrophication are lacking, there is abundant correlative evidence within Monterey Bay and in other areas of California (Anderson et al. 2008). Strong linkages have been demonstrated between nutrient enrichment and phytoplankton production in estuarine and marine waters for a wide range of geographic scales (Nixon 1992, Mallin et al. 1993). Scholin et al. (2000) provided indirect evidence that a massive HAB event in Monterey Bay was triggered by post-El Niño runoff. Domoic acid production by Psuedo-nitzchia species has been shown to be responsive to inputs from coastal watersheds including copper (Ladizinsky 2003) and urea (Howard et al. 2006). Toxic HAB species (Pseudo-nitzchia and Alexandrium catenella) may use dissolved organic nitrogen forms such as urea, which has been measured at substantial concentrations in nearshore waters and is likely derived from anthropogenic sources (Cochlan et al. 2008, Anderson et al. 2008).

Satellite and surface currents data in Monterey Bay suggest that inputs from coastal watersheds may contribute to the occurrence of algal blooms (Figure 30). Studies of a major red tide event in Monterey Bay during 2007 indicated bloom inception occurred where rain induced flushing of watersheds entered the ocean (Ryan et al. 2008). Although nutrient inputs are likely to be small relative to seasonal upwelling, the influence of nitrogen sources such as urea on HAB dynamics in Monterey Bay is important since such inputs are likely linked to populous zones of the coast (Kudela et al. 2008a). The massive increases in eutrophication globally that have occurred during recent decades may play an important role in local increases in the frequency, spatial extent and duration of HABs (CIMT 2006, Howarth 2008). Heisler et al. (2008) conclude that there is a scientific consensus that nutrient pollution promotes the development and persistence of many HABs and that management of nutrient inputs can lead to a significant reduction in HABs.

Red Tide Patterns Linked to Land-Sea Exchange

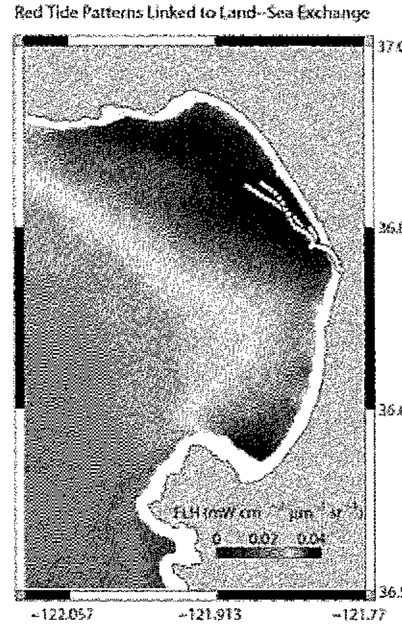


Figure 30. Satellite-collected Fluorescence Line Height (FLH) data, 2002-2007, was used to calculate the mean concentration (red is high, purple is low) of microscopic algae during the months of August-November , a period when red tides have been observed with high frequency in the northern Monterey Bay. Representative drifter tracks, which mark the northward surface transport pattern of land-derived nutrients and material, indicate highest average bloom intensity in the wake of land-sea exchanges. *(Source: Ryan et al., unpubl. monitoring data)*

HABs can negatively affect the ecosystem either due to their production of toxins or due to the manner in which the cells' physical structure or accumulated biomass affect co-occurring organisms and alter food web dynamics (Anderson et al. 2002). In California, HAB problems are dominated by two organisms, *Alexandrium catenella*, which produces a toxin that causes paralytic shellfish poisoning (PSP) and *Pseudo-*

nitzchia, which produces the neurotoxin domoic acid (Anderson et al. 2008). Domoic acid and PSP toxins have been detected in the offshore food web in Monterey Bay and in some cases have been linked to mortality events of seabirds and marine mammals (Fritz et al. 1992, Scholin et al. 2000, Jester 2008). HABs (including those from algal species that do not produce toxins) can deplete oxygen levels as the blooms decay or they can destroy habitat for fish or shellfish by blocking light from reaching submerged vegetation. In 2007, a bloom of the dinoflagellete *Akashiwo sanguinea* was responsible for a mass-stranding event of seabirds in Monterey Bay. Jessup et al. (2009) determined that the algae did not produce a biotoxin, but instead produced a detergent-like protein that dissolved the natural oils found in the feathers of seabirds, which prevented the birds from flying, hunting, and keeping warm. In all, 550 birds were found stranded, while 207 were found dead.

3. Do Sanctuary waters pose risks to human health?

A rating of "good/fair" is given in response to the question with an "undetermined" trend since selected conditions have the potential to affect human impacts, but impacts have not been reported. Selected conditions in offshore waters, including low levels of a number of toxic pollutants and toxins produced by HABs have the potential to affect human health. While there is some evidence of increasing loads of biotoxins and contaminants, a clear trend in the risk to human health could not be determined.

POPs and biotoxins tend to biomagnify as they are passed up the food chain, and long-term exposure can be toxic to a wide range of animals, including humans. Some large, wide-ranging species of fish, marine mammals (e.g., killer whales), and pelagic seabirds (e.g., Black-Footed Albatross) found in offshore waters of the sanctuary have been tested for contaminants and show detectable levels of some contaminants such as DDT, PCBs, and chlordanes (Black et al. 2003, Kannan et al. 2004, Finkelstein et al. 2007). Such contamination, however, has not been directly linked to the water quality conditions in the offshore environment of the sanctuary. Similarly, elevated concentrations of some trace metals, such as mercury, are a health concern for humans who consume some species of large pelagic fishes, such as swordfish and albacore tuna. However, trace metal concentrations are not being monitored in either the offshore waters or in offshore species. Thus, it is not known if fishes harvested in the sanctuary have elevated levels of these contaminants or if the offshore environment of the sanctuary is a significant source of trace metals into the offshore ecosystem.

The toxins produced during harmful algal blooms can accumulate in the marine food web, especially in some fishes and shellfish, and therefore, pose a health risk when consumed. For example, in 1991 and 1998 large blooms of Pseudo-nitzschia australis, a diatom that can produce the neurotoxin domoic acid, were observed in Monterey Bay. Subsequently, domoic acid was detected in planktivorous fishes (e.g., anchovy, sardines) and linked to the deaths of fish-eating birds and mammals (Fritz et al. 1992, Scholin et al. 2000). Recent studies have shown that inputs of urea and copper may promote the growth of domoic acid-producing phytoplankton and may increase the production of domoic acid resulting in higher toxicity blooms (Armstrong et al. 2007). A shift in the taxonomic structure of the phytoplankton community occurred in 2004 towards dinoflagellate species that produce paralytic shellfish poisoning toxins rather than domoic acid (Jester 2008). PSP toxins were detected in samples of northern anchovies and Pacific sardines collected between 2003 and 2005, which was the first time these toxins have been detected in California's pelagic food web (Jester 2008).

4. What are the levels of human activities that may influence water quality and how are they changing?

The level of human activities that directly influence offshore water quality are considered to be "fair" in that they result in measurable local impacts to the ocean and "improving" due to increased regulation and remediation efforts since establishment of the sanctuary. In many instances it is difficult or impossible to directly measure the impacts of human activity on offshore water

The Beach Coastal Ocean Mammal and Bird Education and Research Surveys (Beach COMBERS) Program uses trained volunteers to survey beached marine birds and mammals monthly at selected sections of beaches throughout the Monterey Bay area.

quality conditions, but select activities have notable impacts. The main contributor from land-based activities is inputs of contaminants and nutrients linked to urban development and agriculture. The main activity occurring in the offshore waters of the sanctuary is vessel traffic, which can result in acoustic impacts and discharge of ballast water, bilge oil, and trash.

In recent years, algal blooms in Monterey Bay have occurred more frequently and have been more persistent than in past years (CIMT 2006). Humans could be influencing algal blooms by increasing nutrient availability via runoff, climate change, or by assisting in the transport of new species into an area (Glibert et al. 1995, CIMT 2006). Human-derived runoff, sewage, and fertilizers may be interacting with increased sea surface temperatures to alter the natural pattern of blooms.

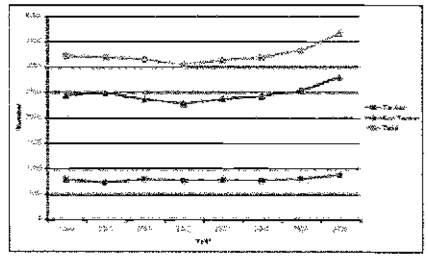


Figure 31. The number of deep draft vessel arriving in San Francisco Bay each year from 1999 to 2006. Click here for a larger image. *(Data source: HSCSFBR 2007; Graph: J. Brown, NOAA/MBNMS/SIMoN)*

Vessel traffic in and out of San Francisco Bay and Monterey Bay ports has the potential to negatively impact water quality in the offshore environment of the sanctuary. Based on trends in the number of deep draft vessels entering San Francisco Bay, it is likely that vessel traffic through the offshore waters of the sanctuary has increased in recent years (Figure 31). Oil spills from on-going vessel activity, as well as oil releases from sunken vessels in and adjacent to the sanctuary, pose substantial risk to sanctuary resources. In response, the sanctuary developed strategies to move vessel traffic zones farther offshore and use north-south transit lanes to reduce threats of spills from vessels such as tankers, ships containing hazardous materials, barges, and large commercial vessels. These strategies have been approved at the international level and were implemented in 2000. Recent remediation efforts to remove oil from submerged vessels have reduced further the risk of oil spills. Oil leaking from the S.S. Jacob Luckenbach, which sank offshore of the Golden Gate in 1953, was responsible for significant seabird oiling events in the winter of 1997-98, 2001-2002, and 2004-05. Removal of approximately 100,000 gallons of bunker oil from this submerged vessel has removed this source of oil into the offshore waters of the sanctuary.

Sanctuary regulations prohibiting the dumping of grey water and bilge water, including recent additional limitations on discharges from cruise ships, serve to reduce some impacts of these activities on water quality. For example, the Beach COMBERS monitoring program found that the average oiling rate of beachcast bird carcasses (percent oiled carcasses per kilometer per month) was 2% during 1997-2002, which was less than the 8% oiling rate recorded by Pt. Reyes Bird Observatory during 1971 - 1985 (Nevins et al. 2003). This comparison indicates that oil pollution prevention measures implemented during the past 20 years have likely reduced oiling rates in the sanctuary. However, the continued observation of oiled bird carcasses on sanctuary beaches (Nevins et al. in prep) and the observation of oil slicks during aerial surveys of offshore living resources from 2001 to 2008 (K. Forney, NMFS-SWFSC, unpubl. monitoring data) suggest that continued mitigation and enforcement of sanctuary regulations is needed to further reduce the release of oil discharge into the offshore waters of the sanctuary.

Offshore Environment Water Quality Status and Trends

Good | Good/Fair | Fair | Fair/Poor | Poor | Undet.

Trends:
- ▲ Conditions appear to be improving.
- — Conditions do not appear to be changing.
- ▼ Conditions appear to be declining.
- ? Undetermined trend.
- N/A Question not applicable.

#	Issue	Rating	Basis For Judgement	Description of Findings
1.	Stressors	▼	Elevated levels of contaminants (e.g., persistent organic pollutants), and ocean temperature and chemistry changes, some of which have been linked to	Selected conditions may inhibit the development of assemblages and may cause measurable but not severe declines in living resources and habitats

		changes in the offshore ecosystem.	
2. Eutrophic Condition	▼	Nutrient enrichment in selected areas, increased nutrient loading, and increased frequency and intensity of harmful algal blooms.	Selected conditions may preclude full development of living resource assemblages and habitats, but are not likely to cause substantial or persistent declines.
3. Human Health	?	Measurable levels of biotoxins and contaminants in some locations that have the potential to affect human health; no reports of human impacts.	Selected conditions that have the potential to affect human health may exist but human impacts have not been reported.
4. Human Activities	▲	Inputs of pollutants from agriculture and urban development; reduced risk of impacts from vessels due to regulation of traffic patterns and discharges, removal of oil from sunken ships.	Selected activities have resulted in measurable resource impacts, but evidence suggests effects are localized, not widespread.

Offshore Environment Habitat

The offshore environment of the sanctuary can be divided into pelagic habitats (i.e., the water column) and benthic habitats (i.e., the seafloor). Pelagic habitats are more difficult to define than benthic habitats, and although these habitats play a key role in the sanctuary ecosystem, they are less well studied than the benthic habitats. This is due, in part, to the logistical and economic hurdles that must be overcome when using large vessels to deploy nets, remotely operated vehicles or submersibles to sample and explore this vast volume of water that is in a constant state of flux. Nevertheless, it is widely recognized that the productivity of the offshore ecosystem supports a great diversity and abundance of invertebrates, fishes, seabirds, and marine mammals. It should be noted, however, that due to the relative dearth of biological knowledge on the water column itself, the offshore environment status and trends are focused primarily on benthic habitats, since this is where the bulk of knowledge resides. The physical and chemical oceanography of the offshore pelagic habitat was discussed in the Water Quality section (above).

The following information provides an assessment of the status and trends pertaining to the current state of offshore marine habitats.

5. What is the abundance and distribution of major habitat types and how is it changing?

The abundance and distribution of major habitat types in the offshore environment of the sanctuary is rated as "fair" based on the past and current levels of human activities that influence the distribution, abundance, and quality of benthic habitats and associated living resources. The trend could not be determined due to a lack of information on both the rate and degree of recovery of habitat and associated living resources inside areas recently closed to bottom-contact fishing gear and the associated changes in the distribution and intensity of fishing activities in the remaining open areas.

The most abundant habitats in the Monterey Bay sanctuary are the open waters - three-dimensional habitats not associated with the seafloor. The total volume of open waters of the sanctuary is 12.026 trillion cubic meters or approximately 4.8 billion Olympic-sized swimming pools. Open water can be subdivided into three zones by depth. The epipelagic zone, which includes the upper 200 meters of the water column, comprises 18% of the open water habitat. The mesopelagic zone, from 200 to 1,000 meters, makes up nearly half of the open water. The remaining 35% of the volume of the open water is deeper than 1,000 meters and is called the bathypelagic zone. The abundance and distribution of the major water column habitats in the sanctuary have not changed over the last few decades, but the quality of these open water habitats is influenced by natural and anthropogenic factors. These changes in the quality of open water habitats have been discussed in the water quality section of this report.

As of September 2007, approximately 72% of the benthic habitats in the offshore waters of the Monterey Bay sanctuary have been mapped with good resolution using sidescan sonar (16%) and multibeam (64%), including some areas of overlap (National Marine Sanctuary: Seafloor Mapping Data Inventory, Figure 32). The remaining 28% of the area has been mapped with a resolution of 200 meters using drop-line surveys (NOAA National Ocean Service). The majority of the benthic habitat in the offshore environment is composed of soft sediments with various mixtures of sand, mud, and silt. Under natural conditions, these soft-bottom habitats are structured by both physical processes, such as currents, and the activities of animals that increase the physical complexity of the habitat by creating mounds, burrows, and depressions. Hard substrates, such as deep reef, rock, and gravel, occur in patches of various sizes, but tend to be less abundant in the deeper portions of the sanctuary. Attached and emergent living organisms, such as deep-sea corals, sponges, and sea pens, provide additional structure. All these different types of fine-scale habitat structure can be used by fishes, crabs, and other taxa as refugia from predation and currents.

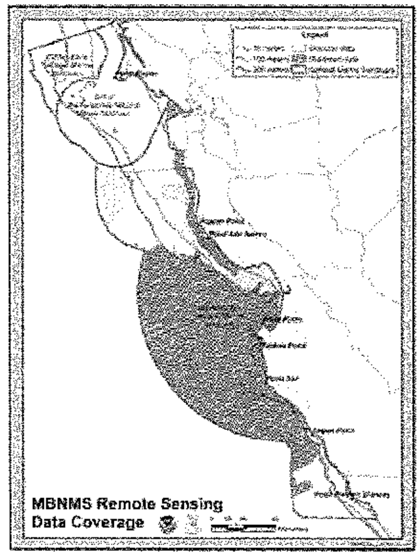


Figure 32. Areas in the Monterey Bay National Marine Sanctuary where major benthic habitat type has been mapped using sidescan sonar (hatched areas) or multibeam sonar (orange areas). Click here for a larger image. *(Data Source: MBNMS Remote Sensing Data Coverage; Map: C. King, NOAA/MBNMS/SIMoN)*

Most of the offshore environment in the Monterey Bay sanctuary has not received the detailed characterization and monitoring necessary to quantify the impact of human activities on the distribution, abundance, and quality of major and finescale benthic habitat types and associated living resources. It is unlikely that human activities, such as the installation of submerged cables and fishing with bottom-contact gear, have substantially altered the abundance and distribution of major habitat types. However, based on limited study within major habitat types, these human activities can alter the physical complexity of sediments and alter or remove less common meso-scale habitat types (e.g, bolder, rock, corals) and their associated living resources.

In 2002 NOAA's Office of Oceanic and Atmospheric Research (OAR), in collaboration with researchers from the Monterey Bay Aquarium Research Institute and the sanctuary, studied the impact of the Pioneer Seamount cable, a 95 kilometer long coaxial cable installed in 1995 (Kogan et al. 2006). At depths below 20 meters, there was little evidence of effects of the cable on the seafloor habitat. The cable did appear to influence the abundance and distribution of a few benthic species. Sea anemones colonized the cable when it was exposed on the seafloor, and were therefore generally more abundant on the cable than in surrounding, sediment-dominated seafloor habitats (Figure 33). Some fishes were also more abundant near the cable, apparently due to the higher habitat complexity it provides.

Figure 33. Several invertebrate species living on or near the Pioneer Seamount cable, which crosses the continental shelf offshore of Half Moon Bay. The animals in this image include sea stars and basket stars, an anemone, and a number of young rockfish. For scale, the cable is about 3.2 centimeters (1.25 inches) in diameter. *(Photo: (c) 2003 MBARI).*

The most widespread physical alteration of sanctuary habitats has likely resulted from fishing with bottom-contact gear, such as otter trawls. Among the various environmental impacts resulting from use of this type of gear are removal of structure-forming organisms and the smoothing of bedforms (Auster and Langton 1999, Lindholm et al. 2004). The results of a recent habitat recovery project along the central coast of California (de Marignac et al. 2009) indicate that microtopographic structures on the seafloor, such as biogenic depressions and biogenic mounds, were significantly more abundant in an area that was recovering (3+ years) from trawling as compared to an area that continued to be actively trawled. Similar effects were observed in the Monterey Bay sanctuary in the late-1990's (Engel and Kvitek 1998). Although detailed information on historic and current conditions in the sanctuary's offshore seafloor habitat is limited, the degree and extent of alteration to the physical complexity of these habitats resulting from past activity are a cause for concern. Based on the known physical impacts of bottom trawling (NRC 2002), the limited study of trawling impacts to habitat in the sanctuary, the known extent of trawling effort in the sanctuary over the past 11 years (Figure 34), and the long history of bottom-contact gear use in the offshore environment, the condition of offshore habitats is considered to be "fair". While many impacts to soft-sediments may be less persistent (e.g., homogenization of sediment structure and loss of microhabitat structure), other impacts are long-term (e.g., removal or displacement of boulders and rocks).

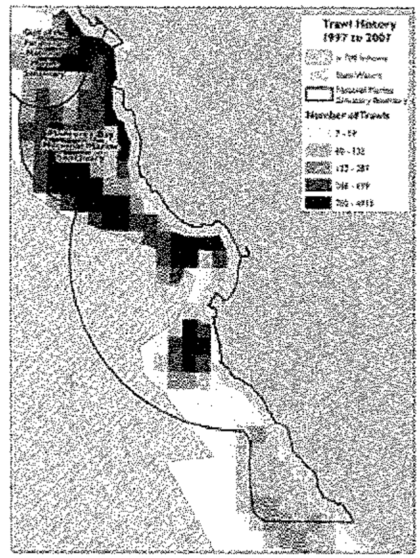


Figure 34. The history of groundfish trawling along the central California coast from 1997 to 2007. Number of trawls per block was calculated by counting trawl tracks that started, ended, or passed through each block. It is based on trawl logbook data provided by the California Department of Fish and Game. Blocks with less than seven trawls (an average of one trawl per year) or fewer than three unique vessels fishing within them are not shown for reasons of confidentiality. Trawling was prohibited during the study period in the light blue portion of state waters. Due to gear limitations, trawling is unlikely to occur in waters deeper than 700 fathoms (blue with grey hatching). This "untrawlable area" comprises 1,343 square miles, or approximately 25% of the area, inside the Monterey Bay sanctuary boundary. Click here for a larger image. *(Map: S. De Beukelaer, NOAA/MBNMS)*

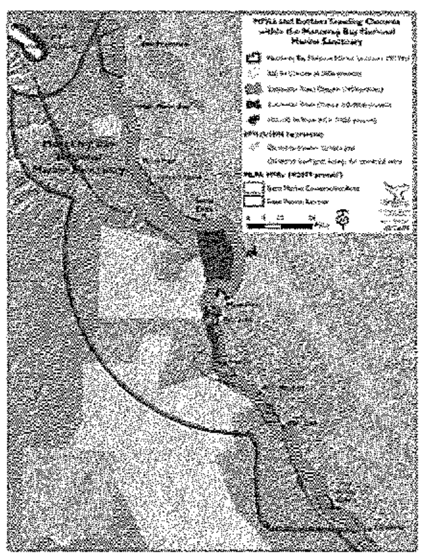


Figure 35. Existing Marine Protected Areas (MPAs) and bottom trawling closures in the Monterey Bay sanctuary. Some portions of state waters in the sanctuary have been closed to bottom trawling since 1913 (Scofield 1948). The current closure began in 1953 (CDFG 1961) as a prohibition on the use of bottom trawling gear from the shoreline out to 3 nautical miles in most areas of the sanctuary (light green) and was expanded to include all state waters in 2006 (dark green). State Marine Life Protection Act MPAs (red and blue areas) were implemented in state waters in September 2007. Essential Fish Habitat (EFH) areas has prohibited trawl gear (yellow) or all bottom contact gear (orange). The Trawl Rockfish Conservation Area (RCA) prohibits trawling since 2003. The minimum extent of the Trawl RCA has been 100-150 fathoms

A (purple), but the extent of this boundary has fluctuated with a maximum extent of 0-200 fathoms. Click here for a larger image. *(Map: S. De Beukelaer, NOAA/MBNMS)*

variety of recent management measures directed towards trawling, including an expansion of the prohibition on the use of bottom trawling gear in state waters, the Rockfish Conservation Area, and the Essential Fish Habitat Closures (Figure 35), have limited the extent of trawling activity in the sanctuary. Due to gear limitations, trawling is unlikely to occur in waters deeper than 700 fathoms. The prohibition on the use of bottom trawl gear at depths below 700 fathoms, which began in 2006, prevents an expansion of trawling into this untrawled area. The combined effect of these management measures by NOAA's National Marine Fisheries Service and the Pacific Fisheries Management Council is to prohibit the use of bottom trawling gear in 55.5% of the Monterey Bay sanctuary. The effect of these measures may be an improvement in the condition of offshore habitats due to some recovery of seafloor habitats in the areas that were previously trawled, though a directed study to determine the degree and the speed of recovery for different ecosystem components is needed.

6. What is the condition of biologically structured habitats and how is it changing?

The condition of offshore, biologically-structured habitats is rated as "fair/poor" and the trend is "undetermined." A variety of structure-forming and structure-building species occur in the offshore environment of the sanctuary. However, information on the distribution and condition of these organisms is limited, especially in more remote areas and in comparison to historic abundance and distribution patterns. ROV surveys have recorded a variety of structure-forming species, including soft-corals, gorgonians, sponges, and brachiopods, on the continental slope and submarine canyons in the central and northern portions of the sanctuary (J. Barry, MBARI, unpubl. data). NOAA Fisheries trawl surveys of the continental shelf and slope provide additional records of corals, sponges, anemones, sea pens, and sea whips in the sanctuary (NMFS 2004). These data are augmented by recent towed camera sled and submersible video surveys by the sanctuary in limited areas and occasional observations by West Coast research institutions (Etnoyer and Morgan 2003). The Monterey Submarine Canyon was identified as an area with a relatively high concentration of deep-sea corals compared to other areas along the west coast (Morgan et al. 2005).

Two additional types of biologically-structured habitats in the sanctuary, cold seep communities and whale falls, are known to support very diverse and unique biological communities. Cold seep communities, which are characterized by bacterial mats and chemosynthetic clams and tubeworms, have been found most frequently on steep slopes at depths exceeding 550 meters (Figure 36) (Barry 1996, Paull et al. 2005). It is likely that these long-lived communities occur throughout the sanctuary, but very little exploration of deep-sea habitats has occurred outside the Monterey Bay region. Researchers monitoring whale falls (the sunken carcasses of whales) in the sanctuary have found that these carcasses support a wide diversity of species, including mobile scavengers, dense assemblages of worms and crustaceans, and sulphur-loving bacteria, some of which are newly discovered species (Goffredi et al. 2004).

Figure 36. The location where cold seeps (orange circles) have been observed in the Monterey Bay region. Black lines show the locations where the Monterey Bay Aquarium Research Institute (MBARI) conducted remotely operated vehicle (ROV) surveys from April 1989 to June 2002. Click here for a larger image. *(Data Source: C. Paull, MBARI; Map: S. De Beukelaer, NOAA/MBNMS)*

Activities that injure or remove structure-forming invertebrates and associated physical structures result in losses of habitat that supports the offshore living resource assemblage. The most significant impact to structure-forming invertebrates has likely resulted from fishing with bottom-contact gear, such as otter trawls. The results of a recent habitat recovery project along the central coast of California (de Marignac et al. 2009) show that significant differences exist in both microhabitat structure (biogenic mounds and depressions) and macrofaunal invertebrate community structure between an area that was recovering (3+ years) from trawling as compared to an area that continued to be actively trawled. During ROV surveys of the deep seafloor, researchers have observed that areas without trawl marks on the soft bottom tend to have more benthic invertebrate megafauna and associated species and show more advanced community development compared to areas with trawl marks (J. Barry, MBARI, pers. comm.). The impacts of bottom-contact gear on the benthos are very evident and it is possible that ecosystem integrity has suffered as a result of degradation of the benthic community. However, this is an area of research that is, in general, data poor.

Based on the known negative impacts of bottom-contact fishing gear on biologically-structured habitats (Morgan and Chuendpagdee 2003) and the extensive use of these gears in the offshore environment in the past (Figure 34), it is likely that these habitats have been impacted in portions of the sanctuary where these gears were used. However, studies of these deep-sea communities are very limited and the impact of trawling and other human activities have not been assessed broadly. Approximately 25% of the sanctuary is deeper than 700 fathoms and thus inaccessible to existing bottom trawl gear (blue grey hatching in Figure 35 in Habitat section, Question 5). Given the recent closures of approximately 30% of the trawlable area to bottom trawling gear (see Figure 35 in Habitat section, Question 5), the status of structure-forming habitats may be improving in the closed areas. The trend is undetermined at this time. These habitats may not recover quickly or may never re-establish to their original abundance or composition even in the absence of future pressures.

7. What are the contaminant concentrations in sanctuary habitats and how are they changing?

Based on elevated levels of pesticides in shelf and canyon sediments at sites offshore of urban and agricultural pollution sources the condition of offshore habitats is rated as "good/fair". The trend in contaminant concentrations in offshore habitats has not been well studied. However, limited research suggests little to no attenuation in the concentration of some persistent contaminants in sediments on the continental shelf and continued inputs and delivery of some contaminants to deep sea habitats, such as submarine canyons. This limited information suggests an overall "declining" trend for this question.

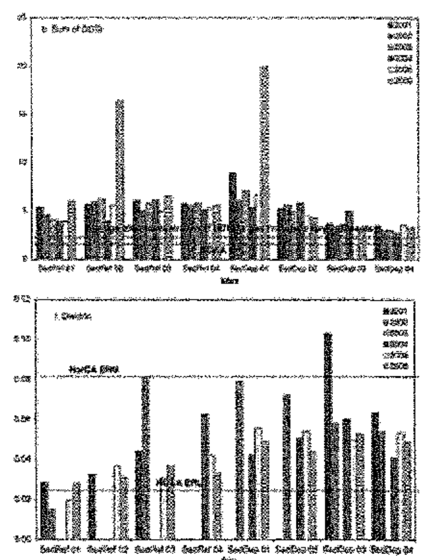


Figure 37. Concentration of DDT and dieldrin, two types of persistent organic pollutants, in sediments collected from eight CCLEAN sites in 2001- 2006. NOAA ERL (Effects Range Low) refers to sediment guidelines developed by the U.S. National Oceanic and Atmospheric Administration based upon the incidence of acute toxicity to amphipods in laboratory tests. NorCA ERM is based on the NOAA Effect Range Median, calibrated to Northern California data (north of Pt. Conception). Source DDT data: modified from CCLEAN 2009; Click here for a larger image. *(Source dieldrin data: CCLEAN, unpubl. monitoring data)*

Sediment samples have been collected annually since 2001 from eight sites along the 80-meter contour in Monterey Bay to test for persistent organic pollutants (CCLEAN 2006). Sediment quality guidelines predictive of toxicity called the NOAA Effects Range-Low (ERL) were exceeded for dieldrin in 30 of the 48 samples (Figure 37) (CCLEAN unpubl. monitoring data). Concentrations of DDTs in every sediment sample exceeded the ERL and also exceeded the average concentration of DDTs in San Francisco Bay sediments collected in 2002 (Figure 37) (CCLEAN 2009). Comparison of these DDT levels with those in sediments collected from nearby sites in 1969-1970s indicated that only one site in southern Monterey Bay has experienced a significant decline in DDTs (CCLEAN 2006).

Samples from the shelf and slope (down to 1200 meters), and in submarine canyons between San Francisco and the Big Sur coast indicate that DDT concentrations are highest in sediments on the shelf between Half Moon and Monterey Bays and in Ascension, Año Nuevo, and Monterey/Soquel Canyons (Hartwell 2008). Watersheds in the Monterey Bay, especially the Salinas and Pajaro watersheds, appeared to be the primary source of DDT, which were then delivered to the deep ocean via all three canyons (CCLEAN 2006, Hartwell 2008). A similar pathway was identified by Paull et al. (2002) based on a trail of residues of the pesticide DDT. The residues marked the axis of Monterey Canyon as the pathway for sediment transport between the continental shelf and the deep sea. Dilution of the pesticides appeared to occur primarily at the coastline, with little further dilution as the sediments moved downslope into >3 kilometer water depths.

A comparison of PAH and PCBs concentrations in sediment samples from the shelf, slope, and submarine canyons between Point Reyes and the Big Sur coast, found the highest levels in the canyons, and the lowest concentrations on the shelf (Hartwell 2008) (Figure 38). Normalizing data for total organic carbon (TOC) content of the sediment shows where concentrations are elevated after adjusting for the affinity of the sediment to accumulate organic contaminants. For the PAH and PCB data, this procedure illustrates that the sediments in the Gulf of the Farallones appear to receive PAHs and PCBs from San Francisco Bay through tidal exchange through the Golden Gate and the offshore sewer outfall more than from longshore drift up the coast. This study suggests that San Francisco Bay is the primary source of PAHs and PCBs to the Monterey Bay sanctuary.

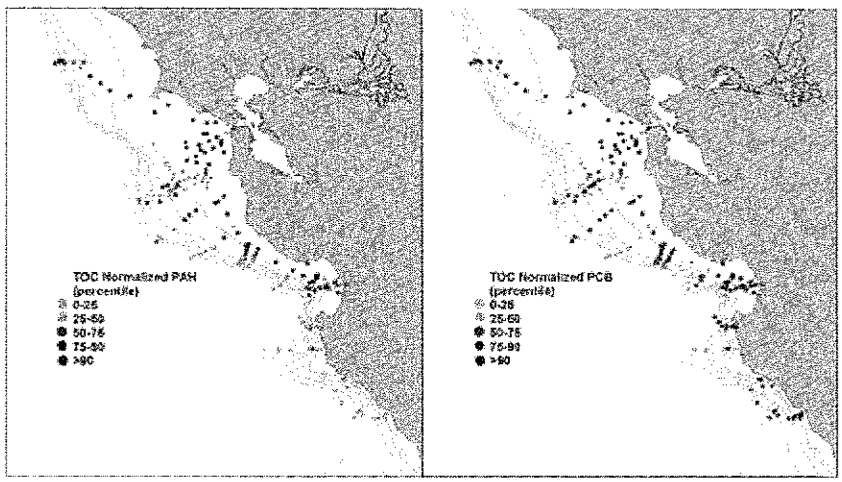


Figure 38. Relative concentration of total PAHs and PCBs normalized for sediment total organic carbon content. PAH and PCB concentrations are the highest in the canyons and lowest on the shelf. Concentration rangers are 25th, 50th, 75th, and 90th percentiles. Click here for a larger image. *(Source: Hartwell 2008)*

There has been very limited study of the impacts of contaminants in offshore sediments on living resources. As part of the CCLEAN program, ecological effects on benthic infaunal species have been investigated by examining the relationship between sediment characteristics, river discharges, and the numbers of organisms for the most abundant taxa. Results suggest suspended sediment from the rivers, primarily the Pajaro River, may be having negative effects on benthic organisms along the 80-meter contour. Moreover, total abundance may be negatively affected by the cumulative concentrations of POPs (CCLEAN 2006). In a separate study, analysis of the concentration of persistent organic pollutants in demersal fish and invertebrates in the Monterey Bay region found an enrichment of both the PCBs and DDTs up to a factor of four when going from surface to deepwater fish, and a species of deep-sea brittle star showed the highest concentration of DDTs, chlordances and toxaphenes of all samples from the region (Froescheis et al. 2000, Looser et al. 2000). These studies suggest persistent contaminants are being transported to and sequestered in deep-sea habitats through sediment transport processes and that they are being incorporated into the local food web.

8. What are the levels of human activities that may influence habitat quality and how are they changing?

The level of human activities that influence habitat quality in the offshore environment is rated as "fair/poor" because bottom-contact fishing gear has been employed widely for many decades and marine debris has been accumulating for decades in offshore habitats.

Recently, the level of fishing with bottom-contact fishing gear, particularly trawling, has been reduced by landing restrictions, gear restrictions, and area closures. Two federal gear restrictions adopted area-wide that reduce impacts to physical and biogenic habitat are: a restriction on the use of large footrope (roller) gear for continental shelf species implemented in 2000 (PFMC 2005); and a prohibition on the use of trawl nets to take spot prawn adopted by the Fish and Game Commission in 2003. The area closed to trawling in state waters was expanded in 2006 to include all of Monterey Bay and state waters south of Yankee Point to Point Sur (see Figure 35 in Habitat section, Question 5). In federal waters, area closures were implemented to help rebuild overfished populations (Rockfish Conservation Areas (RCA)) and protect groundfish essential fish habitat (EFH) (see Figure 35 in Habitat section, Question 5). The Trawl RCA restricts commercial bottom trawling for federally regulated groundfish near the outer edge of the continental shelf and the non-trawl RCA restricts longline, hook and line, and pot gear for groundfish on the continental shelf from 30 to 150 fathoms. The EFH areas in the Monterey Bay sanctuary restrict the use of bottom trawl gear. These changes in fisheries management have resulted in decreases in the overall trawling and bottom fishing effort, but may also lead to redistribution of fishing effort and increased fishing pressure in areas open to fishing.

Two other activities that can negatively influence the quality of offshore benthic habitats are installation of submerged cables and loss of fishing gear. Installing submerged cables is strictly regulated by the sanctuary. Four new cables, with a combined total length of 114 kilometers within sanctuary boundaries, have been permitted since the sanctuary was designated in 1992. A recent survey of the ATOC/Pioneer Seamount cable found no measurable impacts of the cable on benthic habitat below 30 meters and only minor influences of the cable on the abundance and distribution of benthic invertebrates (Kogan et al. 2006).

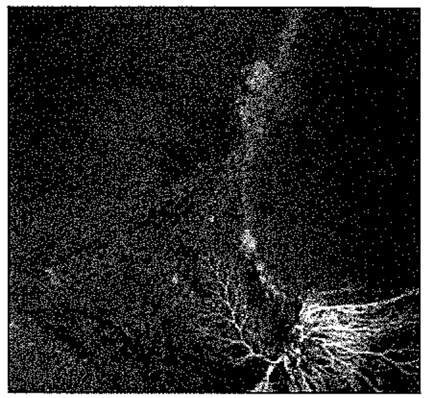


Figure 39. Video surveys from submersibles help locate and quantify types of marine debris, such as this commercial fishing net which poses an entanglement risk for a variety of animals. *(Photo: T. Laidig, NOAA/NMFS/SWFSC)*

Marine debris directly alters physical habitats by settling on the seafloor (i.e., adding artificial structure) or by removing/damaging biologically structured habitat. In addition, marine debris in the water column, such as lost fishing nets, poses an entanglement risk to pelagic animals, especially large fishes, sea turtles, seabirds, and mammals. Watters et al. (2008) examined the distribution, abundance, type, and potential impacts of marine debris on shelf and canyon benthic habitats in the Monterey Bay region in 1993 and 1994 In this preliminary study 148 transects (typically 10-15 minutes in duration) with a combined length of 44,730 meters were surveyed. Marine debris was found along 47% of transects and was composed most frequently of plastic. Monofilament line used by recreational anglers was the primary source of the debris, followed by commercial fishing nets and longlines (Figure 39). The Monterey Bay sanctuary is working with partners to design and implement a multi-year project to remove lost fishing gear from the sanctuary. The dual purpose of the project is to help eliminate benthic and pelagic hazards to marine organisms posed by fishing debris lost on the bottom, and to provide outreach tools that would assist in the location of lost gear via reports from divers, researchers, fishermen and other parties.

Offshore Environment Habitat Status and Trends

Good/Fair | Fair | Fair/Poor | Undet.

Trends:

- ▲ Conditions appear to be improving.
- — Conditions do not appear to be changing.
- ▼ Conditions appear to be declining.
- ? Undetermined trend.
- N/A Question not applicable.

# Issue	Rating	Basis For Judgement	Description of Findings
5. Abundance/Distribution	?	Benthic habitat loss and modification due to fishing with bottom-contact gear; recovery of seafloor	Selected habitat loss or alteration may inhibit the development of assemblages, and may cause measurable but

		habitats resulting from management measures is unknown.	not severe declines in living resources or water quality.
6. Structure	?	Damage to and loss of structure-forming and structure-building taxa due to trawl fishing; recovery of biogenic habitat resulting from management measures is unknown.	Selected habitat loss or alteration has caused or is likely to cause severe declines in some but not all living resources or water quality.
7. Contaminants	▼	No evidence of strong ecosystem level effects; no attenuation of persistent contaminants in sediments; continued input and delivery of some contaminants to deep-sea habitats.	Selected contaminants may preclude full development of living resource assemblages, but are not likely to cause substantial or persistent degradation.
8. Human Impacts	▲	High levels of previous trawl fishing, but recent reductions in trawling activity. Accumulations of marine debris from land and ocean-based human activities.	Selected activities have caused or are likely to cause severe impacts, and cases to date suggest a pervasive problem.

Offshore Environment Living Resources

Biodiversity is variation of life at all levels of biological organization, and commonly encompasses diversity within a species (genetic diversity) and among species (species diversity), and comparative diversity among ecosystems (ecosystem diversity). Biodiversity can be measured in many ways. The simplest measure is to count the number of species found in a certain area at a specified time. This is termed species richness. Other indices of biodiversity couple species richness with a relative abundance to provide a measure of evenness and heterogeneity. When discussing "biodiversity" we primarily refer to diversity indices that include relative abundance. To our knowledge no species have become extinct within the sanctuary, so native species richness remains unchanged since sanctuary designation in 1992. Researchers have described previously unknown species (i.e., new to science) in deeper waters, but these species existed within the sanctuary prior to their discovery. The number of non-indigenous species has increased within the sanctuary. We do not include non-indigenous species in our estimates of native biodiversity.

Key species, such as keystone species, indicators species, sensitive species and those targeted for special protection, are discussed in the responses to questions 12 and 13. Status of key species will be addressed in question 12 and refers primarily to population numbers. Condition or health of key species will be addressed in question 13. Key species in the sanctuary are numerous and all cannot be covered here. Emphasis is placed on examples from various primary habitats of the sanctuary for which some data on status or condition are available.

The following information provides an assessment of the status and trends pertaining to the current state of the sanctuary's living resources in the offshore environment.

9. What is the status of biodiversity and how is it changing?

Thorough historic and current inventories are not available to fully measure biodiversity status and trends in the sanctuary. Species richness remains unchanged; no species in offshore habitats are known to have become locally extinct. However, the relative abundance of those species has been altered substantially by both natural and anthropogenic pressures. Numerous species in the sanctuary have experienced population declines in recent decades to unprecedented low levels. Conversely, a few species that were uncommon visitors in past decades have increased in abundance in recent years, such as jumbo squid. Shifts in the relative abundance of multiple species, especially those at higher trophic levels, are indicators of compromised native biodiversity in the system and impact community and ecosystem structure and function. For these reasons, the status of native biodiversity in the offshore habitats of the sanctuary is rated "fair." However, the cumulative trend in biodiversity could not be determined due to a lack of information on the changes in relative abundance of many deep-sea species and an uncertainty in how to combine the individual trends in species abundance into a cumulative trend in biodiversity.

A historical perspective suggests that many of the higher trophic level species in the offshore environment, such as marine mammals, seabirds, and predatory fishes, have been dramatically reduced by hunting and fishing. The protection and active management of marine mammal populations by state, federal, and international entities has allowed a full recovery of a number of mammal stocks that occur in the sanctuary, such as gray whales, harbors seals, northern elephant seals, and California sea lions (Angliss and Allen 2009, Carretta et al. 2008). On-going monitoring by the National Marine Fisheries Service is finding that other mammals stocks in the sanctuary remain at reduced levels (e.g., blue whales, harbor porpoise), though some are slowly increasing in abundance (e.g., humpback whales) (Angliss and Allen 2009, Carretta et al. 2008).

Some locally breeding seabirds (e.g., Cassin's Auklets, Rhinoceros Auklets, Pigeon Guillemot, Pelagic Cormorant) have experienced reduced reproductive success in recent years due to poor feeding conditions in the coastal ocean (Goericke et al. 2007). Abundance of non-resident species, such as Sooty Shearwaters and Black-footed Albatrosses, have also declined within the waters of Northern California (Ainley and Hyrenbach unpubl. data), potentially due to population declines resulting from human impacts in remote locations. In addition, the central California population of Marbled Murrelets, a seabird that forages in sanctuary waters and nests in old growth forests adjacent to the sanctuary, was recently estimated between 122 and 225 individuals, which represents a 54-55% decline since 2007 and 71-80% decline since 2003 (Peery et al. 2008). This decline is attributed in large part to terrestrial human activities that result in the degradation or loss of breeding habitat.

Decades of fishery extraction have contributed to a shift in the biodiversity of the fish assemblage in offshore waters. Based on fishery-independent trawl surveys conducted from 1977-2001 along the U.S. West Coast (including sampling sites throughout the Monterey Bay sanctuary), Levin et al. (2006) found that there have been fundamental changes in the fish assemblage on the continental shelf and slope. Populations of flatfishes, cartilaginous fishes, and small rockfishes have increased, while populations of large rockfishes have decreased. In 1977, rockfishes were more than 60% and flatfishes were 34% of the fish captured in the survey. In 2001, rockfishes were 17% and flatfishes were nearly 80% of the fish captured in the survey. The species that now dominate the shelf/slope assemblage have vastly different trophic roles and life-history strategies than the species they replaced.

The abundance of jumbo squid (*Dosidicus gigas*) has increased recently in the sanctuary (Figure 40) and may be having impacts on both regional and local biodiversity. Observations from remotely operated vehicle surveys in the Monterey Bay region show that these large squid have been present and sporadically abundant since the 1997-98 El Niño event, particularly between 2003 and 2006 (Zeidberg and Robison 2007). This voracious predator consumes a variety of pelagic and semipelagic fishes, including commercially harvested species (e.g., Pacific hake, sablefish, various rockfishes), and could drive changes in the pelagic food web (Field et al. 2007). For example, the presence of jumbo squid in Monterey Bay surveys has been associated with declines in observations of Pacific hake (Zeidberg and Robison 2007). Jumbo squid are also a key forage item for many higher trophic level fishes and marine mammals throughout their range, including toothed whales and commercially important tunas, billfishes and sharks (Field 2008). These animals are likely to play a major role in structuring offshore ecosystems. The cause of the observed range expansion of jumbo squid has not been determined; possible contributing factors include a switch in the Pacific Decadal Oscillation, harvesting of large pelagic predators, and global warming.

Biodiversity in deep-sea communities of the sanctuary is not well understood because of the logistical challenges of conducting research in deep water. Due to technological advances in undersea research, census and evaluation of ecological integrity of deep-sea habitats has only recently begun for midwater assemblages (e.g., MBARI Midwater Ecology ROV surveys) and benthic communities (e.g., MBARI Benthic Ecology ROV surveys). For example, surveys of whale falls and cold seep communities have led to the discovery of several new species (Barry et al. 1996, Goffredi et al. 2004). There are indications that deepwater sponge and coral communities in the sanctuary have been impacted before many aspects of their basic biology and ecology could be ascertained. Overall, there is much that is unknown about the species richness and evenness of several important communities within the offshore habitats of the sanctuary.

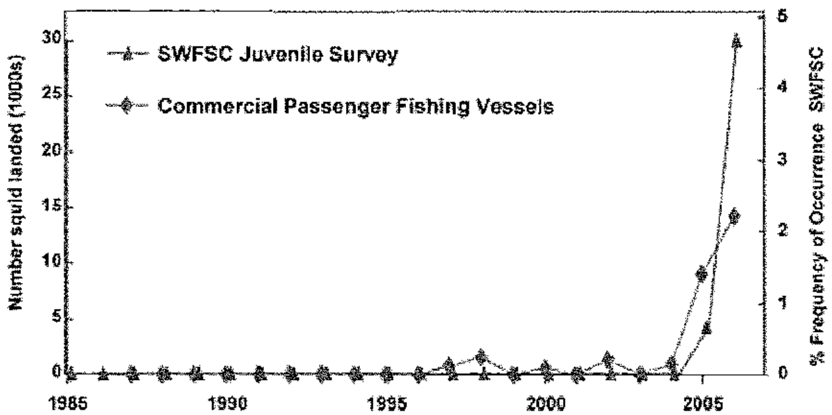


Figure 40. Indices of relative jumbo squid abundance over time. The number of squid caught by California commercial passenger fishing vessels north of Point Conception (orange diamond) and the frequency of occurrence of jumbo squid in pelagic midwater trawl surveys conducted in May and June off of the central California coast by the Southwest Fisheries Science Center (SWFSC) since 1985 (blue triangle) are shown. *(Source: Modified from Field et al. 2007)*

10. What is the status of environmentally sustainable fishing and how is it changing?

Environmentally sustainable fishing or ecologically sustainable fishing may be defined as fishing at a level that the ecosystem can sustain without shifting to an alternative or undesirable state. To determine if environmental fishing is occurring, one has to simultaneously consider the impacts of all harvested species on an ecosystem, and community stability and resilience (Zabel et al. 2003). It is designed to consider fishery yield and the integrity of ecosystem structure, productivity, and function and biodiversity, including habitat and associated biological communities. The past decade has seen a paradigm shift in the management of fisheries from managing target stocks for maximum sustainable yield to ecosystem-based fisheries management. This shift leads to a more holistic consideration of sustaining fishery yield, as well as maintenance of marine ecosystems and their function.

The status and trend ratings of "fair" and "improving" for this question are based on the available scientific knowledge (e.g., published studies, unpublished data, and expert opinion) of targeted and non-targeted living resources that are directly and indirectly affected by fishing. Because this is the first Monterey Bay sanctuary condition report, the status rating reflects a more historical view of the potential effects of fishing activity on biological community development, function, and ecosystem integrity, over the last two to three decades. Subsequent reports will take a more contemporary view of the ecosystem-level impacts of fishing. The status rating does not serve as an assessment of the status of current fisheries management practices in the region. However, the determination of an increasing trend for this question does reflect recent changes in fisheries management practices and their positive effects on living resources in the sanctuary.

Historical accounts, ranging over several timescales from decades to centuries, demonstrate how commercial and recreational fisheries have extracted significant biomass from waters now encompassed by the Monterey Bay sanctuary, in part using methods that are known to reduce physical complexity and damage living structures of seafloor habitats. Several species of whales, pinnipeds, and large sharks were drastically reduced, at least in part as a result of historic fishing, and are currently at depressed population levels (Leet et al. 2001). The effects of reducing the abundance of currently fished stocks, in some cases to less than 50 percent of the unfished biomass, on ecosystem health and integrity are poorly researched and understood, but have the potential to alter ecosystems. Meanwhile, scientists are just beginning to understand fundamental elements of ecosystem function - the distribution and community composition of seafloor habitats, the distribution of and habitat requirements for different life stages of important commercial species, the significance of diverse age structures in sustaining fishery resources, and many other factors that influence community development and function. For these reasons, this question is rated "fair."

The major commercial fisheries that operate in the Monterey Bay sanctuary target groundfish (rockfishes, flatfishes), pelagic finfish (salmon, sardines, anchovy, mackerel), and invertebrates (market squid, Dungeness crab, spot prawn). In the recreational fishery, commercial passenger fishing vessel anglers traditionally target rockfish, salmon, lingcod, and, opportunistically, albacore tuna (CDFG 2008b). Dungeness crab and jumbo squid are the main invertebrates targeted by the central and northern California recreational fishery (CDFG 2008b). In general, fisheries managers appear optimistic that sustainable fisheries in the offshore waters of the sanctuary are possible under new management regimes following historical stock declines. Marine communities in the Monterey Bay sanctuary are subject to complex pressures and interactions and many targeted species are long lived, therefore fishery management actions aiming to allow population recovery may experience a long lag period before changes are observed.

Of the 80 species of groundfish managed under the PFMC's Groundfish Fishery Management Plan, 22 species are managed at the species level. The remaining species are either unassessed or managed in groupings or stock complexes, because individually they comprise a small part of the landed catch or stock assessments have not been completed. For some species, it is unlikely that sufficient information exists to develop adequate stock assessments.

The status and management of many groundfish stocks has undergone dramatic changes over the past few decades. Beginning in the 1970s, improved understanding of life history characteristics led fisheries scientists to conclude that many groundfish species were incapable of sustaining high-intensity fishing pressure using modern fishing methods. Over the next two decades, several groundfish stocks became depleted due to a combination of fishing and natural factors. Since the late 1990s, some formerly depleted groundfish species have recovered quickly (e.g., English sole), while others are rebuilding more slowly (e.g., bocaccio). Four rockfish species - bocaccio, cowcod, yelloweye rockfish, and darkblotched rockfish - are currently considered overfished). All depleted rockfish species with stock assessment data are showing increasing trends in spawning biomass over the past 10 years (Figure 41). Moreover, 11 out of 18 rockfish species show evidence of increasing average body size since 1999 (S. Ralston, NOAA/NMFS, unpubl. data). The recent increase in size of these fishes is consistent with a response to reduced fishing effort.

Salmon have been one the most important species in both commercial and recreational fisheries in the Monterey Bay sanctuary. Managing ocean salmon fisheries is an extremely complex task, due in large part to the wide oceanic distribution of the salmon and difficulty in estimating the size of salmon populations. Salmon at all life history stages are affected by a wide variety of natural and anthropogenic factors in the ocean and on land, including ocean and climatic conditions, habitat degradation and loss, and predation (including humans). Other challenges to a sustainable salmon fishery off central California coast include judging the effects of different regional fisheries on salmon stocks, competition between wild and hatchery salmon, and restoring freshwater habitat. In the last 20 years, commercial and recreational catches of salmon in California have fluctuated in response to population trends, regulatory seasons, and quotas. Many of the salmon stocks that occur off California are listed as threatened or endangered under the Endangered Species Act. Ocean salmon fisheries in California primarily target Chinook salmon since the retention of coho salmon was prohibited in the commercial and recreational fisheries in 1993 and 1996, respectively. Recently, the low returns of Chinook salmon in two stocks, the Klamath River fall run and the Sacramento River fall run, led to very restrictive limits on commercial and recreational fishing for salmon in 2006 and a complete closure of both fisheries south of Cape Falcon, Oregon in 2008 (PFMC 2006, 2008).

Pacific sardine, market squid, northern anchovy and Pacific mackerel are four of the largest volume fisheries in the state of California (CDFG 2008b). Sardine, anchovy, and mackerel stocks are assessed by the National Marine Fisheries Service, whereas market squid and anchovy stocks are monitored by the California Department of Fish and Game. Landing data dating back a couple decades show large fluctuations in harvest for each of these species (Leet et al. 2001, CDFG 2008b). Some of these fluctuations in landings may be due to changes in management, but it appears that population size for these species tends to be influenced strongly by prevailing oceanographic conditions (Leet et al. 2001). Currently, these coastal pelagic fisheries in California appear to be healthy (CDFG 2008b).

The commercial Dungeness crab fishery is one of the top value fisheries in the state (CDFG 2008b). Historically, this fishery has been cyclical with abundance peaking approximately every 10 years (CDFG 2008b). The large fluctuation in landings is likely due to varying ocean conditions including water temperature, food availability and ocean currents (Leet et al. 2001). The Dungeness crab and spot prawn fishery are trap-based fisheries with low by-catch and both appear to be environmentally sustainable fisheries (Leet et al. 2001, Hankin et al. 2004, Larson and Reilly 2008).

Despite the improving trend for many harvested groundfish species and the more restrictive fisheries management measures that have been implemented for groundfish, finfish, and invertebrate fisheries, there is still concern over the ecological impact of the past and present fishing activities in the sanctuary. Fishing can alter marine ecosystems both by altering local environments, as when trawls drag across the ocean floor, and by modifying community composition (Zabel et al. 2003). MBARI ROV surveys of the continental shelf and slope in the sanctuary commonly observe trawl marks on soft bottom. Soft-bottom areas that were trawled have been denuded of benthic invertebrate microfauna and associated species, whereas areas that lack trawling show much more advanced community development (Jim Barry, MBARI, pers. comm.). The impacts of the trawl fishery to benthic habitats and communities are very evident and it is possible that ecosystem integrity has suffered as a result of degradation of the benthic community (Jim Barry, MBARI, pers. comm.). Even nominal amounts of trawling in a pristine area can lead to significant damage. Closures of some areas to trawling should lead to improvements over time, but other areas may receive higher pressure due to fishery displacement.

Very little is known about the community and ecosystem-level consequences of repeatedly removing a large portion (up to 60%) of the biomass of multiple species in the same ecosystem. However, some recent studies lead to concerns that past fishing activity has impacted community function and ecosystem integrity in the sanctuary. Levin et al. (2006) found that over the last 25 years there have been fundamental changes in the fish assemblage on the continental shelf and slope of the U.S. Pacific coast. Populations of flatfishes, cartilaginous fishes, and small rockfishes have increased, while populations of large rockfishes have decreased. The species that now dominate the shelf/slope assemblage have vastly different trophic roles and life-history strategies than the species they replaced. In a separate study, Yoklavich et al. (2000) compared the fish assemblage in an area of Monterey Bay that was a natural refuge from fishing to the assemblage in fished area. They found that sites that were less fished had larger fishes, and had significantly higher abundances of major commercial and recreational species, including boccacio and cowcod, than more heavily fished areas. Shifts in community composition may disrupt direct and indirect ecological processes inherent in food webs and alter community trophic interactions and energy flow. For example, in communities with complex species interactions, targeted removals of large predators from a population can reduce the resiliency of that community to perturbations (Baskett et al. 2006).

Fishing can directly affect communities, as when it changes key life-history traits (Zabel et al 2003). For example, fisheries typically seek larger, more valuable fish, decreasing the average size of fish in the target populations. Past fishing practices have resulted in a decrease in both the mean size (Figure 41; Mason 1998) and local density (Yoklavich et al. 2000) of some targeted species, such as large-bodied rockfish, in the sanctuary. Though population-level changes have been measured in the sanctuary, the potential community-level consequences are poorly studied. One recent study by Harvey et al. (2006) estimated the impact of size and density changes on energy consumption and fecundity in a rockfish assemblage that included bocaccio - a large-bodied, overfished species. They found shifts in the allocation of energy and reproductive potential within the assemblage that had the potential to affect the ability of bocaccio and other large rockfish species to recover from overfishing.

As mentioned above, a number of the fished stocks in the sanctuary are known to experience substantial fluctuations in abundance. Some of the fluctuation can be attributed to significant climate shifts that last from a couple of years to several decades. However, there is concern that fishing pressure may contribute to more frequent or more extreme fluctuations in abundance. A recent analysis of long-term monitoring data of the ichthyofaunal assemblage off of southern California found that fishing significantly increases temporal variability of populations in the ecosystem (Hsieh et al. 2008). Exploited populations were found to be more vulnerable to climate variability and lead to unstable boom and bust cycles. The likely cause of this increased variability is that selective harvesting can alter the basic dynamics of exploited population, such as intrinsic growth rates (Anderson et al. 2008). Drastic changes in the abundance of fished stocks could have substantial impacts on the offshore ecosystem, which consists of a complex web of pelagic and demersal fishes and invertebrates, marine mammals, and seabirds.

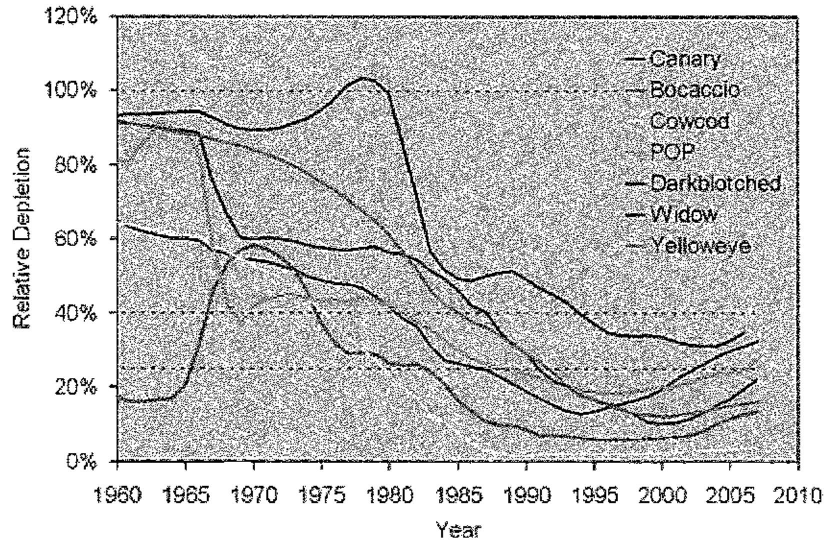


Figure 41. Trend in the relative depletion of overfished rockfish species that are managed by the PFMC. Relative depletion is the estimated size of the spawning population relative to the estimated size of the population if unfished. A stock size of 40% relative to the unfished level is the target management level while a stock size of 25% or less is considered overfished. Data is based on the most recent set of stock assessments. *(Source: S. Ralston and J. Field, NOAA/NMFS/SWFSC)*

11. What is the status of non-indigenous species and how is it changing?

Non-indigenous species in offshore habitats are not suspected or do not appear to affect ecosystem integrity because very few non-indigenous species have been identified in these habitats. Therefore, the rating related to this question is "good" and the trend is "stable". Maloney et al. (2006) reported that four of the species identified from infaunal samples collected in deeper waters (30-120 m) offshore of California were introduced: *Anobothrus gracilis*, *Laonice cirrata*, *Melinna oculata* and *Trochochaeta multisetosa*. All of these species are polychaete worms (phylum: Annelida), and represented only 1% of the total annelid taxa identified from infaunal samples.

Some species that forage in the open ocean are adversely affected by introduced species in habitats outside the boundaries of the Monterey Bay sanctuary, such as in other portions of their geographic range. For example, predation by introduced black rats on eggs and chicks has negatively impacted the reproductive success of nesting seabirds on Anacapa Island, near the Channel Islands sanctuary. Removal of this introduced species has resulted in substantial recovery of rare seabird populations on the island, including Brown Pelican and Xantus's Murrelets that forage during the non-breeding season in the Monterey Bay sanctuary.

12. What is the status of key species and how is it changing?

The status of key species in the offshore environment is rated "good/fair" and the trend is "stable." There are many high-profile species in offshore habitats. These include cetaceans, seabirds, pelagic fishes (e.g., salmon, tunas, sharks), and sea turtles. Many of these are apex predators and play important ecological roles in the sanctuary ecosystem. Here we focus on a few examples from each of the major species groups.

Among seabirds, Sooty Shearwaters are key species because of the extremely high densities reached during the summer, when hundreds of thousands of adults forage for fishes and squid in sanctuary waters after migrating from the southern hemisphere (Adams and Harvey 2006). A 32% decline in average densities of Sooty Shearwaters was calculated from the period 1985-1994 to the period 1997-2006 based on shipboard surveys in central California (Ainley and Hyrenbach, unpubl. data). This decline is due potentially to a number of factors occurring outside the Monterey Bay sanctuary including changes in oceanographic conditions and human impacts in remote locations (Hyrenbach and Veit 2003, Scofield and Christie 2002).

Stock assessments suggest that many of the populations of marine mammals that use sanctuary habitats are stable or increasing (Carretta et al. 2008, Angliss and Allen 2009). For example, there is evidence suggesting an increasing population for the eastern North Pacific humpback whale stock (Calambokidis et al. 2004). The population of Steller sea lions off California and Oregon is stable or increasing very slowly (Angliss and Allen 2009). The abundance of this threatened species in the sanctuary is monitored by observing the number of pups and non-pups at the breeding colony on Año Nuevo Island. Pup counts and non-pup counts taken in July have decreased from 1990-2004 at an average annual rate of -2.63% and -1.28%, respectively (M. Lowry, NMFS-SWFSC, pers. comm.). Similar declines have been observed at South Farallon Island, a breeding colony just north of the Monterey Bay National Marine Sanctuary.

Salmon are key species in the sanctuary due to their important role in both the offshore foodweb and in commercial and recreational fisheries. Historically, salmon were abundant in central California rivers, estuaries, and offshore waters. Currently, the abundance of salmon in the sanctuary is drastically reduced and many of the salmon stocks in central California have been listed under the federal Endangered Species Act. Salmon at all life history stages are affected by a wide variety of natural and human-caused factors in the ocean and on land, including ocean and climatic conditions, habitat degradation and loss, and predators (including humans). Ocean survival of salmon can be an important influence on overall population size, and differential ocean survival depends on oceanic conditions. Both the Pacific Decadal Oscillation (PDO) and climate change influence salmon abundance in the sanctuary.

Forage species (e.g., krill, anchovies, squid) are among the most important to the ecosystem as a whole. These forage species directly and indirectly support the tremendous abundances and species diversity of higher trophic levels. Squid serve as both predator and prey in offshore food webs. Market squid are seasonally abundant and population size appears to be influenced more by prevailing oceanographic conditions rather than by fishing pressure, though additional research is needed to better understand the relative influence of environmental variability and fishing pressures on the biomass of this stock (Porzio and Brady 2008). Krill is an abundant shrimp-like crustacean that directly or indirectly feeds much of the pelagic food web. To date there has never been an active fishery for krill along the U.S. West Coast. To assure the protection of this resource for the marine mammals, seabirds, and fishes that rely on krill as a primary food source regulations prohibiting the harvest of krill in state waters of California, Oregon, and Washington were passed in 2000 by each state's legislature. Similarly, a prohibition on the harvesting of krill in the Exclusive Economic Zone (EEZ) off the coasts of California, Oregon, and Washington was adopted in 2006 by the Pacific Fisheries Management Council. The National Marine Fisheries Service published a final rule in the Federal Register which went into effect on August 12, 2009.

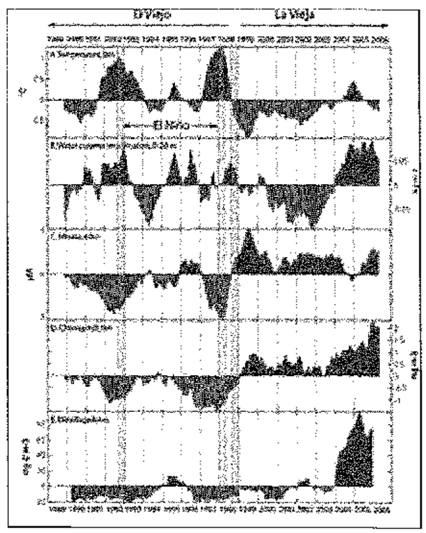


Figure 42. Monitoring data collected by the Monterey Bay Aquarium Research Institute were used to create time series of anomalies, with higher [or lower] than normal values in red [or blue]. (A) 0 m temperatures have in general remained cool since 1998, resulting in high (C) 60 m nitrate and (D) 0 m chlorophyll (overall phytoplankton biomass) values. However, centric diatoms decreased sharply in 2003 and were apparently replaced by (E) dinoflagellates in 2004. This phytoplankton switch may have been caused by increased (B) near-surface stratification (0-20 m difference in the water density parameter, sigma-t) which resulted from decreased wind-driven upwelling after 2003. Timing of two El Niños (pink column) and one La Niña (light blue column) are shown. Click here for a larger image. *(Source: Pennington et al. 2007).*

Phytoplankton is another key component of the ecosystem, and consists of multiple species. Starting in 2003, the biomass of dinoflagellates increased dramatically in the surface waters of the sanctuary, and was correlated with a decrease in upwelling, favorable winds and increases in both water column stratification and surface chlorophyll (an indicator of overall phytoplankton biomass) (Figure 42) (Pennington et al. 2007). This recent change in the phytoplankton assemblage, from a diatom-dominated to a dinoflagellate-dominated assemblage, persisted into 2006 and almost certainly has ecological consequences, most of which are unknown.

13. What is the condition or health of key species and how is it changing?

The condition of key species in the offshore environment is rated "good/fair" and has a "declining" trend. The health of several key species has been compromised by exposure to neurotoxins produced by harmful algal blooms, entanglement in active and lost fishing gear, ingestion of marine debris, and accumulation of persistent contaminants. The continued input of non-biodegradable marine debris and persistent contaminants into the offshore waters of the sanctuary combined with the lack of attenuation of legacy contaminants, indicates that these threats to the condition of key species have steadily increased over the past decades and will continue to increase in the future.

Some species of phytoplankton produce natural toxins that adversely affect several apex predators, including marine mammals and seabirds that forage offshore. In particular, domoic acid, a neurotoxin produced by the diatom *Pseudo-nitzschia*, has been problematic. For example, along the central California coast over 400 California sea lions died and many others displayed signs of neurological dysfunction during May and June 1998, during the same time period that a bloom of *Pseudo-nitzschia* was observed in the Monterey Bay region (Scholin et al. 2000). Large blooms of domoic acid producing phytoplankton were observed in Monterey Bay during 2000, 2002, and 2007 and these blooms were suspected as the cause of increased numbers of stranded and dead seabirds and mammals recorded on beaches in the Monterey Bay region by the BeachCOMBERS (Coastal Ocean Mammal / Bird Education and Research Surveys) monitoring program (Nevins et al. in prep).

A health concern for key species in the sanctuary, including marine mammals, seabirds, and sea turtles, is interaction with active and lost fishing gear. Monitoring of hauled-out seals and sea lions on Southeast Farallon Island (just outside the Monterey Bay sanctuary) during the period 1976-1998 documented a total of 914 individuals that were entangled in synthetic material (Hanni and Pyle 2000). Of a total of 6,196 live stranded seals and sea lions admitted to a rehabilitation center on the central California coast from January 1986 to September 1998, 107 (1.7%) had lesions caused by entanglement with manmade marine debris, including active or discarded fishing nets and monofilament line, packing straps, plastic bags, rope, and rubber o-rings (Goldstein et al. 1999).

Ingestion of plastic marine debris is a health concern for a number of seabird species in the sanctuary. The sanctuary's BeachCOMBERS monitoring program has collected carcasses of dead seabirds for study by local researchers. Analysis of the stomach contents of 190 Northern Fulmars collected along Monterey Bay beaches in 2003-2004 found that 71% of the birds had plastic in their stomachs (Nevins et al. 2005). In similar studies, plastic was observed in the stomachs of 67% of the 27 Red Phalaropes collected in 2005-2006 (Zabka et al. 2006) and 56% of the 16 Horned Puffins collected in 2007 (Phillips et al. 2007). These species of seabirds, and other seabirds such as albatrosses and shearwaters, are migratory birds that depend on the highly productive waters of Monterey Bay to feed. These seabirds are susceptible to plastic ingestion everywhere they feed, including the sanctuary.

The high trophic level and longevity of marine mammals and seabirds put them at risk of accumulating contaminants in their bodies to levels high enough to cause potential health impacts. Measurable loads of organochlorides (e.g., PCBs, DDTs) have been observed in marine mammal and seabird species that occur in the sanctuary, including Steller sea lions (Jarman et al. 1996), harbor porpoise (Calambokidis and Barlow 1991), killer whales (Black et al. 2003, Krahn et al. 2007), Black-footed Albatross (Finkelstein et al. 2006, 2007), and the eggs of a number of species of locally nesting seabirds (Pyle 1999). However, a general lack of consistent long-term data coupled with the wide ranging movement patterns of these species make it difficult to determine whether habitats and prey resources in the sanctuary are a significant source of contaminants for these species. A recent meta-analysis of the available contaminant data in the sanctuary revealed the highest concentrations of multiple contaminants occurred in the Elkhorn Slough and Salinas Valley areas and are probably associated with legacy agricultural applications (Hardin et al. 2007). There has been no measurable attenuation for several legacy contaminants even though their application was banned 20-30 years ago, and PAHs and PCBs increased marginally at some sites (Hardin et al. 2007). Pinpointing the sources of these contaminants is difficult, since there are multiple processes and activities that could account for high contaminant concentrations in the sanctuary, including agricultural practices, urbanization, and some recreational activities.

The decline of the central California breeding population of Steller sea lions may be caused by a combination of factors, including disease, elevated levels of organochlorine and trace metal contaminants (Jarman et al. 1996), competition for prey resources, and entanglement in fishing gear and other marine debris. In some cases, exposure to one threat may make the animals more susceptible to the others (e.g., high level of contaminants may make an animal more susceptible to disease). The relative importance of many of these threats is not known.

Chronic oiling has negatively affected seabirds in Monterey Bay National Marine Sanctuary, despite efforts to mitigate sources such as illegal dumping of bilge water and leakage of oil from sunken vessels. On average, when more than 2% of seabirds surveyed on sanctuary beaches are oiled, a significant oiling event has occurred; such was the case in the winters of 1997-98, 2001-2002, and 2004-05 (Figure 43). These events were subsequently attributed to oil leaking from the S.S. Jacob Luckenbach, which sank offshore of the Golden Gate in 1953. Removal of approximately 100,000 gallons of bunker oil from this submerged vessel has eliminated this source of oil into the offshore waters of the sanctuary.

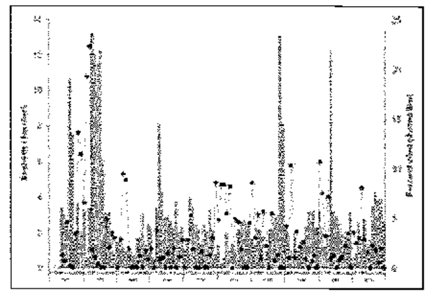


Figure 43. Since 1997, the BeachCOMBERS monitoring program has documented trends in oiled seabirds relative to total seabirds recorded during surveys of stranded seabirds and mammals on beaches in the Monterey Bay sanctuary. The percent of birds recorded that have externally visible oil is plotted (dotted line with diamonds) along with the total number of seabirds per kilometer of beach recorded during each monthly survey (gray bars). On average, when more than 2% of birds are oiled, a significant oiling event is declared. Click here for a larger image. *(Source: BeachCOMBERS).*

14. What are the levels of human activities that may influence living resource quality and how are they changing?

A number of human activities, including fishing, inputs of marine debris, and the laying of submerged cables, influence the quality of living resources in the offshore portion of the sanctuary. The level of these human activities is rated "fair" because most of these activities have resulted in measurable impacts to living resource quality. However, recent changes in fisheries management that have resulted in improved status of fished species and reduced impacts to habitat and non-target species are the basis for an "improving" trend.

Fishing is a human activity that influences sanctuary habitats and living resources in a number of ways beyond the removal of targeted biomass. The offshore seafloor has been negatively impacted by bottom-contact gear that disturbs bottom sediments, damages fragile biogenic animals (e.g., long-lived sponges and corals), and removes non-target species as bycatch. The recent closure of large portions of the offshore seafloor to bottom trawling (see Figure 35 in Habitat section, Question 5) should allow recovery of impacted habitats and associated living resources, though different species and habitats are likely to recover at very different rates and, in some cases, a full recovery may not be possible. Gear restrictions, such as changes in mesh sizes and deployment depths, have resulted in decreases in bycatch of protected and sensitive offshore species. For example, in 2002 the California Department of Fish and Game implemented a prohibition on the use of gillnets in waters shallower than 60 fathoms (approximately 110 meters) in central California to reduced the risk of entanglement of seabirds and marine mammals, including sea otters, harbor porpoise, and Common Murres (Forney et al. 2001).

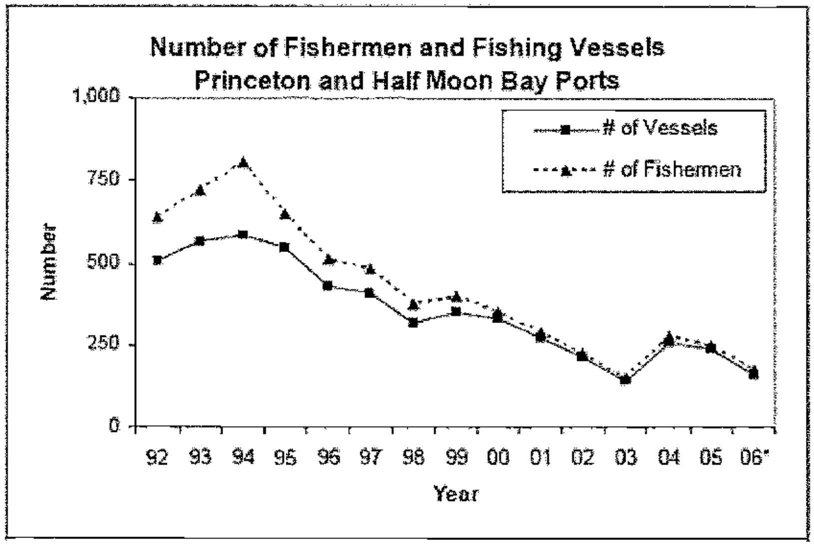


Figure 44. Total number of commercial fishermen and vessels for all ports within Princeton and Half Moon Bay Ports, 1992-2006. Data were compiled from the Commercial Fishery Information System database. The number of fishermen shown is the total number who made at least one landing for each year. Data for 2006 are preliminary. *(Source: CDFG 2007).*

Several fishery management actions over the last few decades led to a decline in the number of commercial fishing vessels registered statewide from approximately 9,200 in 1980 to 3,300 in 2004 (MLPA 2005). Similar declines in the number of commercial fishermen and vessels have been observed at the ports in the Monterey Bay sanctuary (for example see Figure 44). Decreases in the number of participants in commercial fisheries are due to a combination of many factors, including: the poor status of many rockfish stocks; increasingly restrictive fishery management regulations; attempts to reduce bycatch of species of concern; and the goal of reducing potential habitat damage from certain types of fishing gear. However, reductions in the number of participants and overall fishing effort in some sectors of the commercial fishery has not necessarily led to reductions in landings and values at all sanctuary ports. For example, although total landings at Half Moon Bay/Princeton area ports have declined over the period 1992 through 2006, total values have varied over these years, and show no consistent trend. Increased catches of higher value salmon and Dungeness crab in 2004 to 2006 helped maintain value as total landings declined (Figure 45). Commercial landings and values of finfish and invertebrates in Monterey over the period 1999 to 2004 are variable, but show no consistent trend (MLPA 2005).

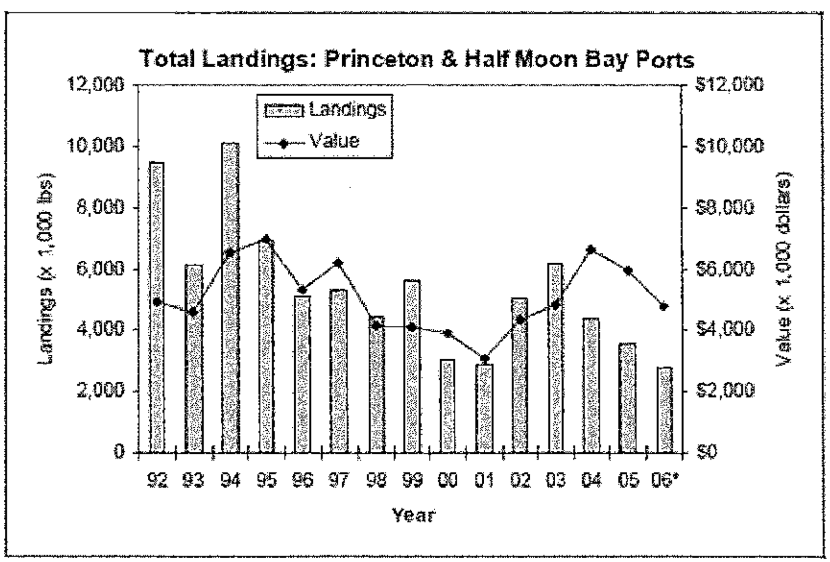


Figure 45. Total landings and values for the commercial fisheries from the Princeton and Half Moon Bay Ports, 1992-2006. Data were compiled from the Commercial Fishery Information System database. Data for 2006 are preliminary. Note: values were adjusted for inflation. *(Source: CDFG 2007).*

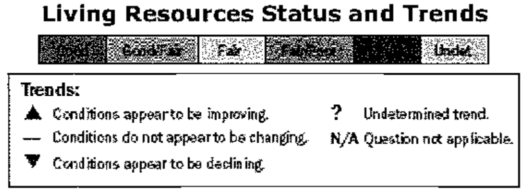
Marine debris impacts marine life in many ways, most notably through entanglement and the ingestion of large plastics (greater than 10 centimeters in dimension) that can clog the digestive tract. Microplastics (less than 10 centimeters in dimension) are present and persist in the marine environment and originate from a variety of sources (Andrady et al. 1998). However, impacts of microplastics to organisms and the environment are largely unknown. Data that conclusively demonstrate negative impacts of microplastics on the marine environment are not available. The ability for plastics to transport contaminants has been documented, but the specifics of sorption and leaching are not fully understood (Arthur et al. 2009).

A large amount of marine debris comes from land, swept by wind or washed by rain off highways and city streets, down streams and rivers, and out to sea. The California Department of Transportation conducted a litter management pilot study during 1998-2000 that found foamed polystyrene represented 15% of the total volume of litter recovered from storm drains (CIWMB 2004). Other significant items included moldable plastic (16%), plastic film (12%), and paper (14%). The Ocean Conservancy coordinates annual International Coastal Cleanup days. In 2007 the top 10 items collected worldwide included, in order of amount: cigarettes/cigarette filters, food wrappers/containers, caps/lids, bags, plastic beverage bottles, cups/plates/forks/knives/spoons, glass beverage bottles, cigar tips, straws/stirrers, and beverage cans. Foamed polystyrene is a significant component in coastal litter collection programs and monitoring studies. The 1999 U.S. Coastal Cleanup Day found that foamed polystyrene pieces were the fourth-largest amount of all materials collected, behind cigarette butts, plastic pieces, and plastic food bags and wrappers.

Cable laying is another human activity that disturbs benthic communities because it requires digging a trench to bury the cable. The laying of submerged cables is strictly regulated by the sanctuary. Four new cables, with a combined total length of 114 kilometers within sanctuary boundaries, have been permitted since the sanctuary was designated in 1992. In a recent survey of the Acoustic Thermometry of Ocean Climate/Pioneer Seamount cable, few changes in the abundance or distribution of benthic fauna were detectable from video observations (epifaunal) and sediment core samples (infauna) indicating that the biological impacts of the cable are minor at most (Kogan et al. 2006). Sea anemones had colonized the cable when it was exposed on the seafloor. Some fishes were also more abundant near the cable, apparently due to the higher habitat complexity provided by the cable.

In comparison to the nearshore or estuarine ecosystems, the offshore ecosystem is more protected from the immediate influence of many human activities. While small-scale and acute impacts may be diminished due to the large size of the open ocean ecosystem, there are other large-scale phenomena that continue to impact this system. Global climate change is increasing sea surface temperatures - this increasing temperature combined with increasing concentrations of atmospheric carbon dioxide are causing the world's oceans to become more acidic. Ocean chemistry is changing at a rapid pace, and by 2100 it is predicted to drop an additional 0.3 pH units (Doney 2006). In addition, there is concern about the potential negative impacts of acoustic pollution (e.g., noise from ships, aircraft, research boats, and military and industrial activities) on living resources, especially marine mammals. Some studies have found that marine mammals will alter their behavior and movement patterns in response to loud noise (NRC 2005). However, it is not well understood if these changes in behavior result in significant negative impacts to the animals.

Living Resources Status and Trends



#	Issue	Rating	Basis For Judgement	Description of Findings
9.	Biodiversity	?	Changes in relative abundance, particularly in targeted, by-catch, and sensitive species.	Selected biodiversity loss may inhibit full community development and function and may cause measurable but not

				severe degradation of ecosystem integrity.
10.	Environmentally Sustainable Fishing	▲	Abundance of many harvested species reduced below unfished levels, some targeted and non-targeted species have been drastically reduced by past fishing activity. Fishery management measures have assisted the initial recovery of some overfished groundfish.	Extraction may inhibit full community development and function and may cause measurable but not severe degradation of ecosystem integrity.
11.	Non-indigenous Species	-	Very few non-indigenous species identified in offshore waters.	Non-indigenous species are not suspected or do not appear to affect ecosystem integrity (full community development and function).
12.	Key Species Status	-	Reduced abundance of a number of key pelagic species; some reductions caused by activities outside the sanctuary.	Selected key or keystone species are at reduced levels, perhaps precluding full community development and function, but substantial or persistent declines are not expected.
13.	Key Species Condition	▼	Compromised health due to exposure to neurotoxins produced by HABs, entanglement in active and lost fishing gear, ingestion of marine debris, and accumulation of persistent contaminants.	The condition of selected key resources is not optimal, perhaps precluding full ecological function, but substantial or persistent declines are not expected.
14.	Human Activities	▲	Fishing and inputs of marine debris have resulted in measurable impacts; recent management actions to reduce marine debris and to recover overfished stocks and impacted habitats.	Selected activities have resulted in measurable living resource impacts, but evidence suggests effects are localized, not widespread.

Offshore Environment Maritime Archaeological Resources

15. What is the integrity of known maritime archaeological resources and how is it changing?

There is great uncertainty regarding the integrity of submerged maritime archaeological resources in the offshore environment in the sanctuary. The sanctuary's inventory contains information on known vessel losses, with little to no verified location information, and few visited sites. To date, only one offshore archaeological site location inventory has been conducted in the sanctuary by NOAA (Schwemmer 2006a). No other site evaluations have been conducted by Federal, State, or private resource management agencies.

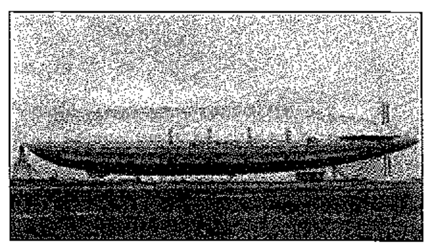


Figure 46a. The U.S. Navy "dirigible" USS *Macon* (ZRS-5) attached to the mooring mast which rode on railroad tracks and was used to move the airship to either end of the hanger. The 785-foot USS *Macon* was the nation's largest and the last U.S. built rigid lighter-than-air craft. *(Photo: Wiley Collection, Monterey Maritime & History Museum).*

The USS *Macon*, a 785-foot dirigible (Figures 46a, b, c), was lost offshore of Point Sur on Feb. 12, 1935 when it foundered tail first into the waters of the Pacific Ocean. For decades, its underwater location remained a mystery. In 1990 and 1991, the Monterey Bay Aquarium Research Institute and the U.S. Navy located the *Macon*'s remains at a depth of over 1,000 feet (304 meters). Archaeologists have concluded that sections of the *Macon*'s

aluminum girder show signs of degradation after 71 years in the offshore marine environment (Schwemmer 2006a). Although a rigid-frame airship cannot be compared to a seagoing vessel, it is expected that steel or iron shipwrecks at similar depths would retain a higher level of structural integrity and mass.

Figure 46b. Sparrowhawk bi-planes flying in formation over Moffett Field. The Curtiss aircraft company adapted their F9C-2 Sparrowhawk bi-plane fighters to be used aboard the "flying aircraft carriers." When the USS *Macon* was lost off Point Sur on Feb. 12, 1935, the airship went down with four bi-planes. *(Photo: Wiley Collection, Monterey Maritime & History Museum).*

There is a high level of uncertainty for offshore wreck sites because the majority of sites have not been visited or investigated. Sites in deep water are naturally in better condition than those in shallow water because they are not impacted by strong currents and the cold, deepwater environment tends to have fewer biological processes accelerating ship degradation. One probable impact in offshore waters is from bottom trawling, but because the majority of wreck locations are unknown, the impacts from historical and recent trawling are unknown. A few technical divers are capable of diving deep-water sites and have visited at least one offshore site (e.g., Dredge *Art Riedel Sr* lost 1990, 95 meters deep). The integrity of known maritime archeological resources in offshore habitats is "undetermined," and the trend is "undetermined."

Figure 46c. Submerged view of the sky-hook located at the center of the Curtiss Sparrowhawk F9C-2 biplane. The pilot, during flight, would position the aircraft below the USS *Macon's* hanger. A trapeze was lowered and the pilot would position the hook onto the trapeze. Sparrowhawk pilots were nicknamed the "men on the flying trapeze". *(Photo: NOAA/MBARI 2006).*

16. Do known maritime archaeological resources pose an environmental hazard and is this threat changing?

The Monterey Bay National Marine Sanctuary's inventory of known maritime archaeological resources suggests offshore shipwrecks have the potential to pose an environmental hazard to sanctuary resources due to deterioration that would result in the release of hazardous cargo and/or bunker fuel (e.g., U.S. Navy aircraft carrier USS *Independence* scuttled 1951, passenger steamship *San Juan* lost 1929, lumber freighter *Howard Olson* lost 1956). Therefore, this question is rated "fair" with a "declining" trend. Additional threats to sanctuary resources are from shipwrecks located just outside the sanctuary boundary (e.g., tanker *Montebello* (Figure 47) sunk by Japanese submarine 1941, cargo freighter *Jacob Luckenbach* lost 1953, tanker *Puerto Rican* lost 1984, freighter *Fernstream* lost 1952, and other vessels scuttled by the military to dispose of weapons). Prevailing currents have a high likelihood of carrying hazardous materials released from these sources into the Monterey Bay sanctuary. The remains of the *Montebello* have been located and the structural integrity of the hull provides the capacity to hold bunker fuel and hazardous cargoes (Schwemmer 2005).

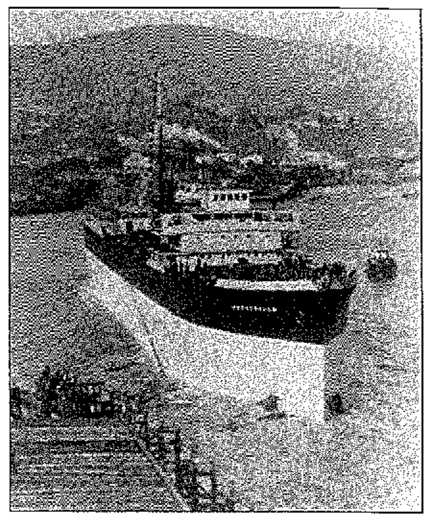


Figure 47. Launch of the Oil Tanker *Montebello* on Jan. 21, 1921, at Southwestern Shipbuilding Company in East San Pedro, Calif. The ship was sunk off Cambria during World War II and may still contain large quantities of oil. *(Photo: Unocal).*

In 2001, extensive tarball deposits along the sanctuary's coastline were estimated to have killed thousands of seabirds, including grebes, cormorants and Common Murres. The source of these tarballs remained unknown for several months, but was ultimately tracked to the S.S. *Jacob Luckenbach* which sank off San Francisco in 1953 (currently located in the Gulf of the Farallones National Marine Sanctuary). Subsequent investigative work matching the oil samples indicated this vessel was the likely source of a number of tarball and oiled bird incidents dating back to at least 1992. The U.S. Coast Guard, California Department of Fish and Game, National Oceanic and Atmospheric Administration, and others collaborated to identify the extent of impacts, to identify means of removing the remaining oil, and to ultimately remove the fuel. During the period of spills linked to the S.S. *Luckenbach*, over 51,000 birds and eight sea otters were estimated to have been killed from north of Bodega to Point Lobos (Luckenbach Trustee Council 2006).

With the exception of the partial bunker fuel removal from the S.S. *Luckenbach* and monitoring of the *Montebello* (both outside the sanctuary boundary), no efforts have been undertaken to locate and investigate other offshore sites. The structural integrity of steel and iron shipwrecks will deteriorate over time in a corrosive ocean environment and eventually collapse.

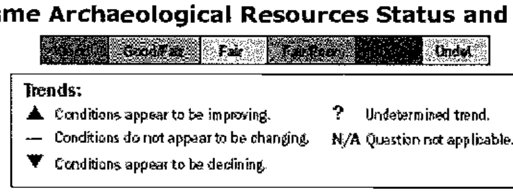
17. What are the levels of human activities that may influence maritime archaeological resource quality and how are they changing?

Historical and recent bottom trawling is one probable impact to offshore maritime archaeological resources that has reduced their quality to "good/fair." Archaeological resources are not able to recover once trawling destroys a site. Recently, the numbers of trawlers and areas available to trawling have decreased due to management regulations. With the recent trawl closures, the shift of fishing effort may increase the risk to resources that have not been impacted in the past. Because the majority of wreck locations are unknown, the impacts from historical and recent trawling are "undetermined."

The development of underwater technologies now affords the public the opportunity to locate and visit deep-water archaeological resources in the offshore environment. The sanctuary is working in collaboration with the technical diving community to locate new resources (e.g., *Art Riedel Sr.*). As with divers visiting accessible nearshore archaeological sites, the diving community must be educated on the regulations in place in order to protect these archaeological resources.

Archaeological resources in deeper and calmer offshore waters are generally in a more stable environment (limiting physical effects). Cold, deepwater environments tend to have fewer biological processes accelerating ship degradation compared to nearshore sites. However, because these sites are intact they may be attractive to looters, particularly those with technical diving capabilities who may access sites even though it's unlawful. Other emerging threats to offshore archaeological sites are the trenching of submerged communication cables that may impact submerged resources.

Maritime Archaeological Resources Status and Trends



# Issue	Rating	Basis For Judgement	Description of Findings
15. Integrity	?	To date, only one of potentially hundreds of archaeological site inventories has been conducted.	Not enough information to make a determination.
16. Threat to Environment	▼	Known resources containing hazardous material continue to deteriorate.	Selected maritime archaeological resources may cause measurable, but not severe, impacts to certain sanctuary resources or areas, but recovery is possible.
17. Human Activities	?	Archaeological resources, particularly those that are undocumented, are vulnerable to degradation from trawling.	Some potentially relevant activities exist, but they do not appear to have had a negative effect on maritime archaeological resource integrity.

Offshore Environment | Nearshore Environment | Estuarine Environment

ATTACHMENT F

Treatment Technology Review and Assessment

Association of Washington Business
Association of Washington Cities
Washington State Association of Counties

December 4, 2013

HDR

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Acronyms

Acronym	Definition
AACE	Association for the Advancement of Cost Engineering
AOP	advanced oxidation processes
AWB	Association of Washington Businesses
BAC	biological activated carbon
BAP	benzo(a)pyrene
BOD	biochemical oxygen demand
BTU	British thermal unit
CEPT	Chemically-enhanced primary treatment
cf	cubic feet
CIP	clean in place
CRITFC	Columbia River Inter-Tribal Fish Commission
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
FCR	fish consumption rate
g/day	grams per day
GAC	granular activated carbon
gal	gallon
gfd	gallons per square foot per day
GHG	greenhouse gas
gpd	gallons per day
gpm	gallons per minute
GWh	giga watt hours
HDR	HDR Engineering, Inc.
HHWQC	human health water quality criteria
HRT	hydraulic residence time
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
KWh/MG	kilowatt-hours per million gallons
lb	pound
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	microfiltration
mgd	million gallons per day
mg/L	milligrams per liter
MMBTU	million British thermal units
MWh/d	megawatt-hours per day
NF	nanofiltration
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
ODEQ	Oregon Department of Environmental Quality
PAC	powdered activated carbon
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PE	population equivalents
PIX	potable ion exchange

Acronym	Definition
ppm	parts per million
RO	reverse osmosis
SDWA	Safe Drinking Water Act
sf	square feet
SGSP	salinity gradient solar pond
SRT	solids retention time
Study Partners	Association of Washington Businesses/Association of Washington Cities and Washington State Association of Counties consortium
TDS	total dissolved solids
TMDL	total maximum daily load
TSS	total suspended solids
UF	ultrafiltration
µg/L	micrograms per liter
USDA	U.S. Department of Agriculture
UV	ultraviolet
WAC	Washington Administrative Code
WAS	waste activated sludge
WLA	waste load allocation
WWTP	wastewater treatment plant
ZLD	zero liquid discharge

Executive Summary

This study evaluated treatment technologies potentially capable of meeting the State of Washington Department of Ecology's (Ecology) revised effluent discharge limits associated with revised human health water quality criteria (HHWQC). HDR Engineering, Inc. (HDR) completed a literature review of potential technologies and an engineering review of their capabilities to evaluate and screen treatment methods for meeting revised effluent limits for four constituents of concern: arsenic, benzo(a)pyrene (BAP), mercury, and polychlorinated biphenyls (PCBs). HDR selected two alternatives to compare against an assumed existing baseline secondary treatment system utilized by dischargers. These two alternatives included enhanced secondary treatment with membrane filtration/reverse osmosis (MF/RO) and enhanced secondary treatment with membrane filtration/granulated activated carbon (MF/GAC). HDR developed capital costs, operating costs, and a net present value (NPV) for each alternative, including the incremental cost to implement improvements for an existing secondary treatment facility.

Currently, there are no known facilities that treat to the HHWQC and anticipated effluent limits that are under consideration. Based on the literary review, research, and bench studies, the following conclusions can be made from this study:

- Revised HHWQC based on state of Oregon HHWQC (2001) and U.S. Environmental Protection Agency (EPA) "National Recommended Water Quality Criteria" will result in very low water quality criteria for toxic constituents.
- There are limited "proven" technologies available for dischargers to meet required effluent quality limits that would be derived from revised HHWQC.
    - Current secondary wastewater treatment facilities provide high degrees of removal for toxic constituents; however, they are not capable of compliance with water quality-based National Pollutant Discharge Elimination System (NPDES) permit effluent limits derived from the revised HHWQC.
    - Advanced treatment technologies have been investigated and candidate process trains have been conceptualized for toxics removal.
        - Advanced wastewater treatment technologies may enhance toxics removal rates; however, they will not be capable of compliance with HHWQC-based effluent limits for PCBs. The lowest levels achieved based on the literature review were between <0.00001 and 0.00004 micrograms per liter (µg/L), as compared to a HHWQC of 0.0000064 µg/L.
        - Based on very limited performance data for arsenic and mercury from advanced treatment information available in the technical literature, compliance with revised criteria may or may not be possible, depending upon site specific circumstances.
            - Compliance with a HHWQC for arsenic of 0.018 µg/L appears unlikely. Most treatment technology performance information available in the literature is based on drinking water treatment applications targeting a much higher Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) of 10 µg/L.
            - Compliance with a HHWQC for mercury of 0.005 µg/L appears to be potentially attainable on an average basis, but perhaps not if effluent limits are structured on a maximum monthly, maximum weekly or maximum daily basis. Some secondary treatment facilities attain average effluent mercury levels of 0.009 to 0.066 µg/L. Some treatment facilities with effluent filters attain average effluent mercury levels of 0.002 to 0.010 µg/L. Additional

advanced treatment processes are expected to enhance these removal rates, but little mercury performance data is available for a definitive assessment.

- Little information is available to assess the potential for advanced technologies to comply with revised BAP criteria. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

  - Some technologies may be effective at treating identified constituents of concern to meet revised limits while others may not. It is therefore even more challenging to identify a technology that can meet all constituent limits simultaneously.
  - A HHWQC that is one order-of-magnitude less stringent could likely be met for mercury and BAP; however, it appears PCB and arsenic limits would not be met.

- Advanced treatment processes incur significant capital and operating costs.
  - Advanced treatment process to remove additional arsenic, BAP, mercury, and PCBs would combine enhancements to secondary treatment with microfiltration membranes and reverse osmosis or granular activated carbon and increase the estimated capital cost of treatment from $17 to $29 in dollars per gallon per day of capacity (based on a 5.0-million-gallon-per-day (mgd) facility).
  - The annual operation and maintenance costs for the advanced treatment process train will be substantially higher (approximately $5 million - $15 million increase for a 5.0 mgd capacity facility) than the current secondary treatment level.
- Implementation of additional treatment will result in additional collateral impacts.
  - High energy consumption.
  - Increased greenhouse gas emissions.
  - Increase in solids production from chemical addition to the primaries. Additionally, the membrane and GAC facilities will capture more solids that require handling.
  - Increased physical space requirements at treatment plant sites for advanced treatment facilities and residuals management including reverse osmosis reject brine processing.
- It appears advanced treatment technology alone cannot meet all revised water quality limits and implementation tools are necessary for discharger compliance.
  - Implementation flexibility will be necessary to reconcile the difference between the capabilities of treatment processes and the potential for HHWQC driven water quality based effluent limits to be lower than attainable with technology

Table ES-1 indicates that the unit NPV cost for baseline conventional secondary treatment ranges from $13 to $28 per gallon per day of treatment capacity. The unit cost for the advanced treatment alternatives increases the range from the low $20s to upper $70s on a per gallon per-day of treatment capacity. The resulting unit cost for improving from secondary treatment to advanced treatment ranges between $15 and $50 per gallon per day of treatment capacity. Unit costs were also evaluated for both a 0.5 and 25 mgd facility. The range of unit costs for improving a 0.5 mgd from secondary to advanced treatment is $60 to $162 per gallon per day of treatment capacity. The range of unit costs for improving a 25 mgd from secondary to advanced treatment is $10 to $35 per gallon per day of treatment capacity.

Table ES-1. Treatment Technology Costs in 2013 Dollars for a 5-mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)***	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
Baseline (Conventional Secondary Treatment)*	59 - 127	5 - 11	65 - 138	13 - 28
Incremental Increase to Advanced Treatment - MF/RO	48 - 104	26 - 56	75 - 160	15 - 32
Advanced Treatment - MF/RO**	108 - 231	31 - 67	139 - 298	28 - 60
Incremental Increase to Advanced Treatment - MF/GAC	71 - 153	45 - 97	117 - 250	23 - 50
Advanced Treatment - MF/GAC	131 - 280	50 - 108	181 - 388	36 - 78

* Assumed existing treatment for dischargers. The additional cost to increase the SRT to upwards of 30-days is about $12 - 20 million additional dollars in total project cost for a 5 mgd design flow.

** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.

*** Does not include the cost for labor.

mgd=million gallons per day
MG=million gallons
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
O&M=operations and maintenance
Net Present Value = total financed cost assuming a 5% nominal discount rate over an assumed 25 year equipment life.

Costs presented above are based on a treatment capacity of 5.0 mgd, however, existing treatment facilities range dramatically across Washington in size and flow treated. The key differences in cost between the baseline and the advanced treatment MF/RO are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (>8 days versus <8 days).
- Additional pumping stations to pass water through the membrane facilities and granulated activated carbon facilities. These are based on peak flows.
- Membrane facilities (equipment, tanks chemical feed facilities, pumping, etc.) and replacement membrane equipment.
- Granulated activated carbon facilities (equipment, contact tanks, pumping, granulated activated carbon media, etc.)
- Additional energy and chemical demand to operate the membrane and granulated activated carbon facilities
- Additional energy to feed and backwash the granulated activated carbon facilities.
- Zero liquid discharge facilities to further concentrate the brine reject.
  - Zero liquid discharge facilities are energy/chemically intensive and they require membrane replacement every few years due to the brine reject water quality.
- Membrane and granulated activated carbon media replacement represent a significant maintenance cost.

- Additional hauling and fees to regenerate granulated activated carbon off-site.

The mass of pollutant removal by implementing advanced treatment was calculated based on reducing current secondary effluent discharges to revised effluent limits for the four pollutants of concern. These results are provided in Table ES-2 as well as a median estimated unit cost basis for the mass of pollutants removed.

Table ES-2. Unit Cost by Contaminant for a 5-mgd Facility Implementing Advanced Treatment using Membrane Filtration/Reverse Osmosis

Component	PCBs	Mercury	Arsenic	BAPs
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)	0.002	0.025	7.5	0.006
Total Mass Removed (lbs) over 25 year Period	0.76	7.6	2,800	1.8
Median Estimated Unit Cost (NPV per total mass removed in pounds over 25 years)	$290,000,000	$29,000,000	$77,000	$120,000,000

µg/L=micrograms per liter

lbs=pounds

NPV=net present value

Collateral adverse environmental impacts associated with implementing advanced treatment were evaluated. The key impacts from this evaluation include increased energy use, greenhouse gas production, land requirements and treatment residuals disposal. Operation of advanced treatment technologies could increase electrical energy by a factor of 2.3 to 4.1 over the baseline secondary treatment system. Direct and indirect greenhouse gas emission increases are related to the operation of advanced treatment technologies and electrical power sourcing, with increases of at least 50 to 100 percent above the baseline technology. The energy and air emission implications of advanced treatment employing granulated activated carbon construction of advanced treatment facilities will require additional land area. The availability and cost of land adjacent to existing treatment facilities has not been included in cost estimates, but could be very substantial. It is worthwhile noting residual materials from treatment may potentially be hazardous and their disposal may be challenging to permit. Costs assume zero liquid discharge from the facilities.

1.0 Introduction

Washington's Department of Ecology (Ecology) has an obligation to periodically review waterbody "designated uses" and to modify, as appropriate, water quality standards to ensure those uses are protected. Ecology initiated this regulatory process in 2009 for the human health-based water quality criteria (HHWQC) in Washington's *Surface Water Quality Standards* (Washington Administrative Code [WAC] 173-201A). HHWQC are also commonly referred to as "toxic pollutant water quality standards." Numerous factors will influence Ecology's development of HHWQC. The expectation is that the adopted HHWQC will be more stringent than current adopted criteria. National Pollutant Discharge Elimination System (NPDES) effluent limits for permitted dischargers to surface waters are based on U.S. Environmental Protection Agency (EPA) and state guidance. Effluent limits are determined primarily from reasonable potential analyses and waste load allocations (WLAs) from total maximum daily loads (TMDLs), although the permit writer may use other water quality data. Water quality-based effluent limits are set to be protective of factors, including human health, aquatic uses, and recreational uses. Therefore, HHWQC can serve as a basis for effluent limits. The presumption is that more stringent HHWQC will, in time, drive lower effluent limits. The lower effluent limits will require advanced treatment technologies and will have a consequent financial impact on NPDES permittees. Ecology anticipates that a proposed revision to the water quality standards regulation will be issued in first quarter 2014, with adoption in late 2014.

The Association of Washington Businesses (AWB) is recognized as the state's chamber of commerce, manufacturing and technology association. AWB members, along with the Association of Washington Cities and Washington State Association of Counties (collectively referred to as Study Partners), hold NPDES permits authorizing wastewater discharges. The prospect of more stringent HHWQC, and the resulting needs for advanced treatment technologies to achieve lower effluent discharge limits, has led this consortium to sponsor a study to assess technology availability and capability, capital and operations and maintenance (O&M) costs, pollutant removal effectiveness, and collateral environmental impacts of candidate technologies.

The "base case" for the study began with the identification of four nearly ubiquitous toxic pollutants present in many industrial and municipal wastewater discharges, and the specification of pollutant concentrations in well-treated secondary effluent. The pollutants are arsenic, benzo(a)pyrene (BAP), mercury and polychlorinated biphenyls (PCBs), which were selected for review based on available monitoring data and abundant presence in the environment. The purpose of this study is to review the potential water quality standards and associated treatment technologies able to meet those standards for four pollutants.

A general wastewater treatment process and wastewater characteristics were used as the common baseline for comparison with all of the potential future treatment technologies considered. An existing secondary treatment process with disinfection at a flow of 5 million gallons per day (mgd) was used to represent existing conditions. Typical effluent biochemical oxygen demand (BOD) and total suspended solids (TSS) were assumed between 10 and 30 milligrams per liter (mg/L) for such a facility and no designed nutrient or toxics removal was assumed for the baseline existing treatment process.

Following a literature review of technologies, two advanced treatment process options for toxics removal were selected for further evaluation based on the characterization of removal effectiveness from the technical literature review and Study Partners' preferences. The two tertiary treatment options are microfiltration membrane filtration (MF) followed by either reverse osmosis (RO) or granular activated carbon (GAC) as an addition to an existing secondary treatment facility.

The advanced treatment technologies are evaluated for their efficacy and cost to achieve the effluent limitations implied by the more stringent HHWQC. Various sensitivities are examined, including for less stringent adopted HHWQC, and for a size range of treatment systems. Collateral environmental impacts associated with the operation of advanced technologies are also qualitatively described.

2.0 Derivation of the Baseline Study Conditions and Rationale for Selection of Effluent Limitations

2.1 Summary of Water Quality Criteria

Surface water quality standards for toxics in the State of Washington are being updated based on revised human fish consumption rates (FCRs). The revised water quality standards could drive very low effluent limitations for industrial and municipal wastewater dischargers. Four pollutants were selected for study based on available monitoring data and abundant presence in the environment. The four toxic constituents are arsenic, BAP, mercury, and PCBs.

2.2 Background

Ecology is in the process of updating the HHWQC in the state water quality standards regulation. Toxics include metals, pesticides, and organic compounds. The human health criteria for toxics are intended to protect people who consume water, fish, and shellfish. FCRs are an important factor in the derivation of water quality criteria for toxics.

The AWB/City/County consortium (hereafter "Study Partners") has selected four pollutants for which more stringent HHWQC are expected to be promulgated. The Study Partners recognize that Ecology probably will not adopt more stringent arsenic HHWQC so the evaluation here is based on the current arsenic HHWQC imposed by the National Toxics Rule. Available monitoring information indicates these pollutants are ubiquitous in the environment and are expected to be present in many NPDES discharges. The four pollutants include the following:

- Arsenic
  - Elemental metalloid that occurs naturally and enters the environment through erosion processes. Also widely used in batteries, pesticides, wood preservatives, and semiconductors. Other current uses and legacy sources in fungicides/herbicides, copper smelting, paints/dyes, and personal care products.

- Benzo(a)pyrene (BAP)
  - Benzo(a)pyrene is a polycyclic aromatic hydrocarbon formed by a benzene ring fused to pyrene as the result of incomplete combustion. Its metabolites are highly carcinogenic. Sources include wood burning, coal tar, automobile exhaust, cigarette smoke, and char-broiled food.

- Mercury
  - Naturally occurring element with wide legacy uses in thermometers, electrical switches, fluorescent lamps, and dental amalgam. Also enters the environment through erosion processes, combustion (especially coal), and legacy industrial/commercial uses. Methylmercury is an organometallic that is a bioaccumulative toxic. In aquatic systems, an anaerobic methylation process converts inorganic mercury to methylmercury.

- Polychlorinated Biphenyls (PCBs)
  - Persistent organic compounds historically used as a dielectric and coolant in electrical equipment and banned from production in the U.S. in 1979. Available information indicates continued pollutant loadings to the environment as a byproduct from the use of some pigments, paints, caulking, motor oil, and coal combustion.

2.3 Assumptions Supporting Selected Ambient Water Quality Criteria and Effluent Limitations

Clean Water Act regulations require NPDES permittees to demonstrate their discharge will "not cause or contribute to a violation of water quality criteria." If a "reasonable potential analysis" reveals the possibility of a standards violation, the permitting authority is obliged to develop "water quality-based effluent limits" to ensure standards achievement. In addition, if ambient water quality monitoring or fish tissue assessments reveal toxic pollutant concentrations above HHWQC levels, Ecology is required to identify that impairment ("303(d) listing") and develop corrective action plans to force reduction in the toxic pollutant discharge or loading of the pollutant into the impaired water body segment. These plans, referred to as total maximum daily loads (TMDLs) or water cleanup plans, establish discharge allocations and are implemented for point discharge sources through NPDES permit effluent limits and other conditions.

The effect of more stringent HHWQC will intuitively result in more NPDES permittees "causing or contributing" to a water quality standards exceedance, and/or more waterbodies being determined to be impaired, thus requiring 303(d) listing, the development of TMDL/water cleanup plans, and more stringent effluent limitations to NPDES permittees whose treated wastewater contains the listed toxic pollutant.

The study design necessarily required certain assumptions to create a "baseline effluent scenario" against which the evaluation of advanced treatment technologies could occur. The Study Partners and HDR Engineering, Inc (HDR) developed the scenario. Details of the baseline effluent scenario are presented in Table 1. The essential assumptions and rationale for selection are presented below:

- Ecology has indicated proposed HHWQC revisions will be provided in first quarter 2014. A Study Partners objective was to gain an early view on the treatment technology and cost implications. Ecology typically allows 30 or 45 days for the submission of public comments on proposed regulations. To wait for the proposed HHWQC revisions would not allow sufficient time to complete a timely technology/cost evaluation and then to share the study results in the timeframe allowed for public involvement/public comments.
- Coincident with the issuance of the proposed regulation, Ecology has a statutory obligation to provide a Significant Legislative Rule evaluation, one element of which is a "determination whether the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented" (RCW 34.05.328(1)(d)). A statutory requirement also exists to assess the impact of the proposed regulation to small businesses. The implication is that Ecology will be conducting these economic evaluations in fourth quarter 2013 and early 2014. The Study Partners wanted to have a completed technology/cost study available to share with Ecology for their significant legislative rule/small business evaluations.
- The EPA, Indian tribes located in Washington, and various special interest groups have promoted the recently promulgated state of Oregon HHWQC (2011) as the "model" for Washington's revisions of HHWQC. The Oregon HHWQC are generally based on a increased FCR of 175 grams per day (g/day) and an excess cancer risk of 10^{-6}. While the Study Partners do not concede the wisdom or appropriateness of the Oregon criteria, or the selection of scientific/technical elements used to derive those criteria, the Study Partners nevertheless have selected the Oregon HHWQC as a viable "starting point" upon which this study could be based.

- The scenario assumes generally that Oregon's HHWQC for ambient waters will, for some parameters in fact, become effluent limitations for Washington NPDES permittees. The reasoning for this important assumption includes:
    - The state of Washington's NPDES permitting program is bound by the *Friends of Pinto Creek vs. EPA* decision in the United States Court of Appeals for the Ninth Circuit (October 4, 2007). This decision held that no NPDES permits authorizing new or expanded discharges of a pollutant into a waterbody identified as impaired; i.e., listed on CWA section 303(d), for that pollutant, may be issued until such time as "existing dischargers" into the waterbody are "subject to compliance schedules designed to bring the (waterbody) into compliance with applicable water quality standards." In essence, any new/expanded discharge of a pollutant causing impairment must achieve the HHWQC at the point of discharge into the waterbody.
    - If a waterbody segment is identified as "impaired" (i.e., not achieving a HHWQC), then Ecology will eventually need to produce a TMDL or water cleanup plan. For an existing NPDES permittee with a discharge of the pollutant for which the receiving water is impaired, the logical assumption is that any waste load allocation granted to the discharger will be at or lower than the numeric HHWQC (to facilitate recovery of the waterbody to HHWQC attainment). As a practical matter, this equates to an effluent limit established at the HHWQC.
    - Acceptance of Oregon HHWQC as the baseline for technology/cost review also means acceptance of practical implementation tools used by Oregon. The HHWQC for mercury is presented as a fish tissue methyl mercury concentration. For the purposes of NPDES permitting, however, Oregon has developed an implementation management directive which states that any confirmed detection of mercury is considered to represent a "reasonable potential" to cause or contribute to a water quality standards violation of the methyl mercury criteria. The minimum quantification level for total mercury is presented as 0.005 micrograms per liter (µg/L) (5.0 nanograms per liter (ng/L)).
    - The assumed effluent limit for arsenic is taken from EPA's *National Recommended Water Quality Criteria* (2012) (inorganic, water and organisms, 10^{-6} excess cancer risk). Oregon's 2011 criterion is actually based on a less protective excess cancer risk (10^{-4}). This, however, is the result of a state-specific risk management choice and it is unclear if Washington's Department of Ecology would mimic the Oregon approach.
    - The assumption is that no mixing zone is granted such that HHWQC will effectively serve as NPDES permit effluent limits. Prior discussion on the impact of the Pinto Creek decision, 303(d) impairment and TMDL Waste Load Allocations processes, all lend support to this "no mixing zone" condition for the parameters evaluated in this study.
- Consistent with Ecology practice in the evaluation of proposed regulations, the HHWQC are assumed to be in effect for a 20-year period. It is assumed that analytical measurement technology and capability will continue to improve over this time frame and this will result in the detection and lower quantification of additional HHWQC in ambient water and NPDES dischargers. This knowledge will trigger the Pinto Creek/303(d)/TMDL issues identified above and tend to pressure NPDES permittees to evaluate and install advanced treatment technologies. The costs and efficacy of treatment for these additional HHWQC is unknown at this time.

Other elements of the Study Partners work scope, as presented to HDR, must be noted:

- The selection of four toxic pollutants and development of a baseline effluent scenario is not meant to imply that each NPDES permittee wastewater discharge will include those pollutants at the assumed concentrations. Rather, the scenario was intended to represent a composite of many NPDES permittees and to facilitate evaluation of advanced treatment technologies relying on mechanical, biological, physical, chemical processes.
- The scalability of advanced treatment technologies to wastewater treatment systems with different flow capacities, and the resulting unit costs for capital and O&M, is evaluated.
- Similarly, a sensitivity analysis on the unit costs for capital and O&M was evaluated on the assumption the adopted HHWQC (and effectively, NPDES effluent limits) are one order-of-magnitude less stringent than the Table 1 values.

Table 1: Summary of Effluent Discharge Toxics Limits

Constituent	Human Health Criteria based Limits to be met with no Mixing Zone (µg/L)	Basis for Criteria	Typical Concentration in Municipal Secondary Effluent (µg/L)	Typical Concentration in Industrial Secondary Effluent (µg/L)	Existing Washington HHC (water + org.), NTR (µg/L)
PCBs	0.0000064	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.0005 to 0.0025[b,c,d,e,f]	0.002 to 0.005[i]	0.0017
Mercury	0.005	DEQ IMD[a]	0.003 to 0.050[h]	0.010 to 0.050[h]	0.140
Arsenic	0.018	EPA National Toxics Rule (water + organisms)[k]	0.500 to 5.0[j]	10 to 40[j]	0.018
Benzo(a)Pyrene	0.0013	Oregon Table 40 Criterion (water + organisms) at FCR of 175 grams/day	0.00028 to 0.006[b,g]	0.006 to1.9	0.0028

[a] Oregon Department of Environmental Quality (ODEQ). Internal Management Directive: Implementation of Methylmercury Criterion in NPDES Permits. January 8, 2013.
[b] Control of Toxic Chemicals in Puget Sound, Summary Technical Report for Phase 3: Loadings from POTW Discharge of Treated Wastewater, Washington Department of Ecology, Publication Number 10-10-057, December 2010.
[c] Spokane River PCB Source Assessment 2003-2007, Washington Department of Ecology, Publication No. 11-03-013, April 2011.
[d] Lower Okanogan River Basin DDT and PCBs Total Maximum Daily Load, Submittal Report, Washington Department of Ecology, Publication Number 04-10-043, October 2004.
[e] Palouse River Watershed PCB and Dieldrin Monitoring, 2007-2008, Wastewater Treatment Plants and Abandoned Landfills, Washington Department of Ecology, Publication No. 09-03-004, January 2009
[f] A Total Maximum Daily Load Evaluation for Chlorinated Pesticides and PCBs in the Walla Walla River, Washington Department of Ecology, Publication No. 04-03-032, October 2004.
[g] Removal of Polycyclic Aromatic Hydrocarbons and Heterocyclic Nitrogenous Compounds by A POTW Receiving Industrial Discharges, Melcer, H., Steel, P. and Bedford, W.K., Water Environment Federation, 66th Annual Conference and Exposition, October 1993.
[h] Data provided by Lincoln Loehr's summary of WDOE Puget Sound Loading data in emails from July 19, 2013.
[i] NCASI memo from Larry Lefleur, NCASI, to Llewellyn Matthews, NWPPA, revised June 17, 2011, summarizing available PCB monitoring data results from various sources.
[j] Professional judgment, discussed in August 6, 2013 team call.
[k] The applicable Washington Human Health Criteria cross-reference the EPA National Toxics Rule, 40 CFR 131.36. The EPA arsenic HHC is 0.018 ug/L for water and organisms.

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3.0 Wastewater Characterization Description

This section describes the wastewater treatment discharge considered in this technology evaluation. Treated wastewater characteristics are described, including average and peak flow, effluent concentrations, and toxic compounds of concern.

3.1 Summary of Wastewater Characterization

A general wastewater treatment process and wastewater characteristics were developed as the common baseline to represent the existing conditions as a starting point for comparison with potential future advanced treatment technologies and improvements. A secondary treatment process with disinfection at a flow of 5 mgd as the current, baseline treatment system for existing dischargers was also developed. Typical effluent biochemical oxygen demand (BOD) and total suspended solids (TSS) were assumed between 10 to 30 mg/L from such a facility and no nutrient or toxics removal was assumed to be accomplished in the existing baseline treatment process.

3.2 Existing Wastewater Treatment Facility

The first step in the process is to characterize the existing wastewater treatment plant to be evaluated in this study. The goal is to identify the necessary technology that would need to be added to an existing treatment facility to comply with revised toxic pollutant effluent limits. Rather than evaluating the technologies and costs to upgrade multiple actual operating facilities, the Study Partners specified that a generalized municipal/industrial wastewater treatment facility would be characterized and used as the basis for developing toxic removal approaches. General characteristics of the facility's discharge are described in Table 2.

Table 2. General Wastewater Treatment Facility Characteristics

Average Annual Wastewater Flow, mgd	Maximum Month Wastewater Flow, mgd	Peak Hourly Wastewater Flow, mgd	Effluent BOD, mg/L	Effluent TSS, mg/L
5.0	6.25	15.0	10 to 30	10 to 30

mgd=million gallons per day
mg/L=milligrams per liter
BOD=biochemical oxygen demand
TSS=total suspended solids

In the development of the advanced treatment technologies presented below, the capacity of major treatment elements are generally sized to accommodate the maximum month average wastewater flow. Hydraulic elements, such as pumps and pipelines, were selected to accommodate the peak hourly wastewater flow.

The general treatment facility incorporates a baseline treatment processes including influent screening, grit removal, primary sedimentation, suspended growth biological treatment (activated sludge), secondary clarification, and disinfection using chlorine. Solids removed during primary treatment and secondary clarification are assumed to be thickened, stabilized, dewatered, and land applied to agricultural land. The biological treatment process is assumed to be activated sludge with a relatively short (less than 10-day) solids retention time. The baseline secondary treatment facility is assumed not to have processes dedicated to removing nutrients or toxics. However, some coincident removal of toxics will occur during conventional treatment.

3.3 Toxic Constituents

As described in Section 2.3, the expectation of more stringent HHWQC will eventually trigger regulatory demands for NPDES permittees to install advanced treatment technologies. The Study Group and HDR selected four specific toxic pollutants reflecting a range of toxic constituents as the basis for this study to limit the constituents and technologies to be evaluated to a manageable level.

The four toxic pollutants selected were PCBs, mercury, arsenic, and BAP, a polycyclic aromatic hydrocarbon (PAH). Mercury and arsenic are metals, and PCBs and PAHs are organic compounds. Technologies for removing metals and organic compounds are in some cases different. Key information on each of the compounds, including a description of the constituent, the significance of each constituent, proposed HHWQC, basis for the proposed criteria, typical concentration in both municipal and industrial secondary effluent, and current Washington state water quality criteria, are shown in Table 1. It is assumed that compliance with the proposed criteria in the table would need to be achieved at the "end of pipe" and Ecology would not permit a mixing zone for toxic constituents. This represents a "worst-case," but a plausible assumption about discharge conditions.

4.0 Treatment Approaches and Costs

4.1 Summary of Treatment Approach and Costs

Two advanced treatment process options for toxics removal for further evaluation based on the characterization of removal effectiveness from the technical literature review and Study Group preferences. The two tertiary treatment options are microfiltration MF followed by either RO or GAC as an addition to an existing secondary treatment facility. Based on the literature review, it is not anticipated that any of the treatment options will be effective in reducing all of the selected pollutants to below the anticipated water quality criteria. A summary of the capital and operations and maintenance costs for tertiary treatment is provided, as well as a comparison of the adverse environmental impacts for each alternative.

4.2 Constituent Removal – Literature Review

The evaluation of treatment technologies relevant to the constituents of concern was initiated with a literature review. The literature review included a desktop search using typical web-based search engines, and search engines dedicated to technical and research journal databases. At the same time, HDR's experience with the performance of existing treatment technologies specifically related to the four constituents of concern, was used in evaluating candidate technologies. A summary of the constituents of concern and relevant treatment technologies is provided in the following literature review section.

4.2.1 Polychlorinated Biphenyls

PCBs are persistent organic pollutants that can be difficult to remove in treatment. PCB treatment in wastewater can be achieved using oxidation with peroxide, filtration, biological treatment or a combination of these technologies. There is limited information available about achieving ultra-low effluent PCB concentrations near the 0.0000064 µg/L range under consideration in the proposed rulemaking process. This review provides a summary of treatment technology options and anticipated effluent PCB concentrations.

Research on the effectiveness of ultraviolet (UV) light and peroxide on removing PCBs was tested in bench scale batch reactions (Yu, Macawile, Abella, & Gallardo 2011). The combination of UV and peroxide treatment achieved PCB removal greater than 89 percent, and in several cases exceeding 98 percent removal. The influent PCB concentration for the batch tests ranged from 50 to 100 micrograms per liter (µg/L). The final PCB concentration (for the one congener tested) was <10 µg/L (10,000 ng/L) for all tests and <5 µg/L (5,000 ng/L) for some tests. The lowest PCB concentrations in the effluent occurred at higher UV and peroxide doses.

Pilot testing was performed to determine the effectiveness of conventional activated sludge and a membrane bioreactor to remove PCBs (Bolzonella, Fatone, Pavan, & Cecchi 2010). EPA Method 1668 was used for the PCB analysis (detection limit of 0.01 ng/L per congener). Influent to the pilot system was a combination of municipal and industrial effluent. The detailed analysis was for several individual congeners. Limited testing using the Aroclor method (total PCBs) was used to compare the individual congeners and the total concentration of PCBs. Both conventional activated sludge and membrane bioreactor (MBR) systems removed PCBs. The effluent MBR concentrations ranged from <0.01 ng/L to 0.04 ng/L compared to <0.01 ng/L to 0.88 ng/L for conventional activated sludge. The pilot testing showed that increased solids retention time (SRT) and higher mixed liquor suspended solids concentrations in the MBR system led to increased removal in the liquid stream.

Bench scale studies were completed to test the effectiveness of GAC and biological activated carbon (BAC) for removing PCBs (Ghosh, Weber, Jensen, & Smith 1999). The effluent from the

GAC system was 800 ng/L. The biological film in the BAC system was presumed to support higher PCB removal with effluent concentrations of 200 ng/L. High suspended sediment in the GAC influent can affect performance. It is recommended that filtration be installed upstream of a GAC system to reduce solids and improve effectiveness.

Based on limited available data, it appears that existing municipal secondary treatment facilities in Washington state are able to reduce effluent PCBs to the range approximately 0.10 to 1.5 ng/L. It appears that the best performing existing municipal treatment facility in Washington state with a microfiltration membrane is able to reduce effluent PCBs to the range approximately 0.00019 to 0.00063 µg/L. This is based on a very limited data set and laboratory blanks covered a range that overlapped with the effluent results (blanks 0.000058 to 0.00061 µg/L).

Addition of advanced treatment processes would be expected to enhance PCB removal rates, but the technical literature does not appear to provide definitive information for guidance. A range of expected enhanced removal rates might be assumed to vary widely from level of the reference microfiltration facility of 0.19 to 0.63 ng/L.

Summary of PCB Technologies

The literature review revealed there are viable technologies available to reduce PCBs **but no research was identified with treatment technologies capable of meeting the anticipated human health criteria based limits for PCB removal**. Based on this review, a tertiary process was selected to biologically reduce PCBs and separate the solids using tertiary filtration. Alternately, GAC was investigated as an option to reduce PCBs, although it is not proven that it will meet revised effluent limits.

4.2.2 Mercury

Mercury removal from wastewater can be achieved using precipitation, adsorption, filtration, or a combination of these technologies. There is limited information available about achieving ultra-low effluent mercury concentrations near the 5 ng/L range under consideration in the proposed rulemaking process. This review provides a summary of treatment technology options and anticipated effluent mercury concentrations.

Precipitation (and co-precipitation) involves chemical addition to form a particulate and solids separation, using sedimentation or filtration. Precipitation includes the addition of a chemical precipitant and pH adjustment to optimize the precipitation reaction. Chemicals can include metal salts (ferric chloride, ferric sulfate, ferric hydroxide, or alum), pH adjustment, lime softening, or sulfide. A common precipitant for mercury removal is sulfide, with an optimal pH between 7 and 9. The dissolved mercury is precipitated with the sulfide to form an insoluble mercury sulfide that can be removed through clarification or filtration. One disadvantage of precipitation is the generation of a mercury-laden sludge that will require dewatering and disposal. The mercury sludge may be considered a hazardous waste and require additional treatment and disposal at a hazardous waste site. The presence of other compounds, such as other metals, may reduce the effectiveness of mercury precipitation/co-precipitation. For low-level mercury treatment requirements, several treatment steps will likely be required in pursuit of very low effluent targets.

EPA compiled a summary of facilities that are using precipitation/co-precipitation for mercury treatment (EPA 2007). Three of the full-scale facilities were pumping and treating groundwater and the remaining eight facilities were full-scale wastewater treatment plants. One of the pump and treat systems used precipitation, carbon adsorption, and pH adjustment to treat groundwater to effluent concentrations of 300 ng/L.

Adsorption treatment can be used to remove inorganic mercury from water. While adsorption can be used as a primary treatment step, it is frequently used for polishing after a preliminary treatment step (EPA 2007). One disadvantage of adsorption treatment is that when the adsorbent is saturated, it either needs to be regenerated or disposed of and replaced with new adsorbent. A common adsorbent is GAC. There are several patented and proprietary adsorbents on the market for mercury removal. Adsorption effectiveness can be affected by water quality characteristics, including high solids and bacterial growth, which can cause media blinding. A constant and low flow rate to the adsorption beds increases effectiveness (EPA 2007). The optimal pH for mercury adsorption on GAC is pH 4 to 5; therefore, pH adjustment may be required.

EPA compiled a summary of facilities that are using adsorption for mercury treatment (EPA 2007). Some of the facilities use precipitation and adsorption as described above. The six summarized facilities included two groundwater treatment and four wastewater treatment facilities. The reported effluent mercury concentrations were all less than 2,000 ng/L (EPA 2007).

Membrane filtration can be used in combination with a preceding treatment step. The upstream treatment is required to precipitate soluble mercury to a particulate form that can be removed through filtration. According to the EPA summary report, ultrafiltration is used to remove high-molecular weigh contaminants and solids (EPA 2007). The treatment effectiveness can depend on the source water quality since many constituents can cause membrane fouling, decreasing the effectiveness of the filters. One case study summarized in the EPA report showed that treatment of waste from a hazardous waste combustor treated with precipitation, sedimentation, and filtration achieved effluent mercury concentrations less than the detection limit of 200 ng/L.

Bench-scale research performed at the Oak Ridge Y-12 Plant in Tennessee evaluated the effectiveness of various adsorbents for removing mercury to below the NPDES limit of 12 ng/L and the potential revised limit of 51 ng/L (Hollerman et al. 1999). Several proprietary adsorbents were tested, including carbon, polyacrylate, polystyrene, and polymer adsorption materials. The adsorbents with thiol-based active sites were the most effective. Some of the adsorbents were able to achieve effluent concentrations less than 51 ng/L but none of the adsorbents achieved effluent concentrations less than 12 ng/L.

Bench-scale and pilot-scale testing performed on refinery wastewater was completed to determine treatment technology effectiveness for meeting very low mercury levels (Urgun-Demirtas, Benda, Gillenwater, Negri, Xiong & Snyder 2012) (Urgun-Demirtas, Negri, Gillenwater, Agwu Nnanna & Yu 2013). The Great Lakes Initiative water quality criterion for mercury is less than 1.3 ng/L for municipal and industrial wastewater plants in the Great Lakes region. This research included an initial bench scale test including membrane filtration, ultrafiltration, nanofiltration, and reverse osmosis to meet the mercury water quality criterion. The nanofiltration and reverse osmosis required increased pressures for filtration and resulted in increased mercury concentrations in the permeate. Based on this information and the cost difference between the filtration technologies, a pilot-scale test was performed. The 0.04 um PVDF GE ZeeWeed 500 series membranes were tested. The 1.3 ng/L water quality criterion was met under all pilot study operating conditions. The mercury in the refinery effluent was predominantly in particulate form which was well-suited for removal using membrane filtration.

Based on available data, it appears that existing municipal treatment facilities are capable of reducing effluent mercury to near the range of the proposed HHWQC on an average basis. Average effluent mercury in the range of 1.2 to 6.6 ng/L for existing facilities with secondary treatment and enhanced treatment with cloth filters and membranes. The Spokane County plant data range is an average of 1.2 ng/L to a maximum day of 3 ng/L. Addition of advanced treatment processes such as GAC or RO would be expected to enhance removal rates. Data from the West Basin treatment facility in California suggests that at a detection limit of 7.99 ng/L mercury is not detected in the effluent from this advanced process train. A range of expected enhanced removal rates from the advanced treatment process trains might be expected to ranged from meeting the proposed standard at 5 ng/L to lower concentrations represented by the Spokane County performance level (membrane filtration) in the range of 1 to 3 ng/L, to perhaps even lower levels with additional treatment. For municipal plants in Washington, this would suggest that effluent mercury values from the two advanced treatment process alternatives might range from 1 to 5 ng/L (0.001 to 0.005 µg/L) and perhaps substantially better, depending upon RO and GAC removals. It is important to note that industrial plants may have higher existing mercury levels and thus the effluent quality that is achievable at an industrial facility would be of lower quality.

Summary of Mercury Technologies

The literature search revealed limited research on mercury removal technologies at the revised effluent limit of 0.005 µg/L. Tertiary filtration with membrane filters or reverse osmosis showed the best ability to achieve effluent criteria less than 0.005 µg/L.

4.2.3 Arsenic

A variety of treatment technologies can be applied to capture arsenic (Table 3). Most of the information in the technical literature and from the treatment technology vendors is focused on potable water treatment for compliance with a Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) of 10 µg/L. The most commonly used arsenic removal method for a wastewater application (tertiary treatment) is coagulation/ flocculation plus filtration. This method by itself could remove more than 90 to 95 percent of arsenic. Additional post-treatment through adsorption, ion exchange, or reverse osmosis is required for ultra-low arsenic limits in the 0.018 µg/L range under consideration in the proposed rulemaking process. In each case it is recommended to perform pilot-testing of each selected technology.

Table 3: Summary of Arsenic Removal Technologies[1]

Technology	Advantages	Disadvantages
Coagulation/filtration	• Simple, proven technology • Widely accepted • Moderate operator training	• pH sensitive • Potential disposal issues of backwash waste • As^{+3} and As^{+5} must be fully oxidized
Lime softening	• High level arsenic treatment • Simple operation change for existing lime softening facilities	• pH sensitive (requires post treatment adjustment) • Requires filtration • Significant sludge operation
Adsorptive media	• High As^{+5} selectivity • Effectively treats water with high total dissolved solids (TDS)	• Highly pH sensitive • Hazardous chemical use in media regeneration • High concentration SeO_4^{-2}, F^-, Cl^-, and SO_4^{-2} may limit arsenic removal

Table 3: Summary of Arsenic Removal Technologies[1]

Technology	Advantages	Disadvantages
Ion exchange	• Low contact times • Removal of multiple anions, including arsenic, chromium, and uranium	• Requires removal of iron, manganese, sulfides, etc. to prevent fouling • Brine waste disposal
Membrane filtration	• High arsenic removal efficiency • Removal of multiple contaminants	• Reject water disposal • Poor production efficiency • Requires pretreatment

[1]Adapted from WesTech

The removal of arsenic in activated sludge is minimal (less than 20 percent) (Andrianisa et al. 2006), but biological treatment can control arsenic speciation. During aerobic biological process As (III) is oxidized to As (V). Coagulation/flocculation/filtration removal, as well as adsorption removal methods, are more effective in removal of As(V) vs. As (III). A combination of activated sludge and post-activated sludge precipitation with ferric chloride (addition to MLSS and effluent) results in a removal efficiency of greater than 95 percent. This combination could decrease As levels from 200 µg/L to less than 5 µg/L (5,000 ng/L) (Andrianisa et al. 2008) compared to the 0.018 µg/L range under consideration in the proposed rulemaking process.

Data from the West Basin facility (using MF/RO/AOP) suggests effluent performance in the range of 0.1 to 0.2 µg/L, but it could also be lower since a detection limit used there of 0.15 µg/l is an order of magnitude higher than the proposed HHWQC. A range of expected enhanced removal rates might be assumed to equivalent to that achieved at West Basin in 0.1 to 0.2 µg/L range.

Review of Specific Technologies for Arsenic Removal

Coagulation plus Settling or Filtration

Coagulation may remove more than 95 percent of arsenic through the creation of particulate metal hydroxides. Ferric sulfite is typically more efficient and applicable to most wastewater sources compared to alum. The applicability and extent of removal should be pilot-tested, since removal efficiency is highly dependent on the water constituents and water characteristics (i.e., pH, temperature, solids).

Filtration can be added after or instead of settling to increase arsenic removal. Example treatment trains with filtration are shown in Figures 1 and 2, respectively.

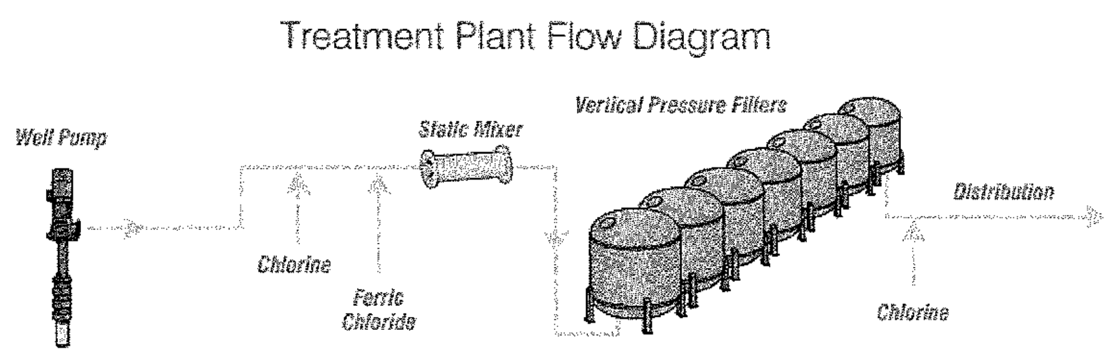

Figure 1. Water Treatment Configuration for Arsenic Removal (WesTech)

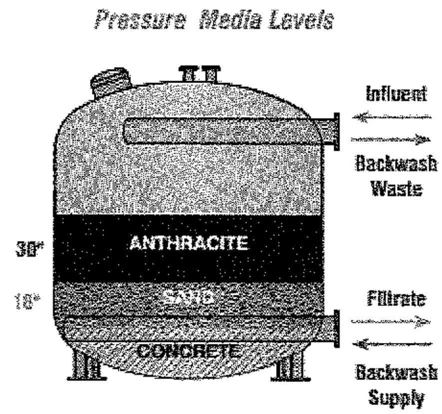

Figure 2. WesTech Pressure Filters for Arsenic Removal

One system for treatment of potable water with high levels of arsenic in Colorado (110 parts per million [ppm]) consists of enhanced coagulation followed by granular media pressure filters that include anthracite/silica sand/garnet media (WesTech). The arsenic levels were reduced to less than the drinking water MCL, which is 10 µg/L (10,000 ng/L). The plant achieves treatment by reducing the pH of the raw water to 6.8 using sulfuric acid, and then adding approximately 12 to 14 mg/L ferric sulfate. The water is filtered through 16 deep bed vertical pressure filters, the pH is elevated with hydrated lime and is subsequently chlorinated and fed into the distribution system. (http://www.westechinc.com/public/uploads/global/2011/3/Fallon%20NV%20Installation%20ReportPressureFilter.pdf).

Softening (with lime)

Removes up to 90 percent arsenic through co-precipitation, but requires pH to be higher than 10.2.

Adsorption processes

Activated alumina is considered an adsorptive media, although the chemical reaction is an exchange of arsenic ions with the surface hydroxides on the alumina. When all the surface hydroxides on the alumina have been exchanged, the media must be regenerated. Regeneration consists of backwashing, followed by sodium hydroxide, flushing with water and neutralization with a strong acid. Effective arsenic removal requires sufficient empty bed contact time. Removal efficiency can also be impacted by the water pH, with neutral or slightly acidic conditions being considered optimum. If As (III) is present, it is generally advisable to increase empty bed contact time, as As (III) is adsorbed more slowly than As (V). Alumina dissolves slowly over time due to contact with the chemicals used for regeneration. As a result, the media bed is likely to become compacted if it is not backwashed periodically.

Granular ferric hydroxide works by adsorption, but when the media is spent it cannot be regenerated and must be replaced. The life of the media depends upon pH of the raw water, the concentrations of arsenic and heavy metals, and the volume of water treated daily. Periodic backwashing is required to prevent the media bed from becoming compacted and pH may need to be adjusted if it is high, in order to extend media life. For maximum arsenic removal, filters operate in series. For less stringent removal, filters can operate in parallel.

One type of adsorption media has been developed for application to non-drinking water processes for arsenic, phosphate and for heavy metals removal by sorption (Severent Trent Bayoxide® E IN-20). This granular ferric oxide media has been used for arsenic removal from mining and industrial wastewaters, selenium removal from refinery wastes and for phosphate polishing of municipal wastewaters. Valley Vista drinking water treatment with Bayoxide® E IN-20 media achieves removal from 31-39 μg/L (31,000-39,000 ng/L) to below 10 μg/L MCL (http://www.severntrentservices.com/News/Successful_Drinking_Water_Treatment_in_an_Arsenic_Hot_Spot_nwMFT_452.aspx).

Another adsorptive filter media is greensand. Greensand is available in two forms: as glauconite with manganese dioxide bound ionically to the granules and as silica sand with manganese dioxide fused to the granules. Both forms operate in pressure filters and both are effective. Greensand with the silica sand core operates at higher water temperatures and higher differential pressures than does greensand with the glauconite core. Arsenic removal requires a minimum concentration of iron. If a sufficient concentration of iron is not present in the raw water, ferric chloride is added.

WesTech filters with greensand and permanganate addition for drinking water systems can reduce As from 15-25 μg/L to non-detect. Sodium hypochlorite and/or potassium permanganate are added to the raw water prior to the filters. Chemical addition may be done continuously or intermittently, depending on raw water characteristics. These chemicals oxidize the iron in the raw water and also maintain the active properties of the greensand itself. Arsenic removal is via co-precipitation with the iron.

Ion Exchange

Siemens offers a potable ion exchange (PIX) arsenic water filtration system. PIX uses ion exchange resin canisters for the removal of organic and inorganic contaminants, in surface and groundwater sources to meet drinking water standards.

Filtronics also uses ion exchange to treat arsenic. The technology allows removal for below the SWDA MCL for potable water of 10 μg/L (10,000 ng/L).

Reverse osmosis

Arsenic is effectively removed by RO when it is in oxidative state As(V) to approximately 1,000 ng/L or less (Ning 2002).

Summary of Arsenic Technologies

The current state of the technology for arsenic removal is at the point where all the processes target the SWDA MCL for arsenic in potable water. Current EPA maximum concentration level for drinking water is 10 ug/l; much higher than 0.0018 μg/L target for arsenic in this study. The majority of the methods discussed above are able to remove arsenic to either EPA maximum contaminant level or to the level of detection. The lowest detection limit of one of the EPA approved methods of arsenic measurements is 20 ng/l (0.020 μg/l) (Grosser, 2010), which is comparable to the 0.018 μg/L limit targeted in this study.

4.2.1 Polycyclic Aromatic Hydrocarbons

BAP During Biological Treatment

During wastewater treatment process, BAP tends to partition into sludge organic matter (Melcer et al. 1993). Primary and secondary processing could remove up to 60 percent of incoming PAHs and BAP in particular, mostly due to adsorption to sludge (Kindaichi et al., NA, Wayne et al. 2009). Biodegradation of BAP is expected to be very low since there are more than five benzene rings which are resistant to biological degradation. Biosurfactant addition to biological process could partially improve biodegradation, but only up to removal rates of 50 percent (Sponza et al. 2010). Existing data from municipal treatment facilities in Washington state have influent and effluent concentrations of BAP of approximately 0.30 ng/L indicating that current secondary treatment has limited effectiveness at BAP removal.

Methods to Enhance Biological Treatment of BAP

Ozonation prior to biological treatment could potentially improve biodegradability of BAP (Zeng et al. 2000). In the case of soil remediation, ozonation before biotreatment improved biodegradation by 70 percent (Russo et al. 2012). The overall removal of BAP increased from 23 to 91 percent after exposure of water to 0.5 mg/L ozone for 30 minutes during the simultaneous treatment process and further to 100 percent following exposure to 2.5 mg/L ozone for 60 minutes during the sequential treatment mode (Yerushalmi et al. 2006). In general, to improve biodegradability of BAP, long exposure to ozone might be required (Haapea et al. 2006).

Sonication pre-treatment or electronic beam irradiation before biological treatment might also make PAHs more bioavailable for biological degradation..

Recent studies reported that a MBR is capable of removing PAHs from wastewater (Rodrigue and Reilly 2009; Gonzaleza et al. 2012). None of the studies listed the specific PAHs constituents removed.

Removal of BAP from Drinking Water

Activated Carbon

Since BAP has an affinity to particulate matter, it is removed from the drinking water sources by means of adsorption, such as granular activated carbon (EPA). Similarly, Oleszczuk et al. (2012) showed that addition of 5 percent activated carbon could remove 90 percent of PAHs from the wastewater.

Reverse Osmosis

Light (1981) (referenced by Williams, 2003) studied dilute solutions of PAHs, aromatic amines, and nitrosamines and found rejections of these compounds in reverse osmosis to be over 99 percent for polyamide membranes. Bhattacharyya et al. (1987) (referenced by Williams, 2003) investigated rejection and flux characteristics of FT30 membranes for separating various pollutants (PAHs, chlorophenols, nitrophenols) and found membrane rejections were high (>98 percent) for the organics under ionized conditions.

Summary of BAP Technologies

Current technologies show that BAP removal may be 90 percent or greater. The lowest detection limit for BAP measurements is 0.006 µg/L, which is also the assumed secondary effluent BAP concentration assumed for this study. If this assumption is accurate, it appears technologies may exist to remove BAP to a level below the proposed criteria applied as an effluent limit of 0.0013 µg/L; however, detection limits exceed this value and it is impossible to know this for certain. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

4.3 Unit Processes Evaluated

Based on the results of the literature review, a wide range of technologies were evaluated for toxic constituent removal. A listing of the technologies is as follows:

- Chemically enhanced primary treatment (CEPT): this physical and chemical technology is based on the addition of a metal salt to precipitate particles prior to primary treatment, followed by sedimentation of particles in the primary clarifiers. This technology has been shown to effectively remove arsenic but there is little data supporting the claims. As a result, the chemical facilities are listed as optional.

- Activated sludge treatment (with a short SRT of approximately 8 days or less): this biological technology is commonly referred to as secondary treatment. It relies on converting dissolved organics into solids using biomass. Having a short SRT is effective at removing degradable organics referred to as BOD compounds for meeting existing discharge limits. Dissolved constituents with a high affinity to adsorb to biomass (e.g., metals, high molecular weight organics, and others) will be better removed compared to smaller molecular weight organics and recalcitrant compounds which will have minimal removal at a short SRT.
- Enhanced activated sludge treatment (with a long SRT of approximately 8 days or more): this technology builds on secondary treatment by providing a longer SRT, which enhances sorption and biodegradation. The improved performance is based on having more biomass coupled with a more diverse biomass community, especially nitrifiers, which have been shown to assist in removal of some of the more recalcitrant constituents not removed with a shorter SRT (e.g., lower molecular weight PAHs). There is little or no data available on the effectiveness of this treatment for removing BAP.

  Additional benefits associated with having a longer SRT are as follows:

  - Lower BOD/TSS discharge load to receiving water
  - Improved water quality and benefit to downstream users
  - Lower effluent nutrient concentrations which reduce algal growth potential in receiving waters
  - Reduced receiving water dissolved oxygen demand due to ammonia removal
  - Reduced ammonia discharge, which is toxic to aquatic species
  - Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
  - Secondary clarifier effluent more conditioned for filtration and disinfection
  - Greater process stability from the anaerobic/anoxic zones serving as biological selectors
- Coagulation/Flocculation and Filtration: this two-stage chemical and physical process relies on the addition of a metal salt to precipitate particles in the first stage, followed by the physical removal of particles in filtration. This technology lends itself to constituents prone to precipitation (e.g., arsenic).
- Lime Softening: this chemical process relies on increasing the pH as a means to either volatilize dissolved constituents or inactivate pathogens. Given that none of the constituents being studied are expected to volatilize, this technology was not carried forward.
- Adsorptive Media: this physical and chemical process adsorbs constituents to a combination of media and/or biomass/chemicals on the media. There are several types of media, with the most proven and common being GAC. GAC can also serve as a coarse roughing filter.
- Ion Exchange: this chemical technology exchanges targeted constituents with a resin. This technology is common with water softeners where the hard divalent cations are

exchanged for monovalent cations to soften the water. Recently, resins that target arsenic and mercury removal include activated alumina and granular ferric hydroxides have been developed. The resin needs to be cleaned and regenerated, which produces a waste slurry that requires subsequent treatment and disposal. As a result, ion exchange was not considered for further.

- Membrane Filtration: This physical treatment relies on the removal of particles larger than the membranes pore size. There are several different membrane pore sizes as categorized below.
    - Microfiltration (MF): nominal pore size range of typically between 0.1 to 1 micron. This pore size targets particles, both inert and biological, and bacteria. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution and bacteria can be removed by the MF membrane.
    - Ultrafiltration (UF): nominal pore size range of typically between 0.01 to 0.1 micron. This pore size targets those solids removed with MF (particles and bacteria) plus viruses and some colloidal material. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution can be removed by the UF membrane.
    - Nanofiltration (NF): nominal pore size range of typically between 0.001 to 0.010 micron. This pore size targets those removed with UF (particles, bacteria, viruses) plus colloidal material. If placed in series with coagulation/flocculation upstream, dissolved constituents precipitated out of solution can be removed by the NF membrane.
- MBR (with a long SRT): this technology builds on secondary treatment whereby the membrane (microfiltration) replaces the secondary clarifier for solids separation. As a result, the footprint is smaller, the mixed liquor suspended solids concentration can be increased to about 5,000 – 10,000 mg/L, and the physical space required for the facility reduced when compared to conventional activated sludge. As with the activated sludge option operated at a longer SRT, the sorption and biodegradation of organic compounds are enhanced in the MBR process. The improved performance is based on having more biomass coupled with a more diverse biomass community, especially nitrifiers which have been shown to assist in removal of persistent dissolved compounds (e.g., some PAHs). There is little or no data available on effectiveness at removing BAP. Although a proven technology, MBRs were not carried further in this technology review since they are less likely to be selected as a retrofit for an existing activated sludge (with a short SRT) secondary treatment facility. The MBR was considered to represent a treatment process approach more likely to be selected for a new, greenfield treatment facility. Retrofits to existing secondary treatment facilities can accomplish similar process enhancement by extending the SRT in the activated sludge process followed by the addition of tertiary membrane filtration units.
- RO: This physical treatment method relies on the use of sufficient pressure to osmotically displace water across the membrane surface while simultaneously rejecting most salts. RO is very effective at removing material smaller than the size ranges for the membrane filtration list above, as well as salts and other organic compounds. As a result, it is expected to be more effective than filtration and MBR methods described above at removing dissolved constituents. Although effective, RO produces a brine reject water that must be managed and disposed.

- Advanced Oxidation Processes (AOPs): this broad term considers all chemical and physical technologies that create strong hydroxyl-radicals. Examples of AOPs include Fenton's oxidation, ozonation, ultraviolet/hydrogen peroxide (UV-H2O2), and others. The radicals produced are rapid and highly reactive at breaking down recalcitrant compounds. Although effective at removing many complex compounds such as those evaluated in this study, AOPs does not typically have as many installations as membranes and activated carbon technologies. As a result, AOPs were not carried forward.

Based on the technical literature review discussed above, a summary of estimated contaminant removal rated by unit treatment process is presented in Table 4.

Table 4. Contaminants Removal Breakdown by Unit Process

Unit Process	Arsenic	BAP	Mercury	Polychlorinated Biphenyls
Activated Sludge Short SRT	No removal	Partial Removal by partitioning		80% removal; effluent <0.88 ng/L
Activated Sludge Long SRT	No removal	Partial removal by partitioning and/or partially biodegradation; MBR could potentially remove most of BAP		>90% removal with a membrane bioreactor, <0.04 ng/L (includes membrane filtration)
Membrane Filtration (MF)	More than 90 % removal (rejection of bound arsenic)	No removal	<1.3 ng/L	>90% removal with a membrane bioreactor, <0.04 ng/L (includes membrane filtration)
Reverse Osmosis (RO)	More than 90% removal (rejection of bound arsenic and removal of soluble arsenic)	More than 98% removal		
Granular Activated Carbon (GAC)	No removal, removal only when carbon is impregnated with iron	90 % removal	<300 ng/L (precipitation and carbon adsorption) <51 ng/L (GAC)	<800 ng/L Likely requires upstream filtration
Disinfection	--	--	--	--

4.4 Unit Processes Selected

The key conclusion from the literature review was that there is limited, to no evidence, that existing treatment technologies are capable of simultaneously meeting all four of the revised discharge limits for the toxics under consideration. Advanced treatment using RO or GAC is expected to provide the best overall removal of the constituents of concern. It is unclear whether these advanced technologies are able to meet revised effluent limits, however these processes may achieve the best effluent quality of the technologies reviewed. This limitation in the findings is based on a lack of an extensive dataset on treatment removal effectiveness in the technical literature for the constituents of interest at the low levels relevant to the proposed criteria, which approach the limits of reliable removal performance for the technologies. As Table 4 highlights, certain unit processes are capable of removing a portion, or all, of the removal requirements for each technology. The removal performance for each constituent will vary from facility to facility and require a site-specific, detailed evaluation because the proposed criteria are such low concentrations. In some cases, a facility may only have elevated concentrations of a single constituent of concern identified in this study. In other cases, a discharger may have elevated concentrations of the four constituents identified in this study, as well as others not identified in this study but subject to revised water quality criteria. This effort is intended to describe a planning level concept of what treatment processes are required to comply with discharge limits for all four constituents. Based on the literature review of unit processes above, two different treatment trains were developed for the analysis that are compared against a baseline of secondary treatment as follows:

- Baseline: represents conventional secondary treatment that is most commonly employed nationwide at wastewater treatment plants. A distinguishing feature for this treatment is the short solids residence time (SRT) (<8 days) is intended for removal of BOD with minimal removal for the toxic constituents of concern.
- Advanced Treatment – MF/RO: builds on baseline with the implementation of a longer SRT (>8 days) and the addition of MF and RO. The longer SRT not only removes BOD, but it also has the capacity to remove nutrients and a portion of the constituents of concern. This alternative requires a RO brine management strategy which will be discussed in sub-sections below.
- Advanced Treatment – MF/GAC: this alternative provides a different approach to advanced treatment with MF/RO by using GAC and avoiding the RO reject brine water management concern. Similar to the MF/RO process, this alternative has the longer SRT (>8 days) with the capacity to remove BOD, nutrients, and a portion of the toxic constituents of concern. As a result, the decision was made to develop costs for both advanced treatment options.

A description of each alternative is provided in Table 5. The process flowsheets for each alternative are presented in Figure 3 to Figure 5.

4.4.1 Baseline Treatment Process

A flowsheet of the baseline treatment process is provided in Figure 3. The baseline treatment process assumes the current method of treatment commonly employed by dischargers. For this process, water enters the headworks and undergoes primary treatment, followed by conventional activated sludge (short SRT) and disinfection. The solids wasted in the activated sludge process are thickened, followed by mixing with primary solids prior to entering the anaerobic digestion process for solids stabilization. The digested biosolids are dewatered to produce a cake and hauled off-site. Since the exact process for each interested facility in Washington is unique, this baseline treatment process was used to establish the baseline capital and O&M costs. The baseline costs will be compared against the advanced treatment alternatives to illustrate the magnitude of the increased costs and environmental impacts.

Table 5. Unit Processes Description for Each Alternative

Unit Process	Baseline	Advanced Treatment – MF/RO	Advanced Treatment - GAC
Influent Flow	5 mgd	5 mgd	5 mgd
Chemically Enhanced Primary Treatment (CEPT); Optional	--	• Metal salt addition (alum) upstream of primaries	• Metal salt addition (alum) upstream of primaries
Activated Sludge	• Hydraulic Residence Time (HRT): 6 hrs • Short Solids Residence Time (SRT): <8 days	• Hydraulic Residence Time (HRT): 12 hrs (Requires more tankage than the Baseline) • Long Solids Residence Time (SRT): >8 days (Requires more tankage than the Baseline)	• Hydraulic Residence Time (HRT): 12 hrs (Requires more tankage than the Baseline) • Long Solids Residence Time (SRT): >8 days (Requires more tankage than the Baseline)
Secondary Clarifiers	Hydraulically Limited	Solids Loading Limited (Larger clarifiers than Baseline)	Solids Loading Limited (Larger clarifiers than Baseline)
Microfiltration (MF)	--	Membrane Filtration to Remove Particles and Bacteria	Membrane Filtration to Remove Particles and Bacteria
Reverse Osmosis (RO)	--	Treat 50% of the Flow by RO to Remove Metals and Dissolved Constituents. Sending a portion of flow through the RO and blending it with the balance of plant flows ensures a stable non-corrosive, non-toxic discharge.	--
Reverse Osmosis Brine Reject Mgmt	--	Several Options (All Energy or Land Intensive)	--
Granular Activated Carbon (GAC)	--	--	Removes Dissolved Constituents
Disinfection	Not shown to remove any of the constituents	Not shown to remove any of the constituents	Not shown to remove any of the constituents

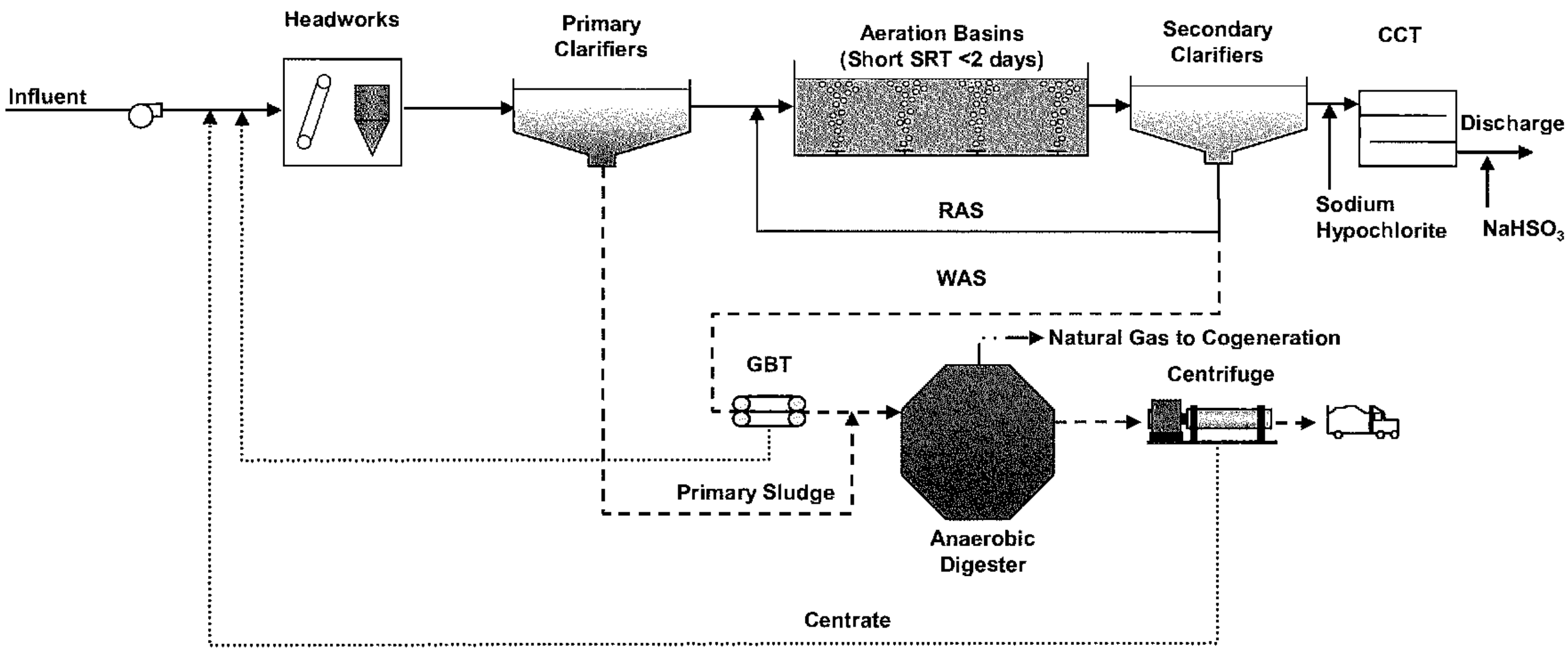

Figure 3. Baseline Flowsheet – Conventional Secondary Treatment

4.4.2 Advanced Treatment – MF/RO Alternative

A flowsheet of the advanced treatment – MF/RO alternative is provided in Figure 4. This alternative builds on the baseline secondary treatment facility, whereby the SRT is increased in the activated sludge process, and MF and RO are added prior to disinfection. The solids treatment train does not change with respect to the baseline. Additionally, a brine management strategy must be considered.

The RO process concentrates contaminants into a smaller volume reject stream. Disposing of the RO reject stream can be a problem because of the potentially large volume of water involved and the concentration of contaminants contained in the brine. For reference, a 5 mgd process wastewater flow might result in 1 mgd of brine reject requiring further management. The primary treatment/handling options for RO reject are as follows:

- Zero liquid discharge
- Surface water discharge
- Ocean discharge
- Haul and discharge to coastal location for ocean discharge
- Sewer discharge
- Deep well injection
- Evaporate in a pond
- Solar pond concentrator

Many of the RO brine reject management options above result in returning the dissolved solids to a "water of the state" such as surface water, groundwater, or marine waters. Past rulings in Washington State have indicated that once pollutants are removed from during treatment they are not to be re-introduced to a water of the state. As a result, technologies with this means for disposal were not considered viable options for management of RO reject water in Washington.

Zero Liquid Discharge

Zero liquid discharge (ZLD) is a treatment process that produces a little or no liquid brine discharge but rather a dried residual salt material. This process improves the water recovery of the RO system by reducing the volume of brine that must be treated and disposed of in some manner. ZLD options include intermediate treatment, thermal-based technologies, pressure driven membrane technologies, electric potential driven membrane technologies, and other alternative technologies.

Summary

There are many techniques which can be used to manage reject brine water associated with RO treatment. The appropriate alternative is primarily governed by geographic and local constraints. A comparison of the various brine management methods and potential costs are provided in Table 6.

Of the listed options, ZLD was considered for this analysis as the most viable approach to RO reject water management. An evaporation pond was used following ZLD. The strength in this combination is ZLD reduces the brine reject volume to treat, which in turn reduces the required evaporation pond footprint. The disadvantage is that evaporation ponds require a substantial amount of physical space which may not be available at existing treatment plant sites. It is also important to recognize that the greenhouse gas (GHG) emissions vary widely for the eight brine management options listed above based on energy and chemical intensity.

Table 6. Brine Disposal Method Relative Cost Comparison

Disposal Method	Description	Relative Capital Cost	Relative O&M Cost	Comments
Zero Liquid Discharge (ZLD)	Further concentrates brine reject for further downstream processing	High	High	This option is preferred as an intermediate step. This rationale is based on the reduction in volume to handle following ZLD. For example, RO reject stream volume is reduced on the order of 50-90%.
Surface Water Discharge	Brine discharge directly to surface water. Requires an NPDES permit.	Lowest	Lowest	Both capital and O&M costs heavily dependent on the distance from brine generation point to discharge. Not an option for nutrient removal.
Ocean Discharge	Discharge through a deep ocean outfall.	Medium	Low	Capital cost depends on location and availability of existing deep water outfall.
Sewer Discharge	Discharge to an existing sewer pipeline for treatment at a wastewater treatment plant.	Low	Low	Both capital and O&M costs heavily dependent on the brine generation point to discharge distance. Higher cost than surface water discharge due to ongoing sewer connection charge. Not an option for wastewater treatment.
Deep Well Injection	Brine is pumped underground to an area that is isolated from drinking water aquifers.	Medium	Medium	Technically sophisticated discharge and monitoring wells required. O&M cost highly variable based on injection pumping energy.
Evaporation Ponds	Large, lined ponds are filled with brine. The water evaporates and a concentrated salt remains.	Low – High	Low	Capital cost highly dependent on the amount and cost of land.
Salinity Gradient Solar Ponds (SGSP)	SGSPs harness solar power from pond to power an evaporative unit.	Low – High	Lowest	Same as evaporation ponds plus added cost of heat exchanger and pumps. Lower O&M cost due to electricity production.
Advanced Thermal Evaporation	Requires a two-step process consisting of a brine concentrator followed by crystallizer	High	Highest	Extremely small footprint, but the energy from H_2O removal is by far the most energy intensive unless waste heat is used.

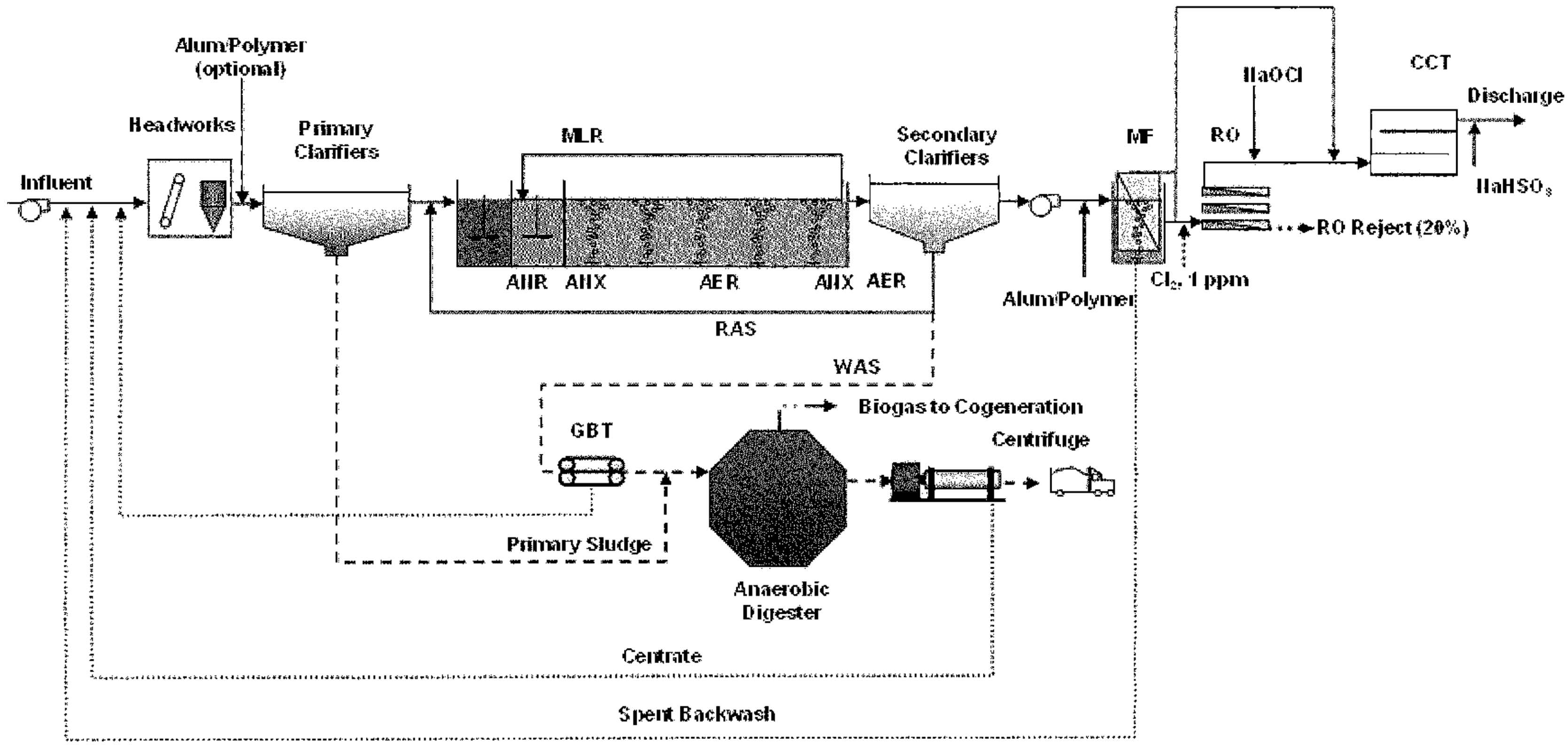

Figure 4. Advanced Treatment Flowsheet – Tertiary Microfiltration and Reverse Osmosis

4.4.3 Advanced Treatment – MF/GAC Alternative

A flowsheet of the advanced treatment – MF/GAC alternative is provided in Figure 5. Following the MF technology, a GAC contactor and media are required.

This alternative was developed as an option that does not require a brine management technology (e.g., ZLD) for comparison to the MF/RO advanced treatment alternative. However, this treatment alternative does require that the GAC be regenerated. A baseline secondary treatment facility can be retrofitted for MF/GAC. If an existing treatment facility has an extended aeration lagoon, the secondary effluent can be fed to the MF/GAC. The longer SRT in the extended aeration lagoon provides all the benefits associated with the long SRT in an activated sludge plant as previously stated:

- Lower BOD/TSS discharge load
- Higher removal of recalcitrant constituents and heavy metals
- Improved water quality and benefit to downstream users
- Less downstream algal growth
- Reduced receiving water dissolved oxygen demand due to ammonia removal
- Reduced ammonia discharge loads, which is toxic to several aquatic species
- Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
- Secondary clarifier effluent more conditioned for filtration and disinfection
- Greater process stability from the anaerobic/anoxic zones serving as a selector

If an existing treatment facility employs a high rate activated sludge process (short SRT) similar to the baseline, it is recommended that the activated sludge process SRT be increased prior to the MF/GAC unit processes. The longer SRT upstream of the MF is preferred to enhance the membrane flux rate, reduce membrane biofouling, increase membrane life, and reduce the chemicals needed for membrane cleaning.

The key technical and operational challenges associated with the tertiary add-on membrane filtration units are as follows:

- The membrane filtration technology is a proven and reliable technology. With over 30 years of experience, it has made the transition in recent years from an emerging technology to a proven and reliable technology.
- Membrane durability dependent on feed water quality. The water quality is individual facility specific.
- Membranes are sensitive to particles, so upstream screening is critical. The newer generations of membranes have technical specifications that require a particular screen size.
- Membrane area requirements based on peak flows as water must pass through the membrane pores. Additionally, membranes struggle with variable hydraulic loading. Flow equalization upstream can greatly reduce the required membrane surface area and provide uniform membrane loading.

- Membrane tanks can exacerbate any foam related issues from the upstream biological process. Foam entrapment in the membrane tank from the upstream process can reduce membrane filtration capacity and in turn result in a plant-wide foam problem.
- Reliable access to the membrane modules is key to operation and maintenance. Once PLC is functionary properly, overall maintenance requirements for sustained operation of the system are relatively modest.
- The membranes go through frequent membrane relaxing or back pulse and a periodic deep chemical clean in place (CIP) process.
- Sizing of membrane filtration facilities governed by hydraulic flux. Municipal wastewaters have flux values that range from about 20 to 40 gallons per square foot per day (gfd) under average annual conditions. The flux associated with industrial applications is wastewater specific.

Following the MF is the activated carbon facilities. There are two kinds of activated carbon used in treating water: powdered activated carbon (PAC) and GAC. PAC is finely-ground, loose carbon that is added to water, mixed for a short period of time, and removed. GAC is larger than PAC, is generally used in beds or tanks that permit higher adsorption and easier process control than PAC allows, and is replaced periodically. PAC is not selective, and therefore, will adsorb all active organic substances making it an impractical solution for a wastewater treatment plant. As a result, GAC was considered for this analysis. The type of GAC (e.g., bituminous and subbituminous coal, wood, walnut shells, lignite or peat), gradation, and adsorption capacity are determined by the size of the largest molecule/ contaminant that is being filtered (AWWA, 1990).

As water flows through the carbon bed, contaminants are captured by the surfaces of the pores until the carbon is no longer able to adsorb new molecules. The concentration of the contaminant in the treated effluent starts to increase. Once the contaminant concentration in the treated water reaches an unacceptable level (called the breakthrough concentration), the carbon is considered "spent" and must be replaced by virgin or reactivated GAC.

The capacity of spent GAC can be restored by thermal reactivation. Some systems have the ability to regenerate GAC on-site, but in general, small systems haul away the spent GAC for off-site regeneration (EPA 1993). For this study, off-site regeneration was assumed.

The basic facilities and their potential unit processes included in this chapter are as follows:

- GAC supply and delivery
- Influent pumping
  - Low head feed pumping
  - High head feed pumping (assumed for this study as we have low limits so require high beds)
- Contactors and backwash facilities
  - Custom gravity GAC contactor
  - Pre-engineered pressure GAC contactor (Used for this study)
  - Backwash pumping
- GAC transport facilities
  - Slurry pumps
  - Eductors (Used for this study)

- Storage facilities
  - Steel tanks
  - Concrete tanks (Used for this study; larger plants would typically select concrete tanks)
- Spent carbon regeneration
  - On-site GAC regeneration
  - Off-Site GAC regeneration

Following the MF is the GAC facility. The GAC contactor provides about a 12-min hydraulic residence time for average annual conditions. The GAC media must be regenerated about twice per year in a furnace. The constituents sorbed to the GAC media are removed during the regeneration process. A typical design has full redundancy and additional storage tankage for spent and virgin GAC. Facilities that use GAC need to decide whether they will regenerate GAC on-site or off-site. Due to challenges associated with receiving air emission permits for new furnaces, it was assumed that off-site regeneration would be evaluated.

The key technical and operational challenges associated with the tertiary add-on GAC units are as follows:

- Nearest vendor to acquire virgin GAC – How frequently can they deliver virgin GAC and what are the hauling costs?
- Contactor selection is typically based on unit cost and flow variation. The concrete contactor is typically more cost effective at higher flows so it was used for this evaluation. The pre-engineered pressure contactor can handle a wider range of flows than a concrete contactor. Additionally, a pressure system requires little maintenance as they are essentially automated
- Periodical contactor backwashing is critical for maintaining the desired hydraulics and control biological growth
- Eductors are preferred over slurry pumps because they have fewer mechanical components. Additionally, the pump with eductors is not in contact with the carbon, which reduces wear.
- Off-site GAC regeneration seems more likely due to the challenges with obtaining an air emissions permit.

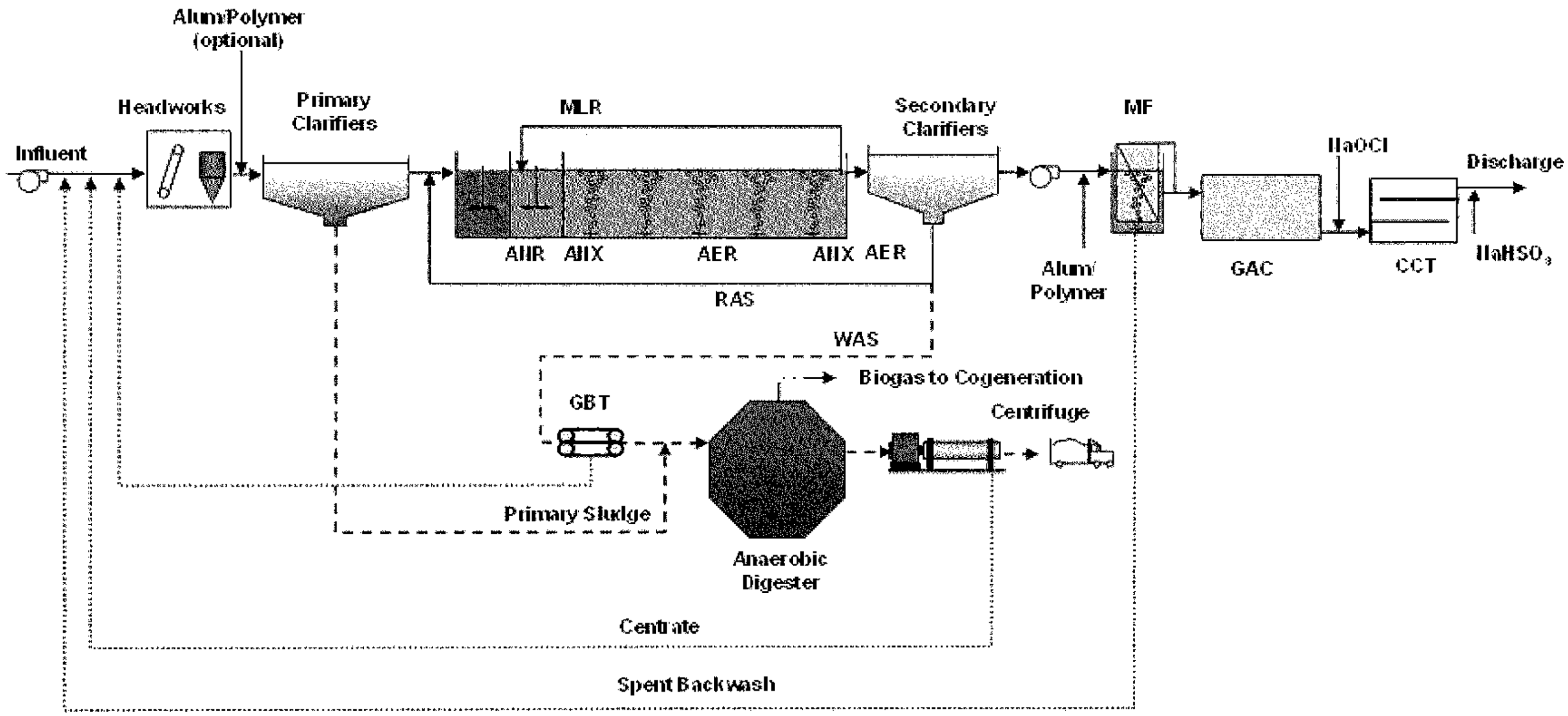

Figure 5. Advanced Treatment Flowsheet – Tertiary Microfiltration and Granular Activated Carbon

4.5 Steady-State Mass Balance

HDR used its steady-state mass balance program to calculate the flows and loads within the candidate advanced treatment processes as a means to size facilities. The design of wastewater treatment facilities are generally governed by steady-state mass balances. For a steady-state mass balance, the conservation of mass is calculated throughout the entire wastewater treatment facility for defined inputs. Dynamic mass balance programs exist for designing wastewater facilities, but for a planning level study such as this, a steady state mass balance program is adequate. A dynamic program is generally used for detailed design and is site-specific with associated requirements for more detailed wastewater characterization.

The set of model equations used to perform a steady-state mass balance are referred to as the model. The model equations provide a mathematical description of various wastewater treatment processes, such as an activated sludge process, that can be used to predict unit performance. The program relies on equations for each unit process to determine the flow, load, and concentration entering and leaving each unit process.

An example of how the model calculates the flow, load, and concentration for primary clarifiers is provided below. The steady-state mass balance equation for primary clarifiers has a single input and two outputs as shown in the simplified Figure 6. The primary clarifier feed can exit the primary clarifiers as either effluent or sludge. Solids not removed across the primaries leave as primary effluent, whereas solids captured leave as primary sludge. Scum is not accounted for.

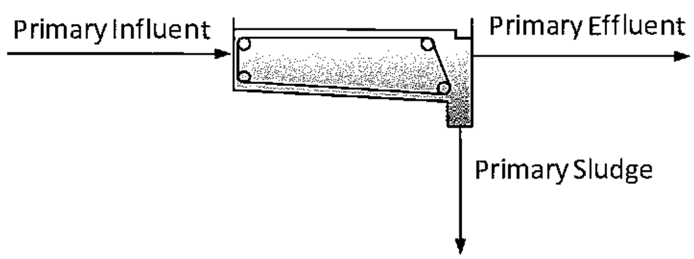

Figure 6. Primary Clarifier Inputs/Outputs

The mass balance calculation requires the following input:

- Solids removal percentage across the primaries (based on average industry accepted performance)
- Primary solids thickness (i.e., percent solids) (based on average industry accepted performance)

The steady-state mass balance program provides a reasonable first estimate for the process performance, and an accurate measure of the flows and mass balances at various points throughout the plant. The mass balance results were used for sizing the facility needs for each alternative. A listing of the unit process sizing criterion for each unit process is provided in Appendix A. By listing the unit process sizing criteria, a third-party user could redo the analysis and end up with comparable results. The key sizing criteria that differ between the baseline and treatment alternatives are as follows:

- Aeration basin mixed liquor is greater for the advanced treatment alternatives which in turn requires a larger volume
- The secondary clarifiers are sized based on hydraulic loading for the baseline versus solids loading for the advanced treatment alternatives

- The MF/GAC and MF/RO sizing is only required for the respective advanced treatment alternatives.

4.6 Adverse Environmental Impacts Associated with Advanced Treatment Technologies

The transition from the baseline (conventional secondary treatment) to either advanced treatment alternatives has some environmental impacts that merit consideration, including the following:

- Land area for additional system components (which for constrained facility sites, may necessitate land acquisition and encroachment into neighboring properties with associated issues and challenges, etc.).
- Increased energy use and atmospheric emissions of greenhouse gases and criteria air contaminants associated with power generation to meet new pumping requirements across the membrane filter systems (MF and RO) and GAC.
- Increased chemical demand associated with membrane filters (MF and RO).
- Energy and atmospheric emissions associated with granulated charcoal regeneration.
- RO brine reject disposal. The zero liquid discharge systems are energy intensive energy and increase atmospheric emissions as a consequence of the electrical power generation required for removing water content from brine reject.
- Increase in sludge generation while transitioning from the baseline to the advanced treatment alternatives. There will be additional sludge captured with the chemical addition to the primaries and membrane filters (MF and RO). Additionally, the GAC units will capture more solids.
- Benefits to receiving water quality by transitioning from a short SRT (<2 days) in the baseline to a long SRT (>8 days) for the advanced treatment alternatives (as previously stated):
  - Lower BOD/TSS discharge load
  - Higher removal of recalcitrant constituents and heavy metals
  - Improved water quality and benefit to downstream users
  - Reduced nutrient loadings to receiving waters and lower algal growth potential
  - Reduced receiving water dissolved oxygen demand due to ammonia removal
  - Reduced ammonia discharge loads, which is toxic to aquatic species
  - Improved water quality for habitat, especially as it relates to biodiversity and eutrophication
  - Secondary clarifier effluent better conditioned for subsequent filtration and disinfection
  - Greater process stability from the anaerobic/anoxic zones serving as a biological selectors

HDR calculated GHG emissions for the baseline and advanced treatment alternatives. The use of GHG emissions is a tool to normalize the role of energy, chemicals, biosolids hauling, and fugitive emissions (e.g., methane) in a single unit. The mass balance results were used to quantify energy demand and the corresponding GHG emissions for each alterative. Energy demand was estimated from preliminary process calculations. A listing of the energy demand for each process stream, the daily energy demand, and the unit energy demand is provided in Table 7. The advanced treatment options range from 2.3 to 4.1 times greater than the baseline. This large increase in energy demand is attributed to the energy required to pass water through the membrane barriers and/or the granular activated carbon. Additionally, there is energy required to handle the constituents removed as either regenerating the GAC or handling the RO brine reject water. This additional energy required to treat the removed constituents is presented in Table 7.

Table 7. Energy Breakdown for Each Alternative (5 mgd design flow)

Parameter	Units	Baseline	Advanced Treatment – MF/GAC	Advanced Treatment – MF/RO
Daily Liquid Stream Energy Demand	MWh/d	11.6	23.8	40.8
Daily Solids Stream Energy Demand	MWh/d	-1.6	-1.1	-1.1
Daily Energy Demand	MWh/d	10.0	22.7	39.7
Unit Energy Demand	kWh/MG Treated	2,000	4,500	7,900

MWh/d = megawatt hours per day
kWh/MG = kilowatt hours per million gallons

Details on the assumptions used to convert between energy demand, chemical demand and production, as well as biologically-mediated gases (i.e., CH4 and N2O) and GHG emissions are provided in Appendix B.

A plot of the GHG emissions for each alternative is shown in Figure 7. The GHG emissions increase from the baseline to the two advanced treatment alternatives. The GHG emissions increase about 50 percent with respect to baseline when MF/GAC is used and the GHG emissions increase over 100 percent with respect to baseline with the MF/RO advanced treatment alternative.

The MF/GAC energy demand would be larger if GAC regeneration was performed on-site. The GHG emissions do not include the energy or air emissions that result from off-site GAC regeneration. Only the hauling associated with moving spent GAC is included. The energy associated with operating the furnace would exceed the GHG emissions from hauling spent GAC.

The zero liquid discharge in the MF/RO alternative alone is comparable to the Baseline. This contribution to increased GHG emissions by zero liquid discharge brine system highlights the importance of the challenges associated with managing brine reject.

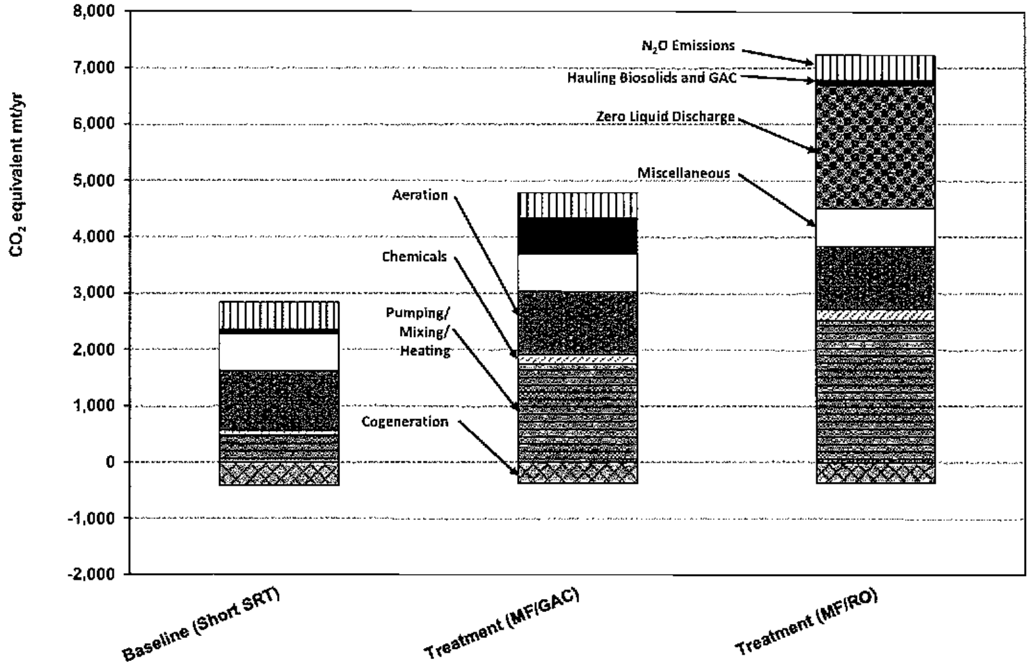

Figure 7. Greenhouse Gas Emissions for Each Alternative

The use of GHG emissions as a measure of sustainability does not constitute a complete comparison between the baseline and advanced treatment alternatives. Rather, it is one metric that captures the impacts of energy, chemical demand and production, as well as biologically-mediated gases (i.e., CH_4 and N_2O). The other environmental impacts of advanced treatment summarized in the list above should also be considered in decision making beyond cost analysis.

4.7 Costs

Total project costs along with the operations and maintenance costs were developed for each advanced treatment alternative for a comparison with baseline secondary treatment.

4.7.1 Approach

The cost estimates presented in this report are planning level opinions of probable construction costs for a nominal 5 mgd treatment plant design flow representing a typical facility without site specific details about local wastewater characteristics, physical site constraints, existing infrastructure, etc. The cost estimates are based on wastewater industry cost references, technical studies, actual project cost histories, and professional experience. The costs presented in this report are considered planning level estimates. A more detailed development of the advanced treatment process alternatives and site specific information would be required to further refine the cost estimates. Commonly this is accomplished in the preliminary design phase of project development for specific facilities following planning.

The cost opinion includes a range of costs associated with the level of detail used in this analysis. Cost opinions based on preliminary engineering can be expected to follow the Association for the Advancement of Cost Engineering (AACE International) Recommended Practice No. 17R-97 Cost Estimate Classification System estimate Class 4. A Class 4 estimate is based upon a 5 to 10 percent project definition and has an expected accuracy range of -30 to +50 percent and typical end usage of budget authorization and cost control. It is considered an "order-of-magnitude estimate." The life-cycle costs were prepared using the net present value (NPV) method.

The cost associated for each new unit process is based on a unit variable, such as required footprint, volume, demand (e.g., lb O_2/hr), and others. This approach is consistent with the approach developed for the EPA document titled "Estimating Water Treatment Costs: Volume 2-Cost Curves Applicable to 1 to 200 mgd Treatment Plants" dated August 1979. The approach has been updated since 1979 to account for inflation and competition, but the philosophy for estimating costs for unit processes has not changed. For example, the aeration system sizing/cost is governed by the maximum month airflow demand. Additionally, the cost associated constructing an aeration basin is based on the volume. The cost considers economies of scale.

The O&M cost estimates were calculated from preliminary process calculations. The operations cost includes energy and chemical demand. For example, a chemical dose was assumed based on industry accepted dosing rates and the corresponding annual chemical cost for that particular chemical was accounted for. The maintenance values only considered replacement equipment, specifically membrane replacement for the Advanced Treatment Alternatives.

4.7.2 Unit Cost Values

The life-cycle cost evaluation was based on using the economic assumptions shown in Table 8. The chemical costs were based on actual values from other projects. To perform detailed cost evaluations per industry, each selected technology would need to be laid out on their respective site plan based on the location of the existing piping, channels, and other necessary facilities.

Table 8. Economic Evaluation Variables

Item	Value
Nominal Discount Rate	5%
Inflation Rate:	
General	3.5%
Labor	3.5%
Energy	3.5%
Chemical	3.5%
Base Year	2013
Project Life	25 years
Energy	$0.06/kWh
Natural Gas	$0.60/therm
Chemicals:	
Alum	$1.1/gal
Polymer	$1.5/gal
Hypochlorite	$1.5/gal
Salt	$0.125/lb
Antiscalant	$12.5/lb
Acid	$0.35/lb
Deionized Water	$3.75/1,000 gal
Hauling:	

Table 8. Economic Evaluation Variables

Item	Value
Biosolids Hauling Distance	100 miles (one way)
Biosolids Truck Volume	6,000 gal/truck
Biosolids Truck Hauling	$250/truck trip
GAC Regeneration Hauling Distance	250 miles (round trip)
GAC Regeneration Truck Volume	$20,000 lb GAC/truck
GAC Regeneration Truck Hauling	Included in cost of Virgin GAC

kWh= kilowatt hours; lbs=pounds; GAC=granulated activated carbon; gal=gallon

4.7.3 Net Present Value of Total Project Costs and Operations and Maintenance Cost in 2013 Dollars

An estimate of the net present value for the baseline treatment process and the incremental cost to implement the advanced treatment alternatives is shown in Table 9. The cost for the existing baseline treatment process was estimated based on new construction for the entire conventional secondary treatment process (Figure 3). The incremental cost to expand from existing baseline secondary treatment to advanced treatment was calculated by taking the difference between the baseline and the advanced treatment alternatives. These values serve as a benchmark for understanding the prospective cost for constructing advanced treatment at the planning level of process development.

Table 9. Treatment Technology Total Project Costs in 2013 Dollars for a 5 mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)*	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
Baseline (Conventional Secondary Treatment)*	59 - 127	5 - 11	65 – 138	13 - 28
Advanced Treatment – MF/RO**	108 - 231	31 - 67	139 - 298	28 - 60
Advanced Treatment – MF/GAC	131 - 280	50 - 108	181 - 388	36 - 78
Incremental Increase to Advanced Treatment MF/RO	48 - 104	26 - 56	75 - 160	15 - 32
Incremental Increase to Advanced Treatment MF/GAC	71 - 153	45 - 97	117 - 250	23 - 50

* The additional cost to increase the SRT to upwards of 30-days is about $12 - 20 million additional dollars in total project cost for a 5 mgd design flow

** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.

O&M=operations and maintenance; MF/RO=membrane filtration/reverse osmosis; MF/GAC=membrane filtration/granulated activated carbon; gpd=gallons per day

4.7.4 Unit Cost Assessment

Costs presented above are based on a treatment capacity of 5.0 mgd, however, existing treatment facilities range dramatically across Washington in size and flow treated. Table 9 indicates that the unit capital cost for baseline conventional secondary treatment for 5.0 mgd ranges between $13 to 28 per gallon per day of treatment capacity. The unit cost for the advanced treatment alternatives increases the range from the low $20s to upper $70s on a per-gallon per-day of capacity. The increase in cost for the advanced treatment alternatives is discussed in the sub-sections below.

Advanced Treatment MF/RO

The advanced treatment MF/RO alternative has a total present worth unit cost range of $28 to $60 million in per gallon per day of capacity. This translates to an incremental cost increase with respect to the baseline of $15 to $32 million dollars in per gallon per day treatment capacity. The key differences in cost between the baseline and the advanced treatment MF/RO are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (<8 days versus >8 days).
- Additional pumping stations to pass water through the membrane facilities (MF and RO). These are based on peak flows.
- Membrane facilities (MF and RO; equipment, tanks chemical feed facilities, pumping, etc.) and replacement membrane equipment.
- Additional energy and chemical demand to operate the membrane facilities (MF and RO) and GAC.
- Zero liquid discharge facilities to further concentrate the brine reject.
- Zero liquid discharge facilities are energy/chemically intensive and they require membrane replacement every few years due to the brine reject water quality.
- An evaporation pond to handle the brine reject that has undergone further concentration by zero liquid discharge.

The advanced treatment MF/RO assumes that 100 percent of the flow is treated by MF, followed by 50 percent of the flow treated with RO. Sending a portion of flow through the RO and blending it with the balance of plant flows ensures a stable water to discharge. The RO brine reject (about 1.0 mgd) undergoes ZLD pre-treatment that further concentrates the brine reject to about 0.1-0.5 mgd. The recovery for both RO and ZLD processes is highly dependent on water quality (e.g., silicate levels).

ZLD technologies are effective at concentrating brine reject, but it comes at a substantial cost ($17.5 per gallon per day of ZLD treatment capacity of brine reject). The zero liquid discharge estimate was similar in approach to the demonstration study by Burbano and Brandhuber (2012) for La Junta, Colorado. The ability to further concentrate brine reject was critical from a management standpoint. Although 8 different options were presented for managing brine reject in Section 4.4.2, none of them is an attractive approach for handling brine reject. ZLD provides a viable pre-treatment step that requires subsequent downstream treatment. Evaporation ponds following ZLD were used for this study. Without ZLD, the footprint would be 3-5 times greater.

Roughly 30 acres of evaporation ponds, or more, may be required to handle the ZLD concentrate, depending upon concentrator effectiveness, local climate conditions, residuals accumulation, residual removal, etc. Precipitation throughout Washington is highly variable which can greatly influence evaporation pond footprint. The approach for costing the evaporation pond was in accordance with Mickley et al. (2006) and the cost was about $2.6 million.

Recent discussions with an industry installing evaporation ponds revealed that they will use mechanical evaporators to enhance evaporation rates. The use of mechanical evaporators was not included in this study, but merits consideration if a facility is performing a preliminary design that involves evaporation ponds. The mechanical evaporators have both a capital costs and annual energy costs.

Advanced Treatment MF/GAC

The advanced treatment MF/GAC alternative has a total present worth unit cost range of $36 to $78 million in per gallon per day capacity. This translates to an incremental cost increase with respect to the baseline of $23 to $50 million dollars on a per gallon per day of treatment capacity basis. The key differences in cost between the baseline and the advanced treatment MF/GAC are as follows:

- Larger aeration basins than the baseline to account for the longer SRT (<8 days versus >8 days).
- Additional pumping stations to pass water through the MF membrane and GAC facilities. These are based on peak flows.
- GAC facilities (equipment, contact tanks, pumping, GAC media, etc.)
- Additional energy to feed and backwash the GAC facilities.
- GAC media replacement was the largest contributor of any of the costs.
- Additional hauling and fees to regenerate GAC off-site.

The advanced treatment MF/GAC assumes that 100 percent of the flow is treated by MF, followed by 100 percent of the flow treated with GAC. The GAC technology is an established technology. The costing approach was in accordance with EPA guidelines developed in 1998.

The critical issue while costing the GAC technology is whether a GAC vendor/regeneration facility is located within the region. On-site regeneration is an established technology with a furnace.

However, there are several concerns as listed in Section 4.4.3:

- Ability to obtain an air emissions permit
- Additional equipment to operate and maintain
- Energy and air emissions to operate a furnace on-site
- Operational planning to ensure that furnace is operating 90-95 percent of the time. Otherwise, operations is constantly starting/stopping the furnace which is energy intensive and deleterious to equipment
- If not operated properly, the facility has the potential to create hazardous/toxic waste to be disposed

If located within a couple hundred miles, off-site regeneration is preferred. For this study, off-site regeneration was assumed with a 250-mile (one-way) distance to the nearest vendor that can provide virgin GAC and a regeneration facility.

Incremental Treatment Cost

The difference in costs between the baseline and the advanced treatment alternatives is listed in Table 10. The incremental cost to retrofit the baseline facility to the advanced treatment was calculated by taking the difference between the two alternatives. These values should serve as a planning level benchmark for understanding the potential cost for retrofitting a particular facility. The incremental cost is unique to a particular facility. Several reasons for the wide range in cost in retrofitting a baseline facility to advanced treatment are summarized as follows:

- Physical plant site constraints. A particular treatment technology may or may not fit within the constrained particular plant site. A more expensive technology solution that is more compact may be required. Alternately, land acquisition may be necessary to enlarge a plant site to allow the addition of advanced treatment facilities. An example of the former is stacking treatment processes vertically to account for footprint constraints. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.
- Yard piping. Site specific conditions may prevent the most efficient layout and piping arrangement for an individual facility. This could lead to additional piping and pumping to convey the wastewater through the plant. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.
- Pumping stations. Each facility has unique hydraulic challenges that might require additional pumping stations not captured in this planning level analysis. This is an additional financial burden that would not be captured in the incremental costs presented in Table 10.

A cursory unit cost assessment was completed to evaluate how costs would compare for facilities with lower (0.5 mgd) and higher capacity (25 mgd), as presented in Table 10. Capital costs were also evaluated for a 0.5 mgd and 25 mgd facility using non-linear scaling equations with scaling exponents. The unit capital cost for baseline conventional secondary treatment for 0.5 mgd and 25 mgd is approximately $44 and $10 per gallon per day of treatment capacity, respectively. The incremental unit costs to implement an advanced treatment retrofit for 0.5 mgd would range between $30 to $96 per gallon per day of treatment capacity and would be site and discharger specific. The incremental unit costs to implement an advanced treatment retrofit for 25 mgd would range between $10 to 35 per gallon per day of treatment capacity and would be site and discharger specific. The larger flow, 25 mgd, is not as expensive on a per gallon per day of treatment capacity. This discrepancy for the 0.5 and 25 mgd cost per gallon per day of treatment capacity is attributed to economies of scale. Cost curve comparisons (potential total construction cost and total net present value) for the baseline and the two tertiary treatment options (MF/RO and MF/GAC) are shown in Figure 8 and Figure 9 between the flows of 0.5 and 25 mgd. It is important to note that while the economies of scale suggest lower incremental costs for the larger size facilities, some aspects of the advanced treatment processes may become infeasible at larger capacities due to factors such as physical space limitations and the large size requirements for components such as RO reject brine management.

Table 10. Treatment Technology Total Project Costs in 2013 Dollars for a 0.5 mgd Facility and a 25 mgd Facility

Alternative	Total Construction Cost, 2013 dollars ($ Million)	O&M Net Present Value, 2013 dollars ($ Million)*	Total Net Present Value, 2013 dollars ($ Million)	NPV Unit Cost, 2013 dollars ($/gpd)
0.5 mgd:				
Baseline (Conventional Secondary Treatment)	15 - 32	0.5 - 1.1	15 - 33	31 - 66
Advanced Treatment – MF/RO**	27 - 58	3.2 - 6.8	30 - 65	60 - 130
Advanced Treatment – MF/GAC	33 - 70	5 - 10.8	38 - 81	76 - 162
Incremental Increase to Advanced Treatment MF/RO	12 - 26	2.7 - 5.7	15 - 32	30 - 64
Incremental Increase to Advanced Treatment MF/GAC	18 - 38	4.6 - 9.8	22 - 48	45 - 96
25 mgd:				
Baseline (Conventional Secondary Treatment)	156 - 335	25 - 54	182 - 389	7 - 16
Advanced Treatment – MF/RO**	283 - 606	157 - 336	440 - 942	18 - 38
Advanced Treatment – MF/GAC	343 - 735	252 - 541	595 - 1276	24 - 51
Incremental Increase to Advanced Treatment MF/RO	127 - 272	131 - 281	258 - 553	10 - 22
Incremental Increase to Advanced Treatment MF/GAC	187 - 401	226.9 - 486	414 - 887	17 - 35

* Does not include the cost for labor.
** Assumes zero liquid discharge for RO brine management, followed by evaporation ponds. Other options are available as listed in Section 4.4.2.
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
O&M=operations and maintenance
gpd=gallons per day

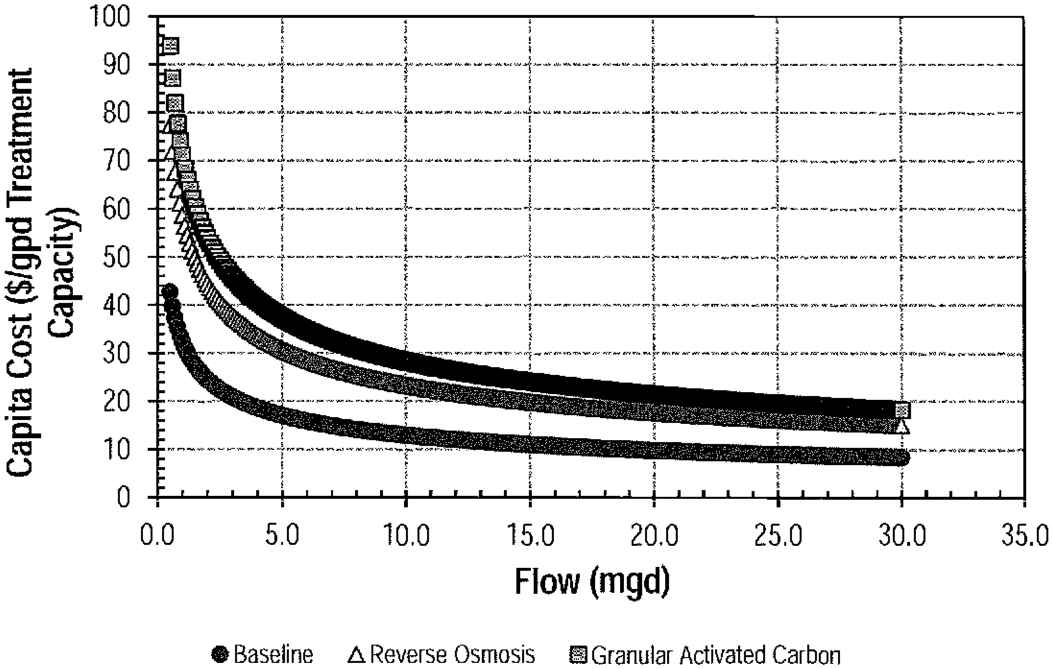

Figure 8: Capital Cost Curve Comparison for Baseline Treatment, MF/RO, and MF/GAC

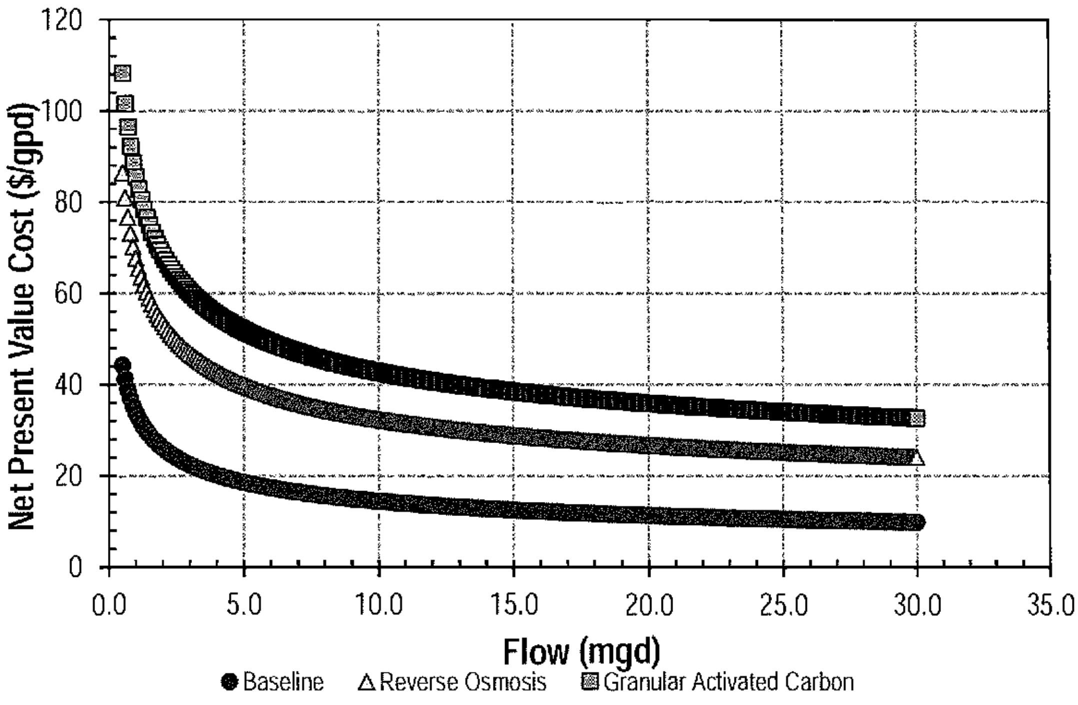

Figure 9: NPV Cost Curve Comparison for Baseline Treatment, MF/RO, and MF/GAC

4.8 Pollutant Mass Removal

An estimate of the projected load removal for the four constituents of concern was developed and is presented in Table 11. The current secondary effluent and advanced treatment effluent data is based on the only available data to HDR and is from municipal treatment plant facilities. Data is not available for advanced treatment facilities such as MF/RO or MF/GAC. Due to this lack of data, advanced treatment using MF/RO or MF/GAC was assumed to remove an additional zero to 90 percent of the constituents presented resulting in the range presented in Table 11. It is critical to note these estimates are based on limited data and are presented here simply for calculating mass removals. Current secondary effluent for industrial facilities would likely be greater than the data presented here and as a result, the projected effluent quality for industrial facilities would likely be higher as well. Based on the limited actual data from municipal treatment facilities, Table 11 indicates that mercury and BAP effluent limits may potentially be met using advanced treatment at facilities with similar existing secondary effluent quality.

Table 11. Pollutant Mass Removal by Contaminant for a 5 mgd Facility

Component	PCBs	Mercury	Arsenic	BAP
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)*	0.0015	0.025	7.5	0.00031
Projected Effluent Quality (µg/L) from Advanced Treatment (MF/RO or MF/GAC)*	0.000041 – 0.00041	0.00012 – 0.0012	0.38 – 3.8	0.000029 - 0.00029
Mass Removed (mg/d)**	21 - 28	451 - 471	71,000 – 135,000	0.4 – 5.0
Mass Removed (lb/d)**	0.000045 – 0.000061	0.00099 – 0.0010	0.16 – 0.30	0.0000010 – 0.0000012

* Based on or estimated for actual treatment plant data from municipal facilities. Data sets are limited and current secondary effluent for industrial facilities would likely be greater than the data presented here.
** 1 lb = 454,000 mg
HHWQC=human health-based water quality criteria
MF/RO=membrane filtration/reverse osmosis
MF/GAC=membrane filtration/granulated activated carbon
µg/L=micrograms per liter
mg/d=milligrams per day
lb/d=pounds per day

Unit costs were developed based on required mass removal from a 5 mgd facility for each of the four constituents of concern to reduce discharges from current secondary effluent quality to the assumed required effluent quality (HHWQC). It important to note that this study concludes it is unclear if existing technology can meet the required effluent quality, however, the information presented in Table 12 assumes HHWQC would be met for developing unit costs. The unit costs are expressed as dollars in NPV (over a 25 year period) per pound of constituent removed over the same 25 year period using advanced treatment with MF/RO. The current secondary effluent quality data presented are based on typical secondary effluent quality expected for a municipal/industrial discharger. Table 12 suggests unit costs are most significant in meeting the PCB, mercury, and PAH required effluent quality.

Table 12. Unit Cost by Contaminant for a 5 mgd Facility Implementing Advanced Treatment using MF/RO

Component	PCBs	Mercury	Arsenic	PAHs
Required HHWQC based Effluent Quality (µg/L)	0.0000064	0.005	0.018	0.0013
Current Secondary Effluent Concentration (µg/L)*	0.002	0.025	7.5	0.006
Total Mass Removed (lbs) over 25-year Period	0.76	7.6	2,800	1.8
Unit Cost (NPV per total mass removed in pounds over 25 years)	$290,000,000	$29,000,000	$77,000	$120,000,000

*Derived from data presented in Table 3.
**Based on assumed 25-year NPV of $219,000,000 (average of the range presented in Table 10) and advanced treatment using MF/RO.
NPV=net present value
HHWQC=human health-based water quality criteria
µg/l=micrograms per liter

4.9 Sensitivity Analysis

The ability of dischargers to meet a HHWQC one order of magnitude less stringent (than HHWQC presented in Table 3 and used in this report) was considered. The same advanced treatment technologies using MF/RO or MF/GAC would still be applied to meet revised effluent quality one order-of-magnitude less stringent despite still not being able to meet less stringent effluent limits. As a result, this less stringent effluent quality would not impact costs. Based on available data, it appears the mercury and BAP limits would be met at a less stringent HHWQC. PCB effluent quality could potentially be met if advanced treatment with RO or GAC performed at the upper range of their projected treatment efficiency. It does not appear the less stringent arsenic HHWQC would be met with advanced treatment. It is important to note that a discharger's ability to meet these less stringent limits depends on existing secondary effluent characteristics and is facility specific. Facilities with higher secondary effluent constituent concentrations will have greater difficulty meeting HHWQC.

5.0 Summary and Conclusions

This study evaluated treatment technologies potentially capable of meeting revised effluent discharge limits associated with revised HHWQC. HDR completed a literature review of potential technologies and engineering review of their capabilities to evaluate and screen treatment methods for meeting revised effluent limits for four constituents of concern: arsenic, BAP, mercury, and PCBs. HDR selected two alternatives to compare against a baseline, including enhanced secondary treatment, enhanced secondary treatment with MF/RO, and enhanced secondary treatment with MF/GAC. HDR developed capital costs, operating costs, and a NPV for each alternative, including the incremental cost to implement from an existing secondary treatment facility.

The following conclusions can be made from this study.

- Revised HHWQC based on state of Oregon HHWQC (2001) and EPA "National Recommended Water Quality Criteria" will result in very low water quality criteria for toxic constituents.
- There are limited "proven" technologies available for dischargers to meet required effluent quality limits that would be derived from revised HHWQC.
    - Current secondary wastewater treatment facilities provide high degrees of removal for toxic constituents; however, they will not be capable of compliance with water quality-based NPDES permit effluent limits derived from revised HHWQC.
    - Advanced treatment technologies have been investigated and candidate process trains have been conceptualized for toxics removal.
        - Advanced wastewater treatment technologies may enhance toxics removal rates, however they will not be capable of compliance with HHWQC based effluent limits for PCBs. The lowest levels achieved based on the literature review were between <0.00001 and 0.00004 µg/L, as compared to a HHWQC of 0.0000064 µg/L.
        - Based on very limited performance data for arsenic and mercury from advanced treatment information available in the technical literature, compliance with revised criteria may or may not be possible, depending upon site specific circumstances.
            - Compliance with a HHWQC for arsenic of 0.018 µg/L appears unlikely. Most treatment technology performance information available in the literature is based on drinking water treatment applications targeting a much higher SDWA MCL of 10 µg/L.
            - Compliance with a HHWQC for mercury of 0.005 µg/L appears to be potentially attainable on an average basis but perhaps not if effluent limits are structured on a maximum monthly, weekly or daily basis. Some secondary treatment facilities attain average effluent mercury levels of 0.009 to 0.066 µg/L. Some treatment facilities with effluent filters attain average effluent mercury levels of 0.002 to 0.010 µg/L. Additional advanced treatment processes are expected to enhance these removal rates, but little mercury performance data is available for a definitive assessment.
        - Little information is available to assess the potential for advanced technologies to comply with revised benzo(a)pyrene criteria. A municipal wastewater treatment plant study reported both influent and effluent BAP concentrations less than the HHWQC of 0.0013 ug/L (Ecology, 2010).

  - Some technologies may be effective at treating identified constituents of concern to meet revised limits while others may not. It is therefore even more challenging to identify a technology that can meet all constituent limits simultaneously.
  - A HHWQC that is one order-of-magnitude less stringent could likely be met for mercury and PAHs however it appears PCB and arsenic limits would not be met.
- Advanced treatment processes incur significant capital and operating costs.
  - Advanced treatment process to remove additional arsenic, benzo(a)pyrene, mercury, and PCBs would combine enhancements to secondary treatment with microfiltration membranes, reverse osmosis, and granular activated carbon and increase the estimated capital cost of treatment from $17 to $29 in dollars per gallon per day of capacity (based on a 5.0 mgd facility).
  - The annual operation and maintenance costs for the advanced treatment process train will be substantially higher (approximately $5 million - $15 million increase for a 5.0 mgd capacity facility) than the current secondary treatment level.
- Implementation of additional treatment will result in additional collateral impacts.
  - High energy consumption.
  - Increased greenhouse gas emissions.
  - Increase in solids production from chemical addition to the primaries. Additionally, the membrane and GAC facilities will capture more solids that require handling.
  - Increased physical space requirements at treatment plant sites for advanced treatment facilities and residuals management including reverse osmosis reject brine processing.
- It appears advanced treatment technology alone cannot meet all revised water quality limits and implementation tools are necessary for discharger compliance.
  - Implementation flexibility will be necessary to reconcile the difference between the capabilities of treatment processes and the potential for HHWQC driven water quality based effluent limits to be lower than attainable with technology

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7.0 Appendices

- Appendix A - Unit Process Sizing Criteria
- Appendix B - Greenhouse Gas Emissions Calculation Assumptions

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APPENDIX A - UNIT PROCESS SIZING CRITERIA

Table A-1. Unit Processes Sizing Criteria for Each Alternative

Unit Process	Units	Baseline Treatment	Advanced Treatment	Comment
Influent Pumping Station	unitless	3 Times Ave Flow	3 Times Ave Flow	This is peaking factor used to size the pumps (peak flow:average flow)
Alum Dose for CEPT (optional)	mg/L	20	20	This is the metal salt upstream of the primaries
Primary Clarifiers	gpd/sf	1000	1000	This is for average annual flows
Primary Solids Pumping Station	unitless	1.25 Times Ave Flow	1.25 Times Ave Flow	This is peaking factor used to size the pumps (maximum month flow:average flow)
Aeration System Oxygen Uptake Rate (OUR)	mg/L/hr	25	25	Average annual OUR is used in tandem with mixed liquor to determine the required aeration basin volume (the limiting parameter governs the activated sludge basin volume)
Aeration Basin Mixed Liquor	mg/L	1250	2500	Average annual mixed liquor is used in tandem with OUR (see next row) to determine the required aeration basin volume (the limiting parameter governs the activated sludge basin volume)
Secondary Clarifiers Hydraulic Loading	gpd/sf	650	--	Only use for Baseline as clarifiers governed hydraulically with short SRT (<2 days)
Secondary Clarifiers Solids Loading	lb/d/sf	--	24	Only use for Advanced Treatment as clarifiers governed by solids with long SRT (>8 days)
Return Activated Sludge (RAS) Pumping Station	unitless	1.25 Times Ave Flow	1.25 Times Ave Flow	RAS must have capacity to meet 100% influent max month Flow. The influent flow is multiplied by this peaking factor to determine RAS pumping station capacity.
Waste Activated Sludge (WAS) Pumping Station	gpm	1.25 Times Ave Flow	1.25 Times Ave Flow	WAS must have capacity to meet max month WAS flows. The average annual WAS flow is multiplied by this peaking factor to determine WAS pumping station capacity.
Microfiltration (MF) Flux	gfd	--	25	Based on average annual pilot experience in Coeur D'Alene, ID
MF Backwash Storage Tank	unitless	--	1.25	Storage tanks must have capacity to meet maximum month MF backwash flows. The average annual MF backwash volume is multiplied by this peaking factor to determine required volume.

Table A-1. Unit Processes Sizing Criteria for Each Alternative

Unit Process	Units	Baseline Treatment	Advanced Treatment	Comment
MF Backwash Pumps	unitless	--	1.25	Backwash pumps must have capacity to meet maximum month MF backwash flows. The average annual MF backwash flow is multiplied by this peaking factor to determine required flows.
Reverse Osmosis (RO)	gallon per square foot per day (gfd)	--	10	
RO Reject	%	--	20	This represents the percentage of feed flow that is rejected as brine
Chlorination Dose	mg/L	15	15	
Chlorination Storage Capacity	days	14	14	
Chlorine Contact Tank	min	30	30	This is for average annual conditions.
Dechlorination Dose	mg/L	15	15	
Dechlorination Storage Capacity	days	14	14	
Gravity Belt Thickener	gpm/m	200	200	This is for maximum month conditions using the 1.25 peaking factor from average annual to maximum month
Anaerobic Digestion	Hydraulic residenc e time (HRT)	18	18	This is for average annual conditions
Dewatering Centrifuge	gpm	120	120	This is for maximum month conditions using the 1.25 peaking factor from average annual to maximum month

gpd=gallons per day; sf=square feet; gpm=gallons per minute

Appendix B – Greenhouse Gas Emissions Calculation Assumptions

The steady state mass balance results were used to calculate GHG emissions. The assumptions used to convert between energy demand, chemical demand and production, as well as biologically-mediated gases (i.e., CH4 and N2O) and GHG emissions are provided in Table B-1. The assumptions are based on EPA (2007) values for energy production, an adaptation of the database provided in Ahn et al. (2010) for N2O emissions contribution, Intergovernmental Panel on Climate Change (IPCC) (2006) for fugitive CH4 emissions, and various resources for chemical production and hauling from production to the wastewater treatment plant (WWTP). Additionally, the biogas produced during anaerobic digestion that is used as a fuel source is converted to energy with MOP8 (2009) recommended waste-to-energy values.

Table B-1. Greenhouse Gas Emissions Assumptions

Parameters	Units	Value	Source
N_2O to CO_2 Conversion	lb CO_2/lb N_2O	296	IPCC, 2006
CH_4 to CO_2 Conversion	lb CO_2/lb CH_4	23	IPCC, 2006
Energy Production			
CO_2	lb CO_2/MWh	1,329	USEPA (2007)
N_2O	lb N_2O/GWh	20.6	USEPA (2007)
CH_4	lb CO_2/GWh	27.3	USEPA (2007)
Sum Energy Production	lb CO_2/MWh	1336	USEPA (2007)
GHGs per BTU Natural Gas			
CO_2	lb CO_2/MMBTU Natural Gas	52.9	CA Climate Action Registry Reporting Tool
N_2O	lb N_2O/MMBTU Natural Gas	0.0001	CA Climate Action Registry Reporting Tool
CH_4	lb CO_2/MMBTU Natural Gas	0.0059	CA Climate Action Registry Reporting Tool
Sum Natural Gas		53.1	CA Climate Action Registry Reporting Tool
Non-BNR N_2O Emissions	g N_2O/PE/yr	32	Ahn et al. (2010)
BNR N_2O Emissions	g N_2O/PE/yr	30	Ahn et al. (2010)
Biogas Purity	% Methane	65	WEF, 2009
Biogas to Energy	BTU/cf CH4	550	WEF, 2009
Digester Gas to Electrical Energy Transfer Efficiency	%	32	HDR Data

Table B-1. Greenhouse Gas Emissions Assumptions

Parameters	Units	Value	Source
Chemical Production			
Alum	lb CO_2/lb Alum	0.28	SimaPro 6.0 - BUWAL250, Eco-indicator 95
Polymer	lb CO_2/lb Polymer	1.18	Owen (1982)
Sodium Hypochlorite	lb CO_2/lb Sodium Hypochlorite	1.07	Owen (1982)
Building Energy Efficiency	kBTU/sf/yr	60	Calif. Commercial End-Use Survey (2006)
Hauling Distance		-	
Local	miles	100	-
Hauling Emissions			
Fuel Efficiency	miles per gallon	8	
CO_2	kg CO_2/gal diesel	10.2	CA Climate Action Registry Reporting Tool
N_2O	kg N_2O/gal diesel	0.0001	CA Climate Action Registry Reporting Tool
CH_4	kg CH_4/gal diesel	0.003	CA Climate Action Registry Reporting Tool
Sum Hauling Fuel	kg CO_2/gal diesel	10.2	CA Climate Action Registry Reporting Tool

GWh = Giga Watt Hours
MWh = Mega Watt Hours
MMBTU = Million British Thermal Units
BTU = British Thermal Unit
PE = Population Equivalents
kBTU/sf/yr = 1,000 British Thermal Units per Square Foot per Year
cf = cubic feet
lb = pound
kg = kilogram
gal = gallon

ATTACHMENT G

ADAMS BROADWELL JOSEPH & CARDOZO
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May 21, 2015

Via U.S. Mail and Electronic Mail

Andrew Barnsdale
California Public Utilities Commission
c/o Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, CA 94108
Email: mpwsp-eir@esassoc.com

Re: **Request for *Immediate Access* to Documents Referenced or Relied Upon in the Draft Environmental Impact Report for the Monterey Peninsula Water Supply Project**

Dear Mr. Barnsdale:

We are writing on behalf of California Unions for Reliable Energy ("CURE") to request ***immediate access*** to any and all documents referenced or relied upon in the Draft Environmental Impact Review ("DEIR") prepared for the Monterey Peninsula Water Supply Project. This request *excludes* a copy of the DEIR and Appendices as posted on the CPUC website.[1]

Our request for all documents referenced or relied upon in the DEIR is made pursuant to the California Environmental Quality Act ("CEQA"), which requires that all documents referenced in an environmental review document be made available to the public for the entire comment period.[2] This request is also made pursuant to Article I, section 3(b) of the California Constitution, which provides a Constitutional right of access to information concerning the conduct of government. Article I, section 3(b) provides that any statutory right to information shall be broadly construed to provide the greatest access to government information and further requires that any statute that limits the right of access to information shall be narrowly construed.

[1] http://www.cpuc.ca.gov/Environment/info/esa/mpwsp/deir_toc.html (accessed May 21, 2015).
[2] *See* Pub. Resources Code, § 21092, subd. (b)(1); 14 Cal. Code Reg. § 150, subd. (c)(5).

We will pay for any direct costs of duplication associated with filling this request up to $200. However, please contact me at (650) 589-1660 with a cost estimate before copying/scanning the materials. If any of the requested items are available on the Internet, we request the CPUC direct us to the appropriate electronic link(s) for accessing the documents.

Pursuant to Government Code section 6253.9, if the requested documents are in electronic format and are 10 MB or less (or can be easily broken into chunks of 10 MB or less), please email them as attachments.

Thank you for your assistance with this matter.

Sincerely,

Laura E. Horton

LEH:clv

ADAMS BROADWELL JOSEPH & CARDOZO
A PROFESSIONAL CORPORATION

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June 25, 2015

Via U.S. Mail and Electronic Mail

Andrew Barnsdale
California Public Utilities Commission
c/o Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, CA 94108
Email: bca@cpuc.ca.gov
mpwsp-eir@esassoc.com

CC Email only:

Eric Zigas, EZigas@esassoc.com
Jonathan Koltz, Jonathan.Koltz@cpuc.ca.gov
Sarah Thomas, sarah.thomas@cpuc.ca.gov
Anna Shimko, ashimko@bwslaw.com
Kelly White, KWhite@esassoc.com

Re: California Public Records Act Request – CalAm Monterey Peninsula Water Supply Project

Dear Mr. Barnsdale, Mr. Zigas, Mr. Koltz, Ms. Thomas, Ms. Shimko and Ms. White:

We are writing on behalf of the California Unions for Reliable Energy to request a copy of the unlocked Excel spreadsheet(s) that support the emission calculations in Appendix G of the DEIR ("Document") for the CalAm Monterey Peninsula Water Supply Project.[1] On May 21, 2015, we previously requested immediate access to any and all documents referenced or relied upon in the DEIR, pursuant to CEQA. On June 17, we followed up on our May 21 letter requesting the Document. However, the CPUC and its consultants informed us that they would not release the Document(s) because they do not believe CEQA requires them to do so. Although we believe CEQA does require release of the Document, this letter

[1] http://www.cpuc.ca.gov/Environment/info/esa/mpwsp/index.html.

serves to clarify that we also seek the Document pursuant to the California Public Records Act. (Government Code §§ 6250, et seq.)

This request is also made pursuant to Article I, section 3(b) of the California Constitution, which provides a Constitutional right of access to information concerning the conduct of government. Article I, section 3(b) provides that any statutory right to information shall be broadly construed to provide the greatest access to government information and further requires that any statute that limits the right of access to information shall be narrowly construed.

Pursuant to Government Code Section 6253.9, if the requested documents are in electronic format and are 10 MB or less (or can be easily broken into sections of 10 MB or less), please email them to me as attachments.

Please call me at the contact information listed above if you have any questions. Thank you for your assistance with this matter.

Sincerely,

Laura E. Horton

LEH:clv

ATTACHMENT H

Monterey Regional Water Pollution Control Agency

"Dedicated to meeting the wastewater and reclamation needs of our member agencies, while protecting the environment."

Administration Office:
5 Harris Court, Bldg. D, Monterey, CA 93940-5756
(831) 372-3367 or 422-1001, FAX: (831) 372-6178
Website: www.mrwpca.org

June 17, 2014

Emily Creel
Environmental Planner
SWCA Environmental Consultants
1422 Monterey Street, C200
San Luis Obispo, CA 93401

RE: City of Marina Slant Test Well Project Notice of Intent to Adopt a Mitigated Negative Declaration

Dear Emily,

You sent a Notice of Intent to adopt a Mitigated Negative Declaration regarding the California American Water Slant Test Well Project to me at MRWPCA. The review period ends today, June 17, 2014, and we would like to provide comments. **MRWPCA-1**

MRWPCA is supportive of the project. Within the Mitigated Negative Declaration (MND) we have identified two issues we would like to comment on:

1) On page 28 of the MND, MRWPCA should be added to the list of Responsible Agencies which have discretionary approval power over the project. As the project proposes to use the Ocean Outfall owned and operated by the MRWPCA we feel it is important to be included in this list, and
2) On pages 142 – 145 concerns previously identified by MRWPCA staff are recognized and appreciated. However the issue raised of the potential need for mechanical screening of sand prior to discharge into the Outfall was not addressed in the **Response to XVII(b)**. If mechanical screening is needed prior to discharge into the Agency Outfall this potential should be recognized. **MRWPCA-2**

In addition, MRWPCA would like to reiterate that if the temporary well does not become permanent, that it would be abandoned in place. Removal of the **MRWPCA-3**

Joint Powers Authority Member Entities:
Boronda County Sanitation District, Castroville Community Services District, County of Monterey, Del Rey Oaks, Fort Ord, Marina Coast Water District, Monterey, Moss Landing County Sanitation District, Pacific Grove, Salinas, Sand City, and Seaside.

temporary well could adversely affect the Land and Ocean Outfalls more than construction. **MRWPCA-3 (continued)**

Overall the MRWPCA has no objection to the City preparing a mitigated negative declaration in connection with California American Water's application for a test well in connection with its proposed desalination facility. **MRWPCA-4**

Sincerely,

Garrett Haertel
Compliance Engineer

1.1.6 Response to Letter from Monterey Regional Water Pollution Control Agency

Comment No.	Response
MRWPCA-1	This comment indicates MRWPCA's support of the project and states that MRWPCA should be included in the list of responsible agencies who have discretionary approval over the project. The comment correctly identifies MRWPCA as a responsible agency due to the proposed connection to and use of the MRWPCA outfall. This is indicated on pages 27 and 28 of the MND.
MRWPCA-2	This comment identifies the potential need for mechanical screening of sand prior to discharge into the outfall. This concern was addressed in Response to XVII(b), on page 144 of the MND. Under the bullet point discussing "Sand", it is recognized that MRWPCA has requested mechanical screening to prevent sand from entering the junction structure or outfall pipe. Cal Am has confirmed that mechanical screening and/or other engineered solutions (such as an inline strainer) would be feasible, as necessary to eliminate the potential for sand to enter the junction structure and/or outfall. This issue will be addressed through the agreement between MRWPCA and Cal Am required by mitigation measure UTIL/mm-1.
MRWPCA-3	This comment reiterates MRWPCA's preference that if the well is not converted to a permanent well for use in the permanent MPWSP, that it be abandoned in place. The MND recognizes this request in the Response to XVII(b), at page 143 of the MND. As currently proposed, in the event the slant test well is not converted into a permanent well, it would be decommissioned pursuant to the requirements of California Well Standards Bulletin 74-81 and 74-90, which require removal to a depth of 5 feet below ground surface. In addition, the MND identified the potential for future re-surfacing of well casing as a result of coastal shoreline erosion, and therefore, recommended removal of the well casing to a depth of 40 feet below ground surface to eliminate the possibility for future exposure. The City and Cal Am are receptive to MRWPCA's concerns that removal of the well could adversely affect the outfall. If removal of the well to the total depth of 40 feet below ground surface upon project completion proves to be infeasible and Cal Am and MRWPCA cannot agree on a feasible and safe method of removing the well to the required depth at the time of project decommissioning, then implementation of HYD/mm-3 and removal of the well casing to a depth of 40 feet below ground surface could be achieved through mutually agreed upon measures, including for example, removal to a safe depth at the time of decommissioning (no less than 5 feet as required by Bulletin 74-81 and 74-90) and future removal to the total depth of 40 feet at a later date. Because the MRWPCA outfall sits at a higher elevation than the slant test well would, it would be subject to exposure as a result of coastal erosion before the slant test well. Removal of the well could be timed to take place as necessary to protect MRWPCA facilities and eliminate the potential for surfacing of the well components. HYD/mm-3 has been modified as follows to clarify this potential: *HYD/mm-3: The slant test well and wellhead vault shall be sited to avoid areas identified in the coastal erosion memorandum prepared by ESA-PWA (March 2014) as subject to coastal erosion during the duration of the project. The alternative slant test well location shall avoid all identified sensitive plant species and shall be limited to the graded area of the CEMEX access road to the maximum extent feasible. The slant test well location shall not encroach north of the graded roadway in closer proximity to the CEMEX settling ponds or Canal Flume. At project*

Comment No.	Response
	decommissioning, the slant test well and all related infrastructure shall be removed to a depth of no less than 40 feet below ground surface to eliminate the possibility for future re-surfacing and exposure of submerged well casing or related project components as a result of coastal erosion and shoreline retreat. Removal of the well would take place upon completion of the test pumping and/or in segments over time as mutually agreed upon by the City, MRWPCA, Cal Am, the California State Lands Commission, and other identified regulatory agencies. If removal to the total required depth of 40 feet below ground surface is not completed within 5 years following completion of the test pumping, the applicant shall post a bond with the City to ensure future removal measures would be appropriately supported and timed to prevent any future resurfacing of the well casing or other project components.
MRWPCA-4	This comment states that MRWPCA has no objection to the City preparing an MND for the proposed slant test well. No response is necessary.

ATTACHMENT I

NOTICE OF PREPARATION

Environmental Impact Report for People's Moss Landing Water Desalination Project

Introduction

In accordance with the provisions of the California Environmental Quality Act (CEQA) and the CEQA Guidelines, the Moss Landing Harbor District (District), as CEQA Lead Agency, is preparing an Environmental Impact Report (EIR) for the People's Moss Landing Water Desalination Project (PMLWDP or Proposed Project). The PMLWDP is proposed by the Moss Landing Green Commercial Park, LLC (MLGCP). It is comprised of various facilities and improvements, including: an approximately 12 million gallons per day (mgd) desalination plant; seawater intake and outfall systems; and desalinated water pipeline and storage facilities.

This Notice provides information on the public scoping period that is now underway. It also describes the location of the Proposed Project, its goals and objectives, and its potential environmental effects. This Notice is organized as follows:

A. Scoping Comments

The District is soliciting comments on the scope of environmental issues to be addressed in the Draft EIR, as well as reasonable alternatives and mitigation measures that should be explored in the Draft EIR. Comments received during the EIR scoping period will be considered during preparation of the PMLWDP EIR. Public agencies and interested organizations and persons will have an opportunity to comment on the Draft EIR after it is published and circulated for public review.

Written scoping comments may be submitted by U.S. mail or email during the NOP review period, or in person at the scoping meetings listed below. **The scoping comment period closes at 5:00 p.m. on July 31, 2015**. Please include your name, address, and email address if you would like to receive future notices on this matter. Comments may be sent by email to PeoplesDesal@aspeneg.com or to the address below:

Linda G. McIntyre, Moss Landing Harbor District
c/o Aspen Environmental Group
235 Montgomery Street, Suite 935
San Francisco, CA 94104

B. Scoping Meetings

In order to ensure that the public and regulatory agencies have an opportunity to ask questions and submit comments on the scope of the EIR, two scoping meetings will be held during the NOP review period. The scoping meetings will start with a brief presentation providing an overview of the Proposed Project and the project alternatives identified to date. Subsequent to the presentation, interested parties may make oral comments on issues to be considered in the EIR, or on alternatives or mitigation measures that may apply. Participants are encouraged to submit written comments, and comment forms will be supplied at the scoping meetings. Written comments may also be submitted anytime during the NOP scoping period to the mailing address or email address listed above. The locations and dates of the scoping meetings are as follows:

2:00 pm Wednesday, July 8, 2015
Moose Family Center
555 Canyon Del Rey Blvd.
Del Rey Oaks, CA 93940

6:00 pm Wednesday, July 8, 2015
Prunedale Grange Hall
17890 Moro Rd
Prunedale, CA 93907

C. CEQA Lead Agency: Moss Landing Harbor District

The Moss Landing Harbor District was formed on June 22, 1943 for the purpose of developing a harbor at Moss Landing pursuant to the Federal Harbors and Navigation Code. The District is managed by the Board of Harbor Commissioners (BOHC), which is dedicated to the efficient management of the Harbor and to the preservation of natural resources within the Harbor. The BOHC is fully empowered to receive and administer funds for the attainment of these objectives, all in accordance with Federal, State and local laws. The District's powers are set forth in Sections 6070-6086 of the California Harbors and Navigation Code. The District has a duty and obligation to promote good harbor management including the development, maintenance and improvement of the Harbor and related facilities as well as the protection of the Harbor's natural environment.

The proposed site of the PMLWDP is within the Moss Landing Green Commercial Park (formerly the Kaiser National Refractories & Minerals Plant); the commercial park facilities are located within the Harbor boundaries and on adjacent lands surrounding the Harbor. The District will be required to approve and issue permits for project related construction performed within the District's jurisdiction. As a result, the District has an interest in the future development, uses, and operations of the Moss Landing Green Commercial Park as it pertains to the harbor. Therefore, the District has agreed to become the CEQA Lead Agency for the PMLWDP. The District's goal is to help facilitate the environmental analysis of a project that will provide the Monterey Peninsula area with a safe and reliable water supply as well as to continue to protect the interests of the Moss Landing Harbor.

D. Goals and Objectives for the People's Moss Landing Desalination Project

The goals and objectives of the Proposed Project are to rehabilitate existing facilities at the Moss Landing Green Commercial Park to develop a desalination project that would provide portions of the Monterey County area with a safe and reliable desalinated water supply of approximately 12 mgd. Specifically, the purpose of this Proposed Project is to provide desalinated water to both the North Monterey County Area and the Monterey Peninsula Area as described below.

- **North Monterey County Area**: The Proposed Project will provide 3,652 afy (3.3 mgd) of "new water" to customers in North Monterey County, including 152 afy (135,000 gallons per day [gpd]) for Moss Landing, 800 afy (714,000 gpd) for the Pajaro Sunny Mesa Water District, 1,000 afy (892,200 gpd) for the Pajaro Valley Water Management Agency and/or the City of Watsonville, as well as 1,700 afy (1.5 mgd) for the Granite Ridge area near Prunedale. These demands have not yet been fully verified, but there has been strong interest for the Proposed Project to serve demands in the North Monterey County Area. Through the EIR process these demands will be evaluated in order that the Proposed Project can serve these potential North County demands.
- **Monterey Peninsula Area**: The Proposed Project will also help to offset the mandated water supply diversion curtailments on the Carmel River and Seaside Basin. Specifically, the purpose of this Project

is to provide the Monterey Peninsula area with 9,752 afy (8.7 mgd). This amount would replace the water needs of the Monterey Peninsula area minus the 3,652 afy that has been identified for the General Plan Build-out needs (the remaining 3652 afy would serve North County demand as described above). The EIR will describe these demands and show the need for the Proposed Project to offset the mandated water supply diversion curtailments on the Carmel River and Seaside Basin.

E. Description of Proposed Project

The PMLWDP is a proposed reverse osmosis desalination plant at the Moss Landing Green Commercial Park. It would produce approximately 12 million gallons per day (mgd) (13,400 afy) of potable water. As described above, about 27% of the water would be provided to North County and 73% would be provided for the Monterey Peninsula, to offset CalAm's mandated water supply diversion curtailments on the Carmel River and Seaside Basin.

E.1 Project Location and Background

The Project would be located at the site of the former Kaiser Refractories Plant at Moss Landing, on a 16–acre portion of the approximately 200-acre site. It would occupy a portion of the Moss Landing Green Commercial Park located in Moss Landing, California at the corner of State Route 1 (SR-1 or Highway 1) and Dolan Road, immediately east of Moss Landing Harbor and south of the existing Moss Landing Power Plant. Figure 1 illustrates the location of the desalination facility and the proposed intake and outfall locations (figures are presented at the end of this notice).

E.2 Project Components

The proposed PMLWDP would provide water to the North Monterey County area, as well as replacement water supplies to meet existing and future growth demands for the approximately 40,000 customers in CalAm's Monterey Peninsula District. Following is an overview of each of the major components of the facility.

Desalination Plant

The desalination plant and appurtenant facilities would be located on approximately 16 acres within the approximately 200-acre Moss Landing Green Commercial Park. Facilities proposed at the PMLWDP desalination plant include pretreatment, reverse osmosis, and post-treatment systems; chemical feed and storage facilities; a brine storage basin; and an administrative building. Facilities would include seawater receiving tanks; pretreatment facilities, reverse osmosis facilities, and post-treatment systems; chemical feed and storage facilities; and associated non-process facilities.

Seawater Intake

The proposed open bay seawater collector system would draw seawater from the Monterey Bay for use as source water for the proposed desalination plant. Approximately 28 to 30 mgd of source water would be needed to produce approximately 12 mgd of desalinated product water.

The proposed intake for the open bay system would use an existing 20-foot diameter intake pump caisson structure that is located on the beach and adjacent to the Moss Landing Marine Laboratories. The existing intake caisson was originally built in the 1940's and used as an open intake facility and pump house; it was replaced by the existing harbor intake system in the 1970's.

The existing open bay intake structure would be rehabilitated to include a new 30-inch intake pipe that would extend out from the existing caisson approximately 50-feet in the open water/bay. The previous intake pipeline was removed and does not currently exist. Three (3) wedge wire passive screens (two active and one standby) would be attached at the end of this new pipeline extension and would be located approximately 15 feet below mean sea level (msl). The general screen design is illustrated in Figure 2 (at the end of this Notice). Each passive screen structure would be 48-inches in diameter and would be used to draw seawater into the existing caisson. The screens would be designed for a maximum through-screen velocity of 0.5 feet per second and with 0.5 millimeter (mm) wedge wire slots to minimize impingement and entrainment.

A new pump house would be built on top of the existing intake structure at a height of approximately 15 feet above msl so that that the pumps would be outside of the tsunami zone of inundation. Vertical turbine pumps would be utilized with pumps submerged in the intake structure and motors in the pump house above. A new 30-inch pipeline would be slip-lined within the existing 36-inch intake pipeline to convey the seawater to the PMLWDP desalination plant at the Moss Landing Green Commercial Park.

Ocean Outfall Facility

Brine produced during the desalination process would be conveyed back to the Bay through the existing approximately 2,700-foot long 51-inch ocean outfall pipe that would be rehabilitated with new diffusers prior to discharging to the Monterey Bay. The outfall would convey concentrate or brine from the reverse osmosis process to the Monterey Bay at a rate of approximately 17.5 mgd and at a salinity concentration of approximately 62,000 milligrams/liter (mg/L), which is approximately 1.8 times the ambient salinity of the Monterey Bay (i.e., approximately 34,000 mg/L)

Pipeline Conveyance and Storage Facilities

The pipeline and storage facilities are illustrated schematically in Figure 3. While not entirely shown due the scale of the map, the Peninsula Product Water Pipeline would terminate in Seaside, CA as described below.

North County Product Water Transmission Pipelines. The 3,652 afy (3.3 mgd) of North County product water transmission pipelines would consist of the following 5 systems:

- **Moss Landing Pipeline System**: Running along Dolan Road, Highway 1, Moss Landing Road, and Sandholt Road, this system would provide about 135,000 gallons per day (gpd) of product water.
- **Pajaro Sunny Mesa Pipeline System**: Running along Dolan Road to its intersection with Elkhorn Road, this system would provide approximately 714,000 gpd.
- **Watsonville Pipeline System**: Running along Dolan Road to Elkhorn Road towards the City of Watsonville, terminating at a new 2 million gallon storage tank near where County Road 612 and Main Street merge.
- **Granite Ridge Pipeline System**: Running along Dolan Road to Castroville Boulevard, terminating at a new 2.0 million gallon storage tank providing approximately 1.5 mgd.

Peninsula Product Water Transmission Pipeline. Approximately 13,400 afy (8.7 mgd) of desalinated product water would be conveyed south via a proposed 17.5-mile pipeline (see Figure 3). The water would be stored in a new 5-million gallon storage tank to serve existing CalAm customers in the Monterey Peninsula. Generally, the proposed 17.5-mile pipeline system would follow public rights-of-way (ROWs), existing railroad easements, and agricultural roads. The two main segments are described below.

- **Transmission Main North Pipeline Alignment Segment.** The pipeline would run along Dolan Road to Union Pacific Railroad (UPRR) ROW, then along Salinas Street in Castroville, crossing under Merritt Street and into Highway 156. It would continue southwest along Highway 156 and Nashua Road to the

Transportation Agency of Monterey County (TAMC) railroad ROW, ending at the intersection of the TAMC ROW and Reservation Road in North Marina.

- **Transmission Main South Pipeline Alignment Segment.** This segment would convey water from Transmission Main North to the proposed Monterey Pipeline and the Terminal Reservoir using approximately 8 miles of pipeline. This alignment would run along LaSalle Avenue, Yosemite Street, and Hilby Avenue to Terminal Reservoir in Seaside.
- **Peninsula Terminal Reservoir.** The proposed Peninsula Terminal Reservoir would be located east of General Jim Moore Boulevard in an area that was formerly Fort Ord, but is currently proposed to be annexed by the City of Seaside. The Terminal Reservoir would consist of two 5-million gallon tanks for a total capacity of 10 million gallons.

E.3 Project Construction

Construction of the PMLWDP is anticipated to take approximately two years. The construction of each component is described as follows.

Desalination Plant. Construction of the desalination plant would include site preparation, equipment delivery, and building construction. Some excavation and grading would be required for locations with uneven gradient. Ground clearing and excavation of the site would be performed using heavy construction equipment such as bulldozers, backhoes, cranes, and graders. Heavy equipment would be used to construct connections with existing water conveyance systems, and to construct footings of tanks and other support equipment. Upon completion of excavation, construction activities would also include pouring concrete footings for tanks, laying pipeline and making connections, installing support equipment such as control panels, and fencing the perimeter of the site.

Intake Facilities. The existing intake would be rehabilitated to include a new 30-inch intake pipe and three wedge wire passive screens. The screens would be 48-inches in diameter and would draw seawater into the existing caisson. A new pump house would be built on top of the existing intake structure at a height of approximately 15 feet above msl so that that the pumps would be outside of the tsunami zone of inundation. Vertical turbine pumps would be utilized with pumps submerged in the intake structure and motors in the pump house above. A new 30-inch pipeline would be installed ("slip-lined") within the existing 36-inch intake pipeline to convey the seawater to the PMLWDP desalination plant. Construction of the open-bay/ocean intake facility would be completed within approximately 2 years from notice to proceed.

Pipelines for Delivery of Water. Pipelines would be installed using conventional open-trench or trenchless technology. Most of the construction would be open-cut trenching. Pipe sections would be placed in a trench of varying depth depending on pipe size and topography, and covered using conventional equipment such as backhoes, side-boom cranes, wheeled loaders, sheep's-foot excavators, and compactors. Typically, earth cover over the pipe would be 5 feet. Variations in this depth would be required to accommodate local topography, hydraulic grade, and utility congestion, among other factors. The trench width would be mostly 10 to 15 feet. The width of the disturbance corridor for the pipeline construction would, under typical circumstances, vary from 50 to 100 feet, depending on the size of the pipe being installed. Trenchless technologies may require wider corridors at entry and exit pits.

For portions of the alignment where it is not feasible to perform open-cut trenching, trenchless technology methods such as boring and jacking, microtunneling, or horizontal directional drilling may be used. These special construction methods would be used in areas where it is difficult to perform open-cut trenching, such as State highway crossings, stream and drainage crossings, and high utility congestion areas.

Typical pipeline installation rates would be up to 250 linear feet per day. All construction activities would be restricted to the ROW approved by the applicable landowner or agency. All roadways disturbed during pipeline installation would be restored. Generally, trench spoils would be temporarily stockpiled within the construction easement, then backfilled into the trench after pipeline installation.

Some pipeline installation would require construction in existing roadways. Traffic control measures would be implemented as necessary, in coordination with local agencies. Construction staging for the project would depend upon the contractor and subcontractors. Typically, the pipe would be brought to the site just ahead of construction and staged along the alignment ready for placement. Equipment and other construction materials may require sites for storage, staging, and lay-down.

E.4 Operation and Maintenance Procedures

General operation and maintenance (O&M) procedures would be developed for the project's system components, including pipelines, pump stations, and the desalination plant. Examples of typical operation and maintenance procedures are briefly described below.

Pipelines. General O&M procedures for pipelines include weekly, visual inspections of the pipeline alignments; mowing of vegetation within pipeline alignments; grade of access roads as needed; testing and service of valves; annual walk of the pipeline alignment to inspect the cathodic protection system; and periodic pressure-testing of the pipeline, painting of pipeline appurtenances, repairing tunnel entrances, and repairing minor leaks in buried pipeline joints or segments.

Pump Stations. General pump station operation and maintenance procedures would include routine tests of pumps during non-emergency periods and verify operational readiness under anticipated full emergency project head; annually major maintenance and cleanup; and service of the motor cooling system (emergency pumps), replacing pump seals, painting pump station and equipment, and disassembling pump to inspect bearings and impeller (recirculation and emergency pumps) as needed.

Desalination Plant. Operation and maintenance personnel at the desalination plant would continuously monitor the seawater desalination facility, and would be present at the location 365 days a year, 24 hours per day. Their duties would include:

- Monitoring of chemical flows to the various processes, water flows into and out of the various processes, equipment operating parameters (e.g., pressure, temperature, and flow rates), and various other continuous operations; maintain, update and order chemicals and equipment to meet operational requirements;
- Preparing monthly records and reports to comply with requirements of local, state, and Federal agencies; and
- Routinely maintaining equipment in accordance with manufacturers' requirements, and provide equipment maintenance for emergency situations and/or breakdowns.

The accumulation of silts or scale on the RO membranes causes fouling, which reduces membrane performance. When this happens, RO membranes must be cleaned to remove the residues. The cleaning process includes two steps: first, a number of cleaning chemicals are circulated in a predetermined sequence through the membranes; and second, the cleaned membranes are flushed with clean water to remove the waste-cleaning solutions and to prepare the membranes for normal operation.

F. Preliminary Alternatives to the Project

In accordance with CEQA Guidelines Section 15126.6, the EIR will describe a reasonable range of potentially feasible alternatives to the PMLWDP. Alternatives are required to achieve most of the basic objectives of the project while avoiding or substantially lessening any of the significant effects of the project. Potential alternatives to the proposed PMLWDP are briefly described below. This list will be refined, and may be modified, based upon comments received and data gathered as part of the EIR preparation process.

Two categories of alternatives are described here: alternative intake locations for bringing seawater into the PMLWDP (Section E.1), and alternative desalination projects (Section E.2).

F.1 Alternative PMLWDP Intake Locations

The EIR, as consistent with CEQA requirements, will evaluate reasonable alternatives that achieve its goals and objectives and that would avoid or reduce significant effects on the environment. At this time, MLGCP, LLC has identified two potential intake alternatives to the Proposed Project. Each is discussed below.

Alternative A: Harbor Intake

The existing intake pump station in the harbor is located across from the west end of Dolan Road. It was originally constructed in the 1940s to serve the Kaiser Refractories Plant and was upgraded in 1968. The existing intake system currently consists of 9 pumps that are housed in a building and supported on a concrete structure. The system was used to provide up to 60 MGD of seawater for the purpose of removing calcium and magnesium as part of the magnesia production.

Under the Harbor Intake Alternative, the intake structure would be rehabilitated and modified by dredging the harbor and installing walls around the existing platform (to form a wet well) and installing passive screens to reduce the intake velocity to less than 0.5 feet per second. Under this alternative, all existing pumps and motors would be removed and replaced. A new pump and control building would be constructed. The intake structure will also house a screen air burst system to prevent clogging of the screens as well as Electro-Chlorination Unit (ECU) to minimize bio growth in the piping and downstream unit processes. Use of a cofferdam will be necessary for a majority of the underwater construction. Due to the water quality of the source water coming into the harbor, this alternative would require additional pretreatment processes within the desalination plant to achieve the product water quality objectives. The outfall facility would be the same as the Proposed Project.

Alternative B –Subsurface Seawater Intake

This intake alternative would be located at the same abandoned intake as the Proposed Project. However, instead of an open bay or water intake, a subsurface facility would be constructed. This type of facility would reduce and/or eliminate potential significant impacts to marine biological resources due to impingement and entrainment and would be the preferred intake alternative. However, to date, it has not been confirmed that this type of facility would yield the required 28-30 mgd of source water to produce 12 mgd of product water. Additional well tests need to be conducted. Until such credible hydrogeological tests prove that a subsurface facility could yield the required feed water, this alternative, including alternative locations, is not considered to be technically viable at his time and thus it is currently expected to be eliminated from further consideration during the EIR development process.

F.2 Regional Alternatives

MLGCP, LLC has identified other project alternatives to the Proposed Project that may be considered in the EIR. Each is discussed below.

The California American Water Company – Monterey Peninsula Water Supply Project (MPWSP)

The MPWSP would include a 9.6 mgd desalination plant and facility improvements to the existing Seaside Groundwater Basin ASR system to secure water supplies for the approximately 40,000 customers in CalAm's Monterey District service area. The primary purpose of the MPWSP is to replace existing water supplies that have been constrained by legal decisions affecting the Carmel River and Seaside Groundwater Basin water resources. A Draft EIR for the project was recently issued for the project by the California Public Utilities Commission.

The MPWSP would be comprised of a seawater intake system consisting of ten 750-foot-long subsurface slant wells located north of the city of Marina and new pipelines to convey the seawater from the slant wells to the new desalination plant. The project would also include up to 28 miles of desalinated water conveyance pipeline and mains, and associated facilities, and improvements to the existing Seaside Groundwater Basin aquifer storage and recovery system. As an alternative to the 9.6-mgd desalination plant, the analysis considers a 6.4-mgd desalination plant coupled with a water purchase agreement for 3,500 afy of product water from the Monterey Regional Water Pollution Control Agency's proposed Pure Water Monterey Groundwater Replenishment Project.

DeepWater Desal Alternative

DeepWater Desal LLC is proposing the DeepWater Desal Project, a 25-mgd (22,300 afy) seawater reverse osmosis desalination facility and co-located seawater-cooled 150-megawatt computer data center campus located on a 110-acre site approximately 1.5 miles east of Moss Landing in Monterey County, California. The California State Lands Commission issued a Notice of Preparation of an EIR for the project on June 1, 2015.

The Project would also include seawater intake and brine discharge pipelines that would extend west from Moss Landing Harbor to the upper reaches of the submarine Monterey Canyon and the north shelf, respectively, within the Monterey Bay National Marine Sanctuary. The DeepWater Desal Project is potentially considering delivering water south to the Monterey Peninsula communities, south to Castroville and southeast to Salinas, and north to Santa Cruz County.

Conservation or Reduced Size Alternative

The EIR may consider an alternative in which CalAm would implement water reduction efforts and other conservation measures to reduce demand on the existing water supply. The Monterey Peninsula Water Management District currently works with CalAm to provide education and encourage water conservation in an effort to protect water resources in the community. These conservation efforts include: conservation billing rates, limited watering schedule, free water audits, free water-saving devices, rebates on high-efficiency appliances, rebates for low water landscaping, and turf removal. This alternative, which would further expand conservation programs, could set stricter conservation requirements for residential and commercial customers. Under this alternative, CalAm would reduce system water loss via leakage control zones, pressure control, acoustic monitoring, transmission main testing, and main replacement programs. CalAm would use tiered rates to reduce water use. CalAm would also work with customers to promote water-wise landscaping and turf replacement, graywater use, plumbing retrofits, and other best management practices.

It is yet to be determined if the Conservation Alternative would be a project alternative, or if the Conservation Alternative, implemented in conjunction with desalination, would enable the proposed PMLWDP desalination plant to be reduced in size.

G. Environmental Issues to be Addressed in the EIR

This NOP does not include an Initial Study that screens out environmental topics. Instead, the PMLWDP EIR will include an analysis for all topics identified in Appendix G of the CEQA Guidelines. The EIR will address potential impacts associated with project construction, operation, and maintenance activities. The analysis will include, but will not be limited to, the following issues of potential environmental impact:

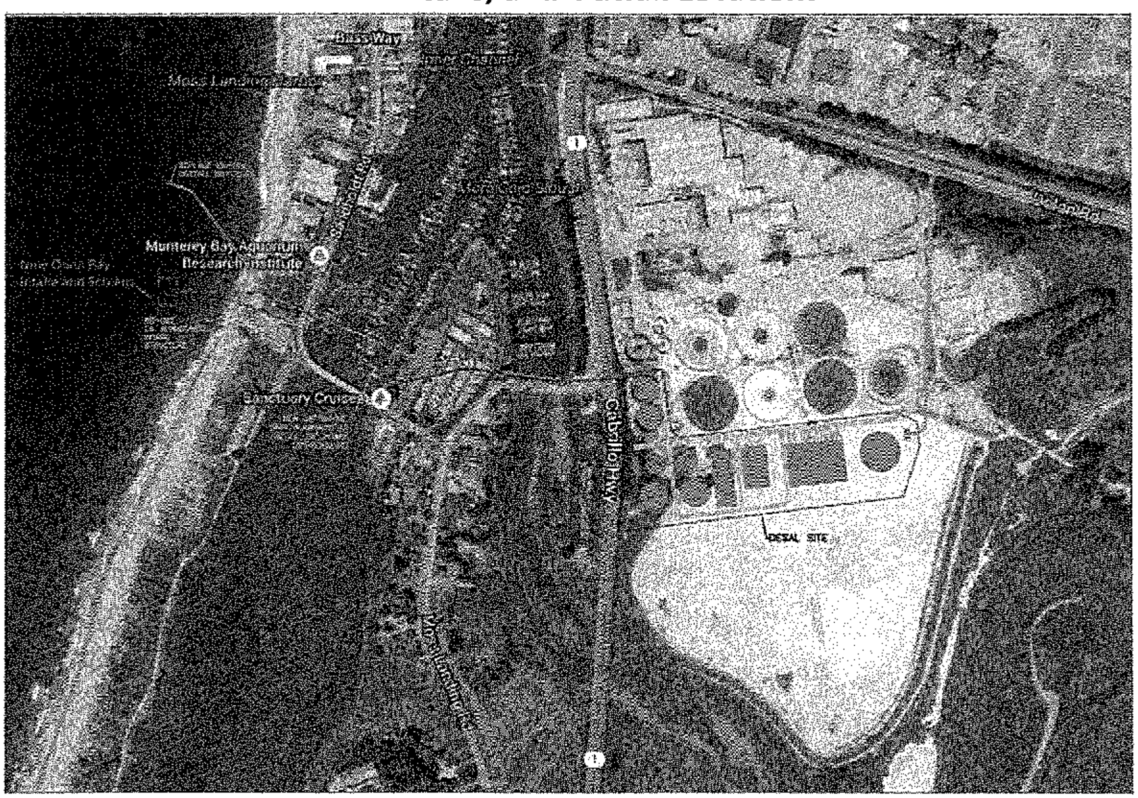
- **Surface Water Hydrology and Water Quality** – Construction and operation of the PMLWDP could increase soil erosion and could adversely affect water quality in receiving waterbodies. Project operations would generate brine that would be discharged to the Monterey Bay. In addition, maintenance and cleaning solutions and other effluents would be discharged to the stormwater system, and sanitary sewers. The EIR will evaluate potential impacts to surface water quality as a result of project construction and operations; changes to existing drainage patterns resulting in increased erosion or runoff; and potential adverse effects of brine discharges on offshore water quality.
- **Groundwater Resources** – The EIR will evaluate potential impacts to groundwater resources. The PMLWDP would not draw on any groundwater resources or existing surface water rights. Therefore, potential impacts to the regional groundwater resources are expected to be beneficial, as there would be less need for groundwater pumping, which could lead to recharge of the local aquifer.
- **Marine and Terrestrial Biological Resources** – Since the PMLWDP is proposing to use an open bay intake system it is anticipated that there will be potential significant impacts to marine and/or terrestrial biological resources, including impingement and entrainment issues. However, the screens will be designed for a maximum through-screen velocity of 0.5 feet per second and 0.5 mm wedge wire slots to help minimize impingement and entrainment of marine aquatic biological resources. Particular attention will be given to potential impacts on marine resources to be evaluated include salinity changes at the ocean outfall from brine discharges and any related effects on benthic and pelagic organisms and environments. In addition, the PMLWDP EIR will evaluate project impacts on terrestrial special-status animal and plant species, sensitive habitats, mature native trees, and migratory birds associated with facility siting and project-related construction activities. The EIR will also evaluate any potential conflicts with applicable plans, policies, and plans related to the protection of marine and/or terrestrial biological resources.
- **Air Quality and Greenhouse Gases** – The EIR will analyze construction-related and operational emissions of criteria air pollutants. Emissions estimates will be evaluated in accordance with all applicable federal, state, and regional ambient air quality standards. Potential human health risks at nearby sensitive receptors from emissions of diesel particulate matter and toxic air contaminants during project construction and operations will be addressed. The EIR will also estimate greenhouse gas (GHG) emissions associated with project construction and operations, and compare these to applicable plans and policies related to reducing GHGs.
- **Mineral and Energy Resources** – The EIR will evaluate potential impacts to mineral resources associated with facility siting and construction. The PMLWDP's energy requirements, particularly the energy needs for desalination, will be evaluated to reflect the proposed plant capacity, specifications, and operations.

- **Geology, Soils, and Seismicity** – The EIR will review site-specific seismic, geologic, and soil conditions and evaluate project-related impacts. The analysis will address the potential for project construction activities to result in increased soil erosion or loss of topsoil, as well as potential slope instability issues associated with facility siting and construction. Particular attention will be given to potential increases in coastal erosion rates resulting from project implementation, as well as damage to facilities in the coastal zone resulting from natural erosion, earthquakes, and tsunamis.
- **Hazards and Hazardous Materials** – The EIR will summarize documented soil and groundwater contamination cases within and around the project area, and evaluate the potential for hazardous materials to be encountered during construction. Inadvertent releases of hazardous construction chemicals, and contaminated soil or groundwater into the environment during construction will be addressed. The analysis will also consider the proper handling, storage, and use of hazardous chemicals that would be used during operations.
- **Noise** – The EIR will evaluate construction-related noise increases and associated effects on ambient noise levels, applicable noise standards, and the potential for indirect impacts to nearby land uses.
- **Transportation and Traffic** – Project construction activities would generate traffic from construction trucks and vehicles, resulting in a temporary increase in traffic volumes along local and regional roadways. The installation of pipelines along or adjacent to road right-of-ways could result in temporary land closures and traffic delays. Potential impacts to vehicular traffic, traffic safety hazards, public transportation, and other alternative means of transportation will be evaluated. Traffic increases associated with project operations will also be addressed.
- **Cultural Resources** – The EIR will evaluate potential impacts on historic, archaeological, and paleontological resources, and human remains. It is anticipated that any potential impacts to cultural resources would be limited to project construction.
- **Land Use** – The EIR will evaluate potential conflicts with established land uses as a result of project construction and operation. Potential conflicts with applicable plans and policies will also be evaluated. Particular attention will be given to consistency with the Coastal Plan.
- **Agricultural Resources** – Agricultural land uses are present within and around the project area. The EIR also evaluate potential impacts to designated farmland and Williamson Act contracts.
- **Utilities and Public Services** – The EIR will evaluate potential conflicts with existing utility lines during project construction, including potential service interruption. Particular attention will be paid to "high-priority" utilities that could pose a risk to workers in the event of an accident during construction. Potential impacts related to landfill capacity associated with the disposal of spoils and debris generated during project construction will be described. Project consistency with federal, state, and local waste diversion goals will also be considered.
- **Aesthetic Resources** – Project facilities would be sited along the coastal zone and immediately adjacent to Highway 1, a designated scenic highway. The project would be on an industrial site within 200 feet of the Moss Landing Harbor and within about 1,500 feet of the Monterey Bay. The EIR will evaluate visual impacts related to the new/proposed facilities.
- **Cumulative Impacts** – The PMLWDP EIR will describe water supply and demand in the CalAm service Peninsula Area and the North Monterey County areas identified for water service under this proposed project. The EIR will evaluate the relationship of the proposed project (including facility sizing and capacities) to meet such water supply demands, including meeting the build-out demands identified in each of the six cities' of the Peninsula Area, and the Monterey County General Plans, and the specific needs of the North Monterey County Area. The potential for implementation of the PMLWDP to result in growth-inducing effects will be evaluated.

- **Growth Inducement** - The PMLWDP EIR will describe water supply and demand in the CalAm service area and the relationship of the proposed project (including facility sizing and capacities) to meet such supply and demand, including meeting the build-out demands identified in each of the six cities' and the Monterey County General Plans. The potential for implementation of the PMLWDP to result in growth-inducing effects will be evaluated.
- **NEPA Considerations.** A CEQA discretionary project is also subject to the National Environmental Policy Act (NEPA) if it (a) involves federal funding; (b) occurs on federal land; (c) requires federal authorizations; and/or (d) is jointly carried out by a federal agency. As the PMLWDP will require federal authorizations for permitting purposes, the EIR will include information to support federal agency consultations under Section 106 of the National Historic Preservation Act, Section 7 of the Federal Endangered Species Act, the Federal Clean Air Act General Conformity Rule[1], and any other applicable federal consultations. If it is determined through the scoping process that additional federal review is required, the District will coordinate with the appropriate federal agency(s) to further comply with NEPA.

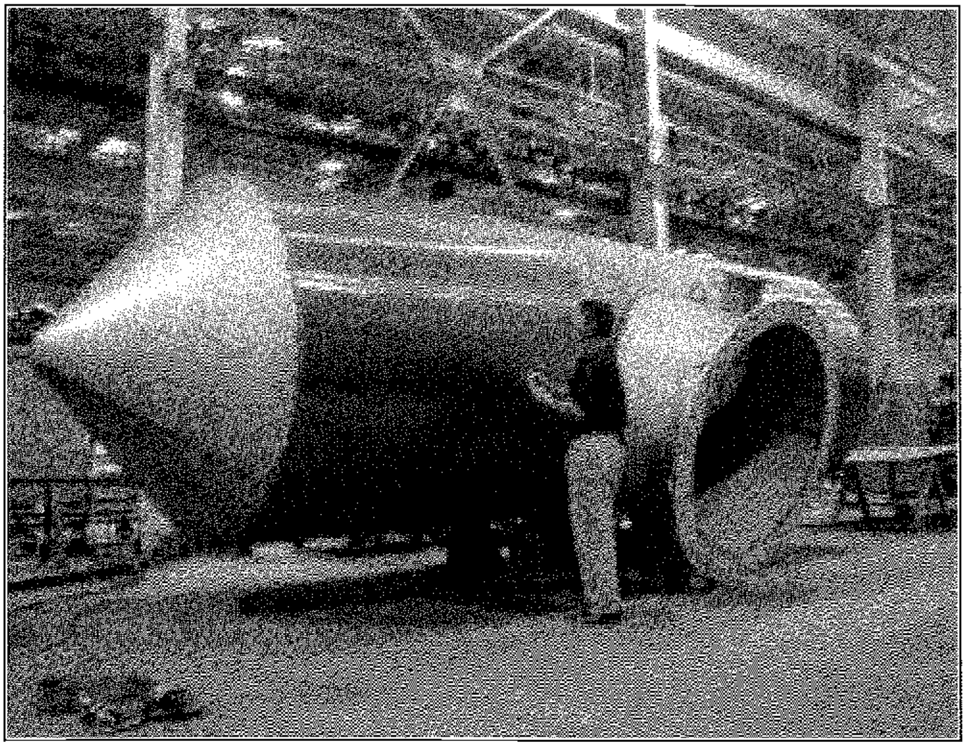
Where feasible, mitigation measures will be proposed to avoid or reduce any identified environmental impacts attributable to the project.

Figure 1: Location of Proposed People's Moss Landing Desalination Plant, Intake, and Outfall Locations

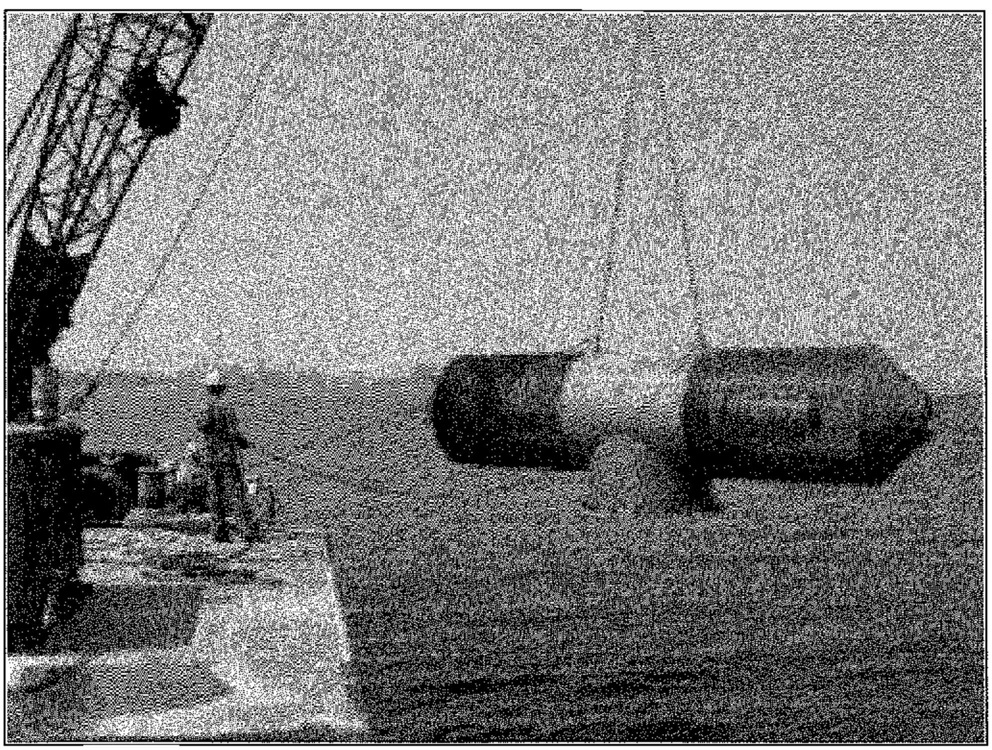


[1] The General Conformity Rule ensures that the actions taken by federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality. As of March 30, 2012, the North Central Coast Air Basin (NCCAB) meets all National Ambient Air Quality Standards and is not subject to a maintenance plan with conformity obligations. Therefore, the PMLWDP EIR will describe why the General Conformity Rule would not apply to the PMLWDP.

Figure 2. Examples of Wedgewire Screens for Seawater Intake

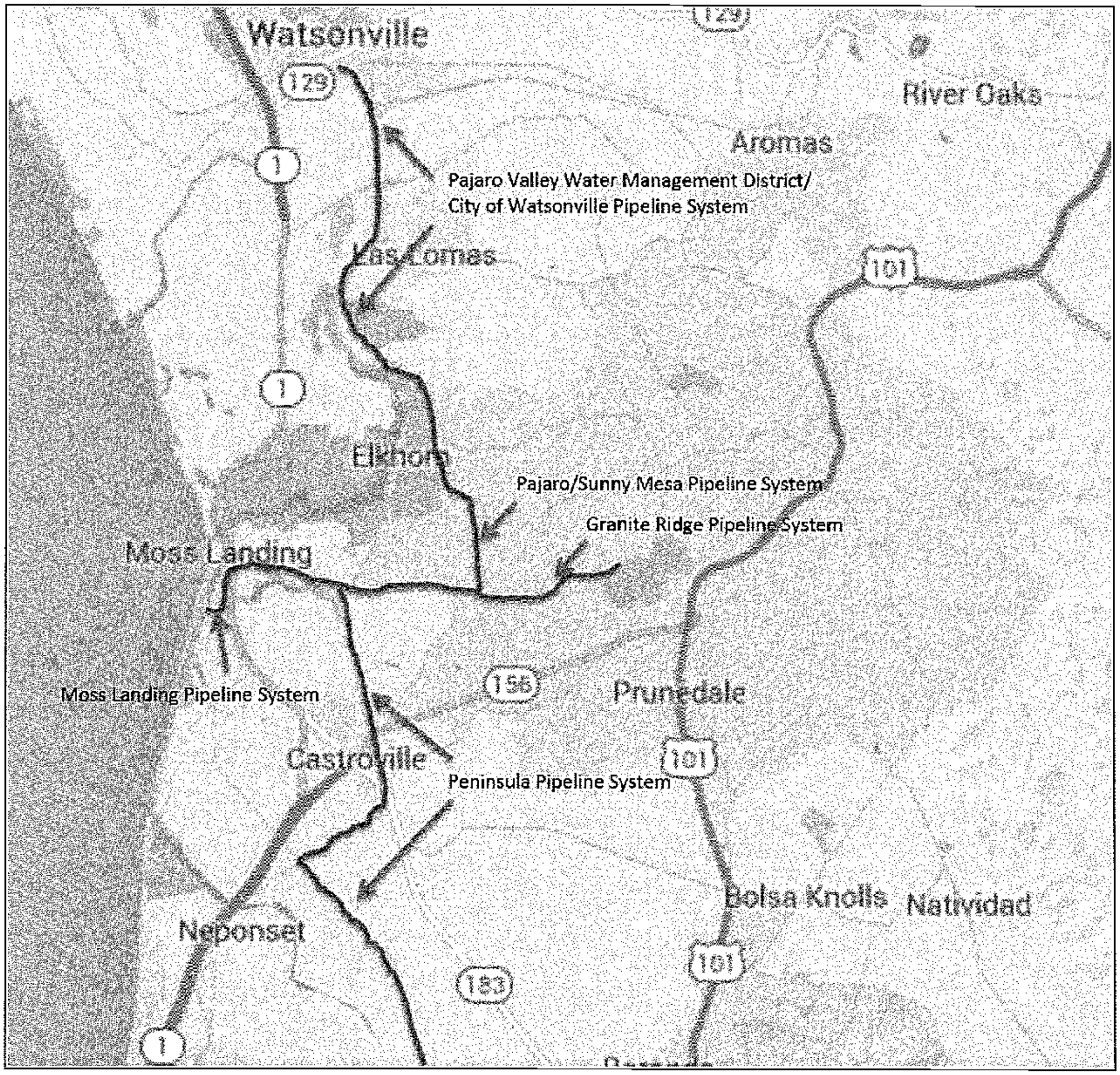


Source: http://www.filtsep.com/view/14321/seawater-desalination-us-desalination-industry-addresses-obstacles-to-growth/



Source: http://www.power-eng.com/articles/print/volume-114/issue-10/features/retrofit-options-to-comply-with-316-b.html

Figure 3: Proposed Pipeline and Storage Tank Locations



ATTACHMENT J

CALIFORNIA STATE LANDS COMMISSION
100 Howe Avenue, Suite 100-South
Sacramento, CA 95825-8202

JENNIFER LUCCHESI, *Executive Officer*
(916) 574-1800 *Fax* (916) 574-1810
California Relay Service TDD Phone 1-800-735-2929
from Voice Phone 1-800-735-2922

***Contact Phone:* (916) 574-1890**
***Contact FAX:* (916) 574-1885**

Established in 1938

June 1, 2015

NOTICE OF PREPARATION / NOTICE OF INTENT OF A DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT AND NOTICE OF PUBLIC SCOPING MEETING

Bid Log 2012-12
W26636, W30193, R11112
CSLC EIR/EIS No. 767
State Clearinghouse No.: 2015061001

NOTICE IS HEREBY GIVEN that the California State Lands Commission (CSLC), as Lead Agency under the California Environmental Quality Act (CEQA), and Monterey Bay National Marine Sanctuary (MBNMS), as Lead Agency under the National Environmental Policy Act (NEPA), will prepare a joint Environmental Impact Report/ Environmental Impact Statement (EIR/EIS), and that CSLC and MBNMS staffs will hold a joint public scoping meeting for the project listed below.

Project Title: **MONTEREY BAY REGIONAL WATER PROJECT**

Applicant: DeepWater Desal, LLC

Project Description and Location: A proposed 25,000 acre-feet per year seawater reverse osmosis (SWRO) desalination facility and co-located seawater-cooled 150-megawatt computer data center campus located approximately 1.5 miles east of Moss Landing, Monterey County, and associated seawater intake and brine discharge pipelines that would extend west from Moss Landing Harbor to the upper reaches of the submarine Monterey Canyon and the north shelf, respectively, within Monterey Bay National Marine Sanctuary (Attachments 1-3).

Meeting Information: **Tuesday, June 16, 2015**; sessions begin at **2 PM** and **6 PM**
Moss Landing Marine Laboratories, Main Building Conference Room
8272 Moss Landing Road
Moss Landing, CA 95039

Please see attachments for further details.

Signature: *Cynthia Herzog* June 1, 2015
Cynthia Herzog, Senior Environmental Scientist Date

NOTICE OF PREPARATION/NOTICE OF INTENT OF A DRAFT ENVIRONMENTAL IMPACT REPORT/ENVIRONMENTAL IMPACT STATEMENT AND NOTICE OF PUBLIC SCOPING MEETING

Date:	June 1, 2015
To:	Responsible, Trustee and Cooperating Agencies and Interested Parties
From:	CALIFORNIA STATE LANDS COMMISSION MONTEREY BAY NATIONAL MARINE SANCTUARY National Oceanic and Atmospheric Administration
Project:	Monterey Bay Regional Water Project
Applicant:	DeepWater Desal, LLC
Project Location:	A proposed 25,000 acre-feet per year (AFY) seawater reverse osmosis (SWRO) desalination facility and co-located seawater-cooled 150-megawatt computer data center campus located on a 110-acre site approximately 1.5 miles east of Moss Landing in Monterey County, California. The Project would also include seawater intake and brine discharge pipelines that would extend west from Moss Landing Harbor to the upper reaches of the submarine Monterey Canyon and the north shelf, respectively, within Monterey Bay National Marine Sanctuary (MBNMS) (Attachments 1-4).
Meeting Information:	Tuesday, June 16, 2015; sessions begin at 2 PM and 6 PM Moss Landing Marine Laboratories (MLML), Main Building Conference Room 8272 Moss Landing Road Moss Landing, CA 95039
Directions:	From the Monterey Peninsula, take Highway 1 North. Turn left onto Moss Landing Road (1.7 miles after Castroville). MLML main lab building is located at 8272 Moss Landing Road on the left directly after the cemetery. From the Santa Cruz area, take Highway 1 South. Turn right onto Moss Landing Road (0.2 miles past the Duke Energy Power Plant). Continue straight through town past the antique stores and post office. MLML main lab building is located at 8272 Moss Landing Road on the right just before the cemetery.

State Clearinghouse No.: 2015061001

This Notice is also available online at www.slc.ca.gov and on the Federal docket at www.Regulations.gov.

1. CEQA/NEPA PROCESS

This Notice of Preparation/Notice of Intent (NOP/NOI) and Notice of Public Scoping Meetings are published in accordance with: the California Environmental Quality Act (CEQA); California Public Resources Code section 21080.4, subdivision (a); State CEQA Guidelines section 15082; section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended; and the White House Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (CEQ NEPA Regulations).[1]

The California State Lands Commission (CSLC) and the MBNMS, as CEQA and NEPA lead agencies respectively, will prepare a joint Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) to identify and assess potential environmental impacts associated with the proposed DeepWater Desal, LLC (DWD or Applicant) Monterey Bay Regional Water Project (Project). Publication of this notice initiates the public scoping process to solicit public and agency comment, in writing or at the public meeting, regarding the full spectrum of environmental issues and concerns relating to the scope and content of the EIR/EIS, including:

- analyses of the human and marine resources that could be affected;
- the nature and extent of the potential significant impacts on those resources;
- a reasonable range of alternatives to the proposed Project; and
- mitigation measures.

Applicable agencies will need to use the EIR/EIS when considering related permits or other approvals for the Project.

Written comments must be received or postmarked by **July 3, 2015**. Please send your comments at the earliest possible date as provided below:

Comments to CEQA Lead Agency:	**Comments to NEPA Lead Agency:**
Email comments, including attachments, to CEQAcomments@slc.ca.gov (preferred option)* or send them via mail or fax** to: Cynthia Herzog Senior Environmental Scientist California State Lands Commission 100 Howe Avenue, Suite 100-South Sacramento, CA 95825 FAX: (916) 574-1885 Phone: (916) 574-1890	Submit comments to the Federal docket at www.Regulations.gov: **Docket ID:** NOAA-NOS-2015-xxx **Agency:** National Oceanic and Atmospheric Administration **Parent Agency**: Department of Commerce

** Please write "Monterey Bay Regional Water Project NOP/NOI Comments" in the email subject line.*
*** If faxed, please also mail a copy to ensure that a readable copy is received by this office.*

[1] CEQA is in California Public Resources Code section 21000 et seq. and the State CEQA Guidelines are in California Code of Regulations, Title 14, section 15000 et seq. NEPA is in 42 United States Code (U.S.C.) section 4321 et seq., and the CEQ NEPA Regulations are at 40 Code of Federal Regulations (CFR) section 1500 et seq.

1.1 Important Notes to Commenters

Before including your mailing or email address, telephone number, or other personal identifying information in your comment, please be aware that the entire comment—including personal identifying information—may become publicly available, including in the EIR/EIS and posted on the Internet. The CSLC and MBNMS will make available for inspection, in their entirety, all comments submitted by organizations, businesses, or individuals identifying themselves as representatives of organizations or businesses.

If you represent a public agency, please provide the name, email address, and telephone number for the contact person in your agency for this EIR/EIS.

1.2 Public Scoping Meeting

Each session of the scoping meeting noticed above will begin with a brief presentation on the proposed Project. The CSLC and MBNMS staffs will then receive comments on the potentially significant environmental issues, Project alternatives, and mitigation measures that should be included in the EIR/EIS, until all persons present who wish to provide oral comments have done so, at which time staff will close the session. If persons present are still providing comments 30 minutes before the scheduled start of the second session, staff may suspend the first session but will continue to take comments after the second session begins. The CSLC and MBNMS staffs may impose a 3-minute time limit on oral comments.

If you require a sign language interpreter, or other reasonable accommodation to conduct business at the scoping meeting for a disability as defined by the Federal Americans with Disabilities Act or California Fair Employment and Housing Act, please contact the CSLC staff person listed in this NOP/NOI at least 48 hours in advance of the meeting to arrange for such accommodation.

2. PROJECT LOCATION AND BACKGROUND

The Applicant has applied to the CSLC and MBNMS to implement the Project at Moss Landing, Monterey County, California (Attachments 1-4). As proposed, DWD would construct and operate a seawater reverse osmosis desalination facility (SWRO Desalination Facility) capable of producing 25,000 acre-feet per year (AFY) of potable water and a co-located seawater-cooled computer data center campus on a 110-acre site located approximately 1.5 miles east of Moss Landing. Seawater intake and brine discharge pipelines would extend west from Moss Landing Harbor to the upper reaches of the submarine Monterey Canyon and the north shelf, respectively, within the MBNMS. A summary of Project components is included in Attachment 6.

The Monterey Bay region obtains most of its municipal water supplies from a combination of groundwater and diversions from local streams and rivers. The region has relatively little storage capacity for surface waters (reservoirs), and over-drafting of groundwater has resulted in seawater intrusion into coastal aquifers. Pending regulatory actions to reduce or eliminate water diversions from local rivers may also further restrict water availability from those sources. The combined effect of these factors makes the region's water supply highly vulnerable in drought conditions.

According to the Applicant, the Monterey Bay region is also under-served by the lack of broadband fiber infrastructure and data storage capability. The proposed Project would address this issue through the development of a seawater-cooled computer data center co-located with the desalination facility.

3. PROJECT OBJECTIVE AND DESCRIPTION

DWD's Project objective is to provide needed potable water for the Monterey Bay region, provide a drought reserve, and enable reduced groundwater pumping and surface water diversion to promote habitat restoration. A seawater-cooled data center would be co-located with the desalination facility to lower the cost of desalinating ocean water and to improve regional data connectivity. The Project would include the construction of the following components.

- SWRO Desalination Facility with Co-located Seawater-Cooled Data Center;
- Fiber Optic Cable Connections;
- Onshore Pipelines and Channel Crossing;
- Wet Well;
- Offshore Pipelines and Intake/Discharge Structures;
- Product Water Pipelines to the Monterey Peninsula, Castroville and Salinas, and Santa Cruz County; and
- Any necessary construction staging/storage areas (to be determined during EIR/EIS preparation).

Attachments 1 and 2 show the locations of these Project components. Attachment 6 provides a summary of the components.

3.1 SWRO Desalination Facility with Co-Located Seawater-Cooled Computer Data Center

SWRO Desalination Facility

The main entrance for the SWRO Desalination Facility site would be through an existing gate located at the western terminus of Via Tanques Road near the intersection of Via Tanques and Dolan Roads. The co-located seawater-cooled computer data center campus, an electrical substation, and water storage facilities would also be located on the site.

The SWRO Desalination Facility would produce 25,000 AFY of potable water from 55,000 AFY of seawater. Ten SWRO pumps (plus one stand-by) would pump the seawater through the SWRO membranes. Each pump has a rated capacity of approximately 1,600 gallons per minute (gpm), and would have discharge pressures ranging from 850 to 1,000 pounds per square inch (psi).

Most SWRO desalination plants employ energy recovery devices to recover pressure from the membrane reject stream and return it to the process. The proposed Project's process and energy recovery systems consist of a modular array and skid approach. One complete standby SWRO skid and energy recovery system would be available to ensure reliable water plant production. The entire membrane and energy recovery systems would be automated, and operating conditions such as pressure and water quality would be continuously monitored using sensors and computer control systems.

Seawater-Cooled Computer Data Center Campus

The seawater-cooled computer data center campus would include four two-story data center buildings. The total land footprint for the buildings is expected to be approximately 775,000 square feet. Each building would contain servers and related equipment requiring some portion of the targeted 150 megawatt (MW) total power load. The distribution of data center equipment (e.g., computer servers) would be roughly proportional to individual building size; approximately 27 MW of server load for the smaller buildings and 52 MW for the larger buildings. In addition to computer server space, each building would include office space, including restrooms, kitchen space and storage. A loading and trash enclosure area would be located to the rear of each building.

Each data center building would include a closed loop cooling system designed to provide air-conditioning to both office and computer server areas of the buildings. In lieu of the chiller units and evaporative cooling systems typically employed for building air conditioning, the data centers would reject heat to the cold seawater being pumped to the inlet side of the SWRO desalination facility. Each data center would draw a slipstream of water from the cold seawater line and run that water through a non-contact, tube-and-shell heat exchanger where it would collect heat from the data center cooling system. The heat exchanger tube sheet would be made of either titanium or an admiralty metal to avoid problems with corrosion. Assuming 150 MW of data center capacity, the incremental change in temperature to the intake seawater would be approximately 5 degrees centigrade. This heated seawater would then be pumped through the SWRO membranes, reducing the energy required to facilitate desalination.

Electrical Substation

The Project would have substantial electrical demands. The data center campus would require 150 MW and the SWRO Desalination Facility and other site infrastructure would require an additional 20 MW of electrical power. The data center campus derives commercial value in part from its ability to provide customers with critical space to support their servers, including access to a steady stream of high-quality electrical power supply. Interruptions of power could lead to server damage or corruption of data stored on the servers. Several high voltage power lines run through a corridor located on the SWRO Desalination Facility site. The proposed interconnection and substation facilities would provide redundant electrical power supply required to ensure reliability for data center operations. The electrical interconnection would require new transmission tower structures to redirect the Moss Landing-Coburn circuit beneath the existing transmission lines and into the new substation. Within the new substation, the

230 kilovolt (kV) circuit would pass through a series of electrical breakers before leaving the new substation on additional, new transmission structures and continuing its original routing on the existing transmission structures. The Project site would house all of the new transmission structures.

Product Water Storage

Product water would be temporarily stored on site prior to forwarding it to a distribution pipeline. The storage facilities would be comprised of two aboveground tanks (approximately 160 feet in diameter and 37 feet tall) constructed of pre-stressed concrete, each with a capacity of 5.5 million gallons, which would provide sufficient retention time to satisfy disinfection requirements prior to distribution. A high-service water pump station would provide high quality drinking water for distribution. Eight operating and one stand-by pumps would each have a rated capacity of approximately 1,900 gpm and capable of discharge pressures reaching 100 psi to the distribution system. The pump bodies would be constructed of stainless steel; pipe and valves would be a combination of stainless steel, thermoplastic or lined steel based on pressure and service location.

3.2 New Fiber Optic Cable Connections for Data Center

The Project would interconnect with existing fiber optic cables running along the nearby Union Pacific Railway line east of the Project site. Fiber optic cable would be buried in new conduits along the routes shown in Attachment 2.

3.3 Onshore Pipelines and Elkhorn Slough Channel Crossing

DWD would install dual intake and discharge pipelines between the SWRO Desalination Facility and a shaft/pit (Shaft/Pit #1, see Attachment 2) using an open trench method to the greatest extent possible. As proposed, the seawater intake pipelines would be 42 inches in diameter; the brine discharge pipelines would be 36 inches in diameter. The pipeline materials used onshore would vary based on subsurface impediments, which are presently unknown, but would likely be composed of flexible polyvinyl chloride (FPVC). Subsurface conflicts that cannot be averted by open trench would be diverted above-grade on pipe saddles consisting of high-density polyethylene (HDPE), FPVC, or glass reinforced plastic (GRP).

Two parallel pilot tube tunnels would be constructed below California State Route 1 (SR-1) using horizontal directional drilling (HDD) technology. Single steel casings would be placed within each tunnel to convey individual discharge and intake lines below SR-1 (i.e., four casings total). The casing diameters are estimated to be 54 inches for the 42-inch intake lines and 48 inches for the 36-inch discharge lines, with a 3-foot clearance horizontally between the casing walls. Alternatively, based on final engineering design, DWD may install two larger-diameter casings, one for both 42-inch intake lines and one for both 36-inch discharge lines. The pipelines would run from Shaft/Pit #1 east of SR-1 through the tube tunnels below SR-1. The intake pipelines would continue to a proposed onshore gravity-fed wet well and pump. The discharge pipelines would run adjacent to the wet well. Both the intake and discharge lines would run under Elkhorn Slough, as described below.

An approximately 130-inch-diameter steel casing would be installed under the Elkhorn Slough seabed using a micro-tunneling system between the onshore gravity-fed wet well/pump area and a second shaft/pit (Shaft/Pit #2) located in the parking area at Moss Landing State Beach. Both the dual 42-inch FPVC intake pipelines and the dual 36-inch FPVC discharge pipelines would run through this casing.

3.4 Wet Well

DWD would construct a wet well, comprised of a concrete basin and pump station, on a privately owned parcel located west of the Moss Landing Power Plant, between the Pacific Gas and Electric Company (PG&E) substation and Elkhorn Slough. The wet well would provide a reservoir of seawater to supply the transfer pumps with seawater via gravity feed (to insure that the pump suctions are always flooded to avoid damaging the pumps) in order to deliver the seawater to the SWRO Desalination Facility site. The concrete basin would receive seawater delivered via the dual 42-inch subsurface intake lines. The pump station would contain six intake pumps (five operating and one stand-by) each with a rated capacity of approximately 6,800 gpm and with a discharge pressure of 55 pounds per square inch gauge (psig), a pig launching system, cathodic protection, and a water quality sampling station. The wet well and pumps would be located below grade. The only equipment planned to be above-grade would be housed in a small building and include transformers and an emergency backup power supply system.

Although the need for biofouling control cannot be determined until after the system is operational, a chemical biofouling control system would be included in the design of the wet well, and further described in the Draft EIR/EIS. The purpose of the biofouling control would be to prevent biological growth on the walls of the conveyance pipelines, which can affect water flow and increase energy demand.

3.5 Offshore Pipelines and Intake/Discharge Structures

DWD would use HDD technology to install two 42-inch-diameter HDPE intake pipelines and two 36-inch-diameter steel discharge pipelines beneath the ocean floor. Due to space limitations on Moss Landing State Beach and the depth of the proposed Elkhorn Slough crossing microtunnel, HDD drilling operations would: (1) start at Shaft/Pit #3, which would be located within a restaurant parking lot across a small channel east of Moss Landing State Beach; (2) continue through Shaft/Pit #2 where the onshore and offshore pipelines would be connected; and (3) terminate offshore. Once the HDD drilling heading is offshore of Moss Landing State Beach, the HDD drives should be about 50 feet below the seafloor or greater until about 500 feet from the discharge and intake points. At that point, the drilling head would turn up at a 4° angle until it breaches the canyon wall for the intake pipeline or the seafloor for the discharge pipeline. The temporary casings used for the HDD drilling between Shaft/Pit #3 and Shaft/Pit #2 would be removed once the pipelines are installed at Shaft/Pit #2.

Intake Pipelines/Structures

Seawater would be extracted from the ocean through a passive, wedgewire-screened, low-velocity intake mounted at the terminus of the two 42-inch intake pipelines. As proposed, the intake would be located on the uppermost northern slope of the Monterey Submarine Canyon approximately 2,565 feet offshore of the ordinary high water mark (OHWM), northwest of the Moss Landing Harbor entrance, at a depth of approximately 100 feet. DWD selected dual intake pipes rather than a single large diameter pipe to provide for flow redundancy during annual pipe cleaning and maintenance operations. Intake pipe redundancy would allow a minimum of 25 million gallons per day of uninterrupted seawater flow per pipe to support data center cooling and desalination operations during pigging operations or other maintenance activities.

At the breakout face where the dual pipelines emerge from the seafloor, the screening manifold for each pipe would be connected with flexible couplings to allow for some movement. However, the screens would also be secured to reinforced concrete pads with concrete pipe supports. In addition, the pads would be secured to the ocean floor with embedment anchors, hollow-bar, or rock-bolt anchors attached to gravity anchors (refer to Attachment 5). Screen sections could be removed entirely for maintenance purposes with little downtime; and the end of each pipe could also be removed to facilitate cleaning or pigging. In addition to the wedgewire screens, the screened deep water intake water velocity would be at or below the regulatory standards for open ocean intakes (0.5 feet per second).

Assertions by the Applicant that will be verified during the EIR/EIS process:

- The combined approach of intake screening and minimized intake velocity would meet the regulatory standard of Best Technology Available for reducing the environmental effects of the seawater intake.
- Withdrawing source water from the Monterey Submarine Canyon below the euphotic zone (the depth of a water column that is exposed to sufficient sunlight for photosynthesis to occur) would minimize environmental impacts that are a concern for open ocean intakes located in shallow water.
- Assessments conducted by the Applicant concluded that, due to a deep-water mass that predominates the upper slope of the canyon, fewer planktonic marine organisms are present in the water column at the depth of the proposed intake.
- The near-shore access to deep water makes siting an intake in deep water economically and technically feasible where it otherwise would not be for other coastal locations.

Discharge Pipelines/Structures

The Applicant's preferred location for mixing brine with seawater is at the deep discharge site located at a depth of 35 meters. Two 36-inch-diameter steel discharge pipelines would be installed from Shaft/Pit #2 to the discharge location approximately 5,675 feet offshore from the OHWM near the terminus of the existing oil pipeline on the north flank of the Monterey Submarine Canyon. A unifying Y-connection would be installed at the terminus of the two discharge pipes, combining them into a single HDPE section to allow for installation of diffusers. An example of the diffuser design is provided in Attachment 5.

The section would extend out to a diffuser system that would be oriented orthogonal to the shoreline. The system would consist of five discharge risers emerging from a manifold and fitted with duckbill diffuser nozzles to assure rapid and thorough mixing with ambient seawater. The diffusers would be attached to a distribution manifold and spaced approximately 3 feet apart (see Attachment 5).

3.6 Product Water Pipelines

In addition to the Project components analyzed fully in the EIR/EIS, the EIR/EIS will discuss at a programmatic level several Product Water Pipelines that could potentially deliver water south to the Monterey Peninsula communities, south to Castroville and southeast to Salinas, and north to Santa Cruz County. These Product Water Pipelines would be separately proposed, permitted, and constructed by the individual water suppliers. The three Product Water Pipelines discussed would include the following:

- Monterey Peninsula Product Water Pipeline. This pipeline would begin at the southeast corner of the SWRO desalination facility and extend 9 miles south along the Union Pacific Railroad through Castroville. The pipeline would then follow the Transportation Agency for Monterey County right-of-way to Beach Road in Marina. From there, the pipeline alignment would continue in a southerly direction for 7 miles connecting with the Seaside and Monterey Pipelines just north of the intersection of Auto Center Parkway and Del Monte Boulevard.
- Castroville and Salinas Product Water Pipeline. The pipeline would exit the SWRO Facility east to the Union Pacific Railroad corridor southward and then continue approximately 12 miles to the Cal Water Salinas distribution system.
- Santa Cruz County Product Water Pipeline. The pipeline would exit the SWRO Facility and cross Elkhorn Slough via HDD. On the north side of Elkhorn Slough, the pipeline would parallel an existing reclaim water pipeline to the Pajaro Valley Water Management Agency recycled water plant within an easement on Beach Road. The pipeline would then continue along San Andreas Road along an abandoned rail line. The pipeline would terminate at the Soquel Creek Water Management Agency's distribution system in Capitola.

4. PERMITS AND PERMITTING AGENCIES

In addition to action by the CSLC, the Project may also require permits and approvals from other reviewing authorities and regulatory agencies that may have oversight over aspects of the proposed Project activities, including but not limited to the following.

- Moss Landing Harbor District
- Monterey County
- Monterey County Air Pollution Control District (MCAPCD)
- California Coastal Commission (CCC)

- California Department of Fish and Wildlife (CDFW)
- Central Coast Regional Water Quality Control Board (RWQCB)
- State Office of Historic Preservation (SHPO)
- State Water Resources Control Board (SWRCB)
- Monterey Bay National Marine Sanctuary, National Oceanic and Atmospheric Administration (NOAA)
- National Marine Fisheries Service (NOAA Fisheries or NMFS)
- U.S. Army Corps of Engineers (USACE)
- U.S. Coast Guard (USCG)
- U.S. Fish and Wildlife Service (USFWS)
- Applicable Native American Tribes

5. SCOPE OF THE EIR/EIS

The CSLC and MBNMS staffs have conducted a preliminary review of the proposed Project and determined that an EIR/EIS is necessary based on the potential for significant impacts resulting from the Project. A preliminary list of environmental issues and alternatives to be analyzed in the EIR/EIS is provided below. Additional issues and/or alternatives may be identified during the scoping process and/or during preparation of the EIR/EIS. The CSLC and MBNMS staffs invite comments and suggestions on the scope and content of the environmental analysis, including the significant environmental issues, reasonable range of alternatives, and mitigation measures that should be included in the EIR/EIS.

Use of the term "significant" differs under CEQA and NEPA. While CEQA requires that a determination of significant impacts be stated in an EIR, NEPA does not require such a determination in an EIS. Under NEPA, significance is used to determine whether an EIS or some other level of documentation is required, and once a decision to prepare an EIS is made, the EIS reports all impacts, regardless of significance, and proposes mitigation wherever it is feasible to do so.

Because CEQA requires significance determinations and NEPA does not, the specific significance determinations in the EIR/EIS will be made under CEQA. The following designations will be used in the EIR/EIS when examining the potential for impacts for each environmental issue area.

Significant Impact	Any impact having a substantial, or potentially substantial, adverse change in the environment, and for which feasible mitigation must be identified and implemented. If any significant impacts are identified that cannot be mitigated to a less than significant level, the impact would be *significant and unavoidable*; if any significant impacts are identified for which feasible, enforceable mitigation measures are developed and imposed to reduce the impacts below applicable significance thresholds, the impact would be *less than significant with mitigation*.

Less Than Significant Impact	Any impact that would not be considered significant under CEQA relative to the applicable significance threshold, and therefore would not require mitigation.
No Impact	The Project would not result in any impact to the associated environment.
Beneficial Impact	The Project would provide an improvement to the associated environment in comparison to the baseline information.

The estimations of impact levels used for this NOP/NOI are based solely on preliminary documents. Impact levels may change and additional impacts may be identified during preparation of the EIR as more information is obtained.

5.1 Currently Identified Potential Environmental Impacts

The EIR/EIS for the MBRWP will discuss and assess the following: the purpose and need for the Project, which would require CSLC approval of a State lease, California Coastal Commission approval for a Coastal Development Permit, and federal approval to construct and operate the Project; the affected environment/baseline; Project alternatives, including the no action/no project alternative and other feasible alternatives identified to reduce significant impacts of the proposed Project; the impacts of the Project and its alternatives on the environment; and feasible mitigation measures to avoid or substantially reduce the environmental effect of the Project and its alternatives.

Based on initial internal scoping, the Project is not anticipated to affect the following environmental issue areas identified in State CEQA Guidelines Appendix G (Environmental Checklist Form), which could therefore be eliminated from consideration in the EIR/EIS.

- **Population or Housing –** The Project is not anticipated to displace existing housing or population or create the need for new temporary housing for construction workers. (The potential for the project to result in long-term growth inducing effects will be addressed in a separate growth-inducement analysis. See Section 5.2.)

Environmental issues that may require detailed analysis include, but are not necessarily limited to the following.

- ***Aesthetics*** – *Potential impacts of aboveground pipeline routes, the water storage tanks, or other Project components on scenic vistas and eligible scenic highways.*

- ***Agriculture*** – *Potential impacts on designated farmland and Williamson Act contracts due to pipeline routes and other Project components.*

- ***Air Quality*** – *Potential for onshore and offshore construction and operation emission impacts on regional air quality and potential health risks from increased air pollutant emissions.*

- ***Biological Resources (Marine and Terrestrial)*** – *Potential direct and indirect impacts on marine and terrestrial biological resources.* The EIR/EIS will: (a) evaluate potential impacts on Essential Fish Habitat, and other critical habitats and natural communities such as wetlands and riparian vegetation, threatened and endangered species and other special status species including marine mammals, fish, turtles, invertebrates, seabirds and shorebirds, invasive species, marine protected areas (see Attachment 3), refuges, preserves, MBNMS and local estuaries, and wetlands; (b) analyze potential noise, vibration and lighting impacts on marine mammals and birds; (c) analyze the potential for entrainment and/or impingement of marine species due to any pumping and processing of seawater; and (d) analyze the effects of vessel traffic creating a potential for an encounter with marine mammals. NEPA mandates that Federal agencies assess proposed Federal actions' environmental impacts, including impacts on marine and terrestrial biological resources. Federal agencies meet their NEPA review responsibilities by completing the NEPA processes set forth in their NEPA implementing procedures and CEQ NEPA Regulations (40 CFR § 1500 et seq.).

- ***Cultural Resources*** – *Potential impacts on cultural resources, both offshore (e.g., shipwrecks) and onshore, and their potential sensitivity and proximity to the Project's nearshore and onshore activities.* Documented sensitive resources would be avoided or mitigated in accordance with existing regulations in consultation with the State Historic Preservation Office (SHPO), local Tribes, and the CSLC and MBNMS. NEPA mandates that Federal agencies assess proposed Federal actions' environmental impacts, including impacts on historic and cultural resources. Federal agencies meet their NEPA review responsibilities by completing the NEPA processes set forth in their NEPA implementing procedures and CEQ NEPA Regulations (40 CFR § 1500 et seq.).

- ***Geology and Soils*** – *Potential impacts associated with geologic and soil hazards (e.g., erosion, differential settlement), seismic hazards and seismically induced hazards, including earthquakes, ground shaking, and tsunamis.*

- ***Greenhouse Gas (GHG) Emissions and Climate Change*** – *Potential impacts due to GHG emissions from Project construction and operation activities based, if applicable, on guidelines provided by the Monterey Bay Unified Air Pollution Control District.* The analysis will include an assessment of projected emissions resulting from co-locating the proposed data center campus with the desalination facility.

- ***Hazardous Materials/Risk of Upset*** – *Potential upset conditions during Project construction and operation that could result in release of hazardous materials, fire, explosion or other conditions that could be hazardous to both the public and specific resources (e.g., Biological Resources; Hydrology, Oceanography and Water Quality).* Potential safety hazards of the Project and alternatives will be based on a change from existing conditions. The EIR/EIS will also address the handling, storage, and disposal of hazardous materials (e.g., petroleum products, solvents, drilling muds and cuttings, and otherwise regulated chemical materials) that could result from Project activities.

- ***Hydrology, Oceanography & Water Quality*** – *Potential impacts on surface water, groundwater, marine hydrology, and water quality resulting from the Project, and specifically the discharge of brine.* This section will rely, in part, on information from various agencies including Monterey County, RWQCB, and NMFS, as well as any new scientific information.

- ***Land Use, Planning*** – *Potential land use and planning impacts associated with the Project in regards to existing land use and planning conditions and consistency with land use policies/plans in the Project vicinity, such as those related to offshore sanctuaries, marine protected areas, designated agricultural areas and sea level rise.*

- ***Mineral Resources*** – *Project alternatives may include the use of sand to filter seawater.* The proposed Project does not preclude or involve significant extraction and removal of that may be deemed to be a locally important mineral resource of value to the region. In addition, the Applicant plans to use prefabricated filters, not sand, to remove suspended solids from the seawater that could otherwise foul the SWRO membranes. The filters would be horizontal pressure-type and constructed of rubber-lined carbon steel.

- ***Noise*** – *Potential noise impacts, both from onshore and offshore short-term (construction) and long-term noise sources, on human recreators, such as divers and beachgoers, workers, and residents.* The Biological Resources section of the EIR/EIS will analyze impacts of underwater noise on marine life (due to the installation of offshore portions of the intake and discharge pipelines).

- ***Public Services*** – *Potential impacts due to the development of a SWRO Facility and data center campus, as it is anticipated that the Project would be served by existing fire and police services within existing service areas.*

- ***Recreation*** – *Potential impacts from temporary construction activities or hazardous materials releases that could preclude the use of nearby marine waters, beach areas and associated activities.* Onshore recreation within the Project area would likely impact bike and pedestrian traffic, parking for anglers, and kayaking. Offshore recreation within the Project area consists of beachgoing, surfing, boating, kayaking and fishing, among other water sports, and the marine waters provide opportunities for fishing and whale watching.

- ***Transportation/Traffic*** – *Potential impacts due to activities that would generate construction vehicle trips, resulting in a temporary increase in traffic volumes along local and regional roadways, and the installation of pipelines along or adjacent to road right-of-ways, resulting in temporary road closures and traffic delays.* In addition, offshore construction may conflict with offshore commercial and recreational vessel traffic in the Project area.

- ***Utilities and Service Systems*** *– Potential impacts associated with electrical power used for the SWRO Facility and seawater-cooled data centers.* A new project substation would be built and interconnected to the 230 kV Moss Landing Coburn Line that crosses Project property. As proposed, brine from the desalination process would be conveyed to an offshore discharge location.

- ***Other Issues: Socioeconomics and Environmental Justice*** *– Whether the Project would have the potential to disproportionately affect area(s) of high-minority population(s) and low-income communities, and the Project's consistency with the CSLC's and Federal Environmental Justice Policies.* Socioeconomic conditions relevant to this analysis may include, but not be limited to, those related to commercial and recreational fishing due to the nature of the ongoing operation of the desalination Project (ocean water intake and brine discharge).

5.2 Special Impact Areas

- ***Cumulative Impacts***. State CEQA Guidelines section 15130 requires an EIR to discuss the cumulative impacts of a project when the project's incremental effect is "cumulatively considerable." NEPA guidance also states that cumulatively significant impacts be discussed (40 CFR § 1508.25). A cumulative impact is created through a combination of the project being analyzed in an EIR and other projects in the area causing related impacts. The EIR/EIS will: define the geographic scope of the area affected by cumulative effects ("Cumulative Impacts Study Area"), which for the proposed Project is presently defined as the Monterey Bay region; discuss the cumulative impacts of the proposed Project in conjunction with other approved and reasonably foreseeable projects in the study area; and identify, if appropriate, feasible measures to mitigate or avoid the Project's contribution to cumulative effects.

- ***Growth-Inducing Impacts***. CEQA and NEPA require a discussion of the ways in which a proposed project could foster economic or population growth, including the construction of additional housing, in the project's vicinity. Under the State CEQA Guidelines (§ 15126.2, subd. (d)), a project is growth-inducing if it fosters or removes obstacles to economic or population growth, provides new employment, extends access or services, taxes existing services, or causes development elsewhere. CEQ NEPA Regulations (40 CFR § 1508.8(b)) state that "indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems."

- ***Irreversible/Irretrievable Commitment of Resources***. The EIR/EIS will include a discussion of the development and commitment of resources.

5.3 EIR/EIS Alternatives Analysis

In addition to analyzing the potential impacts associated with the proposed Project, in accordance with the State CEQA Guidelines, an EIR must:

> *...describe a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project, but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives* (§ 15126.6).

Per NEPA Guidance, an EIS must:

> *...(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated. (b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits* (CEQ NEPA Regulations; 40 CFR § 1502.14).

The State CEQA Guidelines also require that the EIR/EIS evaluate a "no project" alternative and, under specific circumstances, designate an environmentally superior alternative from among the remaining alternatives. CEQ NEPA Regulations specify that an alternative of no action be included in the analysis. Alternatives will be identified as a result of the environmental analysis and on information received during scoping. The EIR/EIS will:

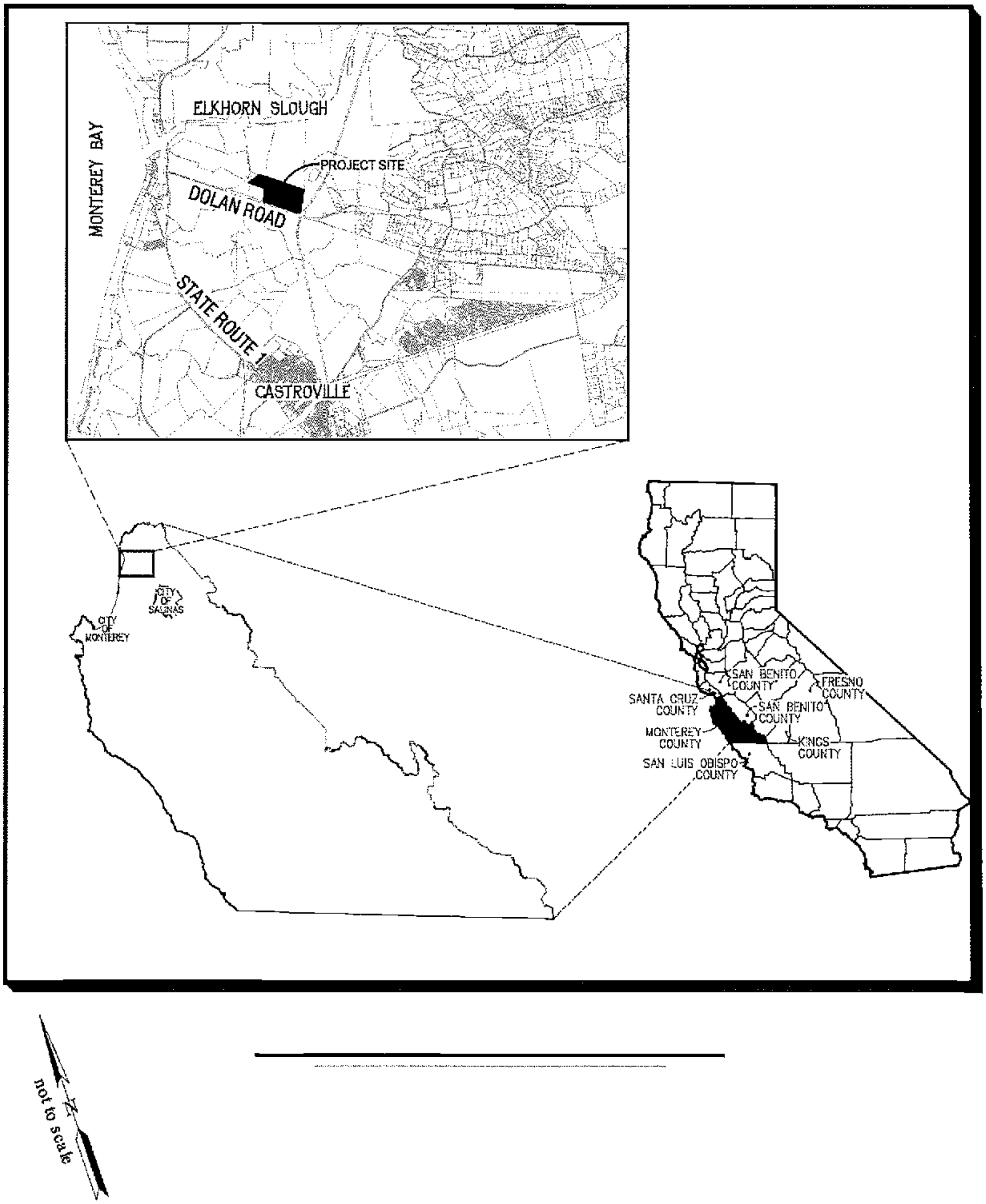
- provide the basis for selecting alternatives that are feasible and that would reduce significant impacts associated with the proposed Project;
- provide a detailed explanation of why any alternatives were rejected from further analysis; and
- evaluate a reasonable range of alternatives including the "no project" alternative.

Examples of possible alternatives, or combinations of alternatives, to be evaluated include the following:

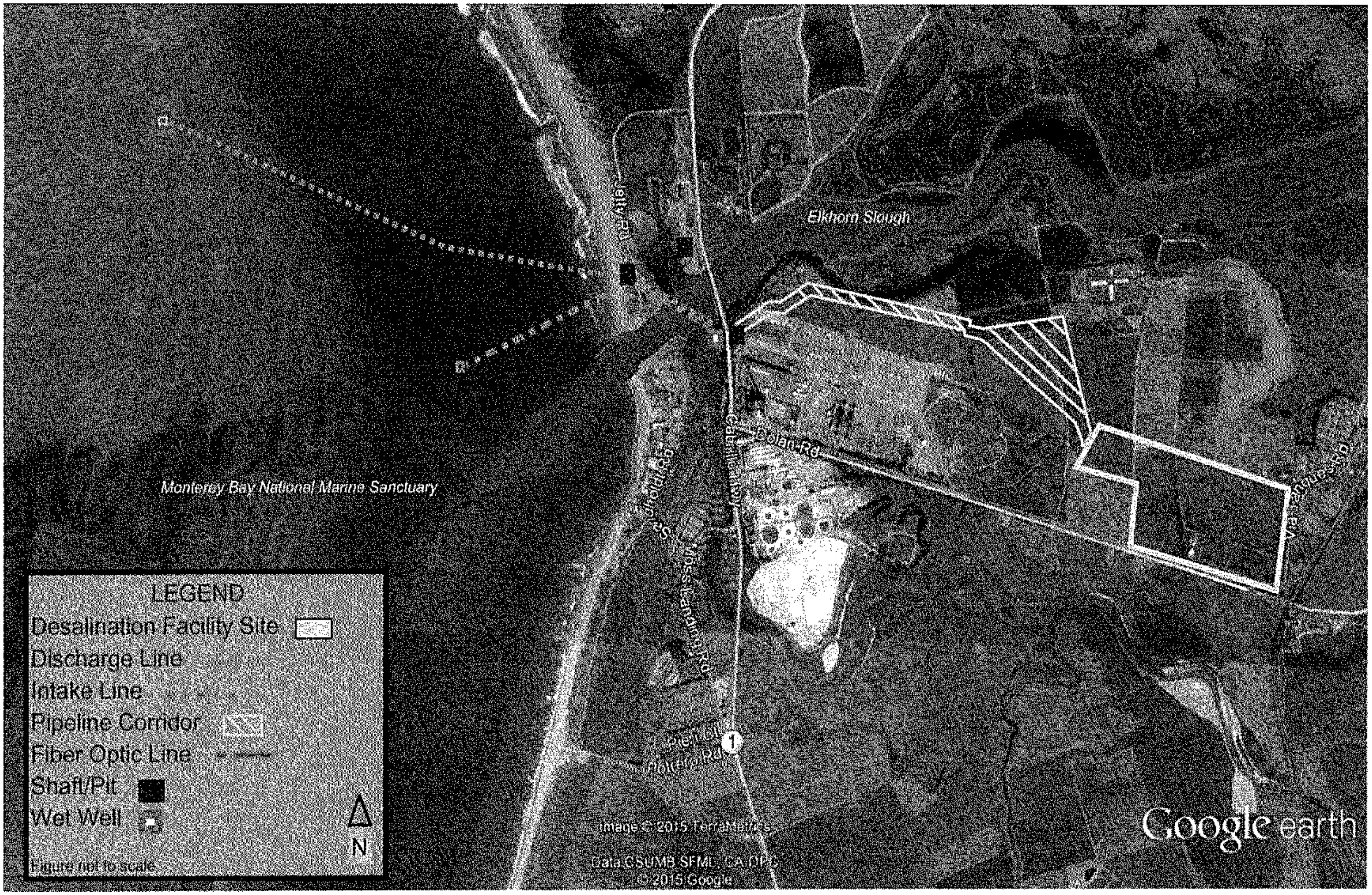
- Alternative subsurface intake
- Alternative locations for intake and discharge inlet and outlets
- Alternative onshore intake/discharge pipeline routes
- Alternative production capacity including fewer or smaller pipelines
- Alternative wet well locations
- No Project Alternative

The EIR/EIS may also include as part of the analysis of Project alternatives, project-level analyses of other currently proposed desalination projects requiring approval by CSLC and MBNMS. The analysis would incorporate by reference information contained in other EIRs prepared by other State and/or local agencies, or application documents prepared by applicable desalination project proponents. Alternatively, the EIR/EIS may analyze these other desalination projects as part of the cumulative impacts discussion.

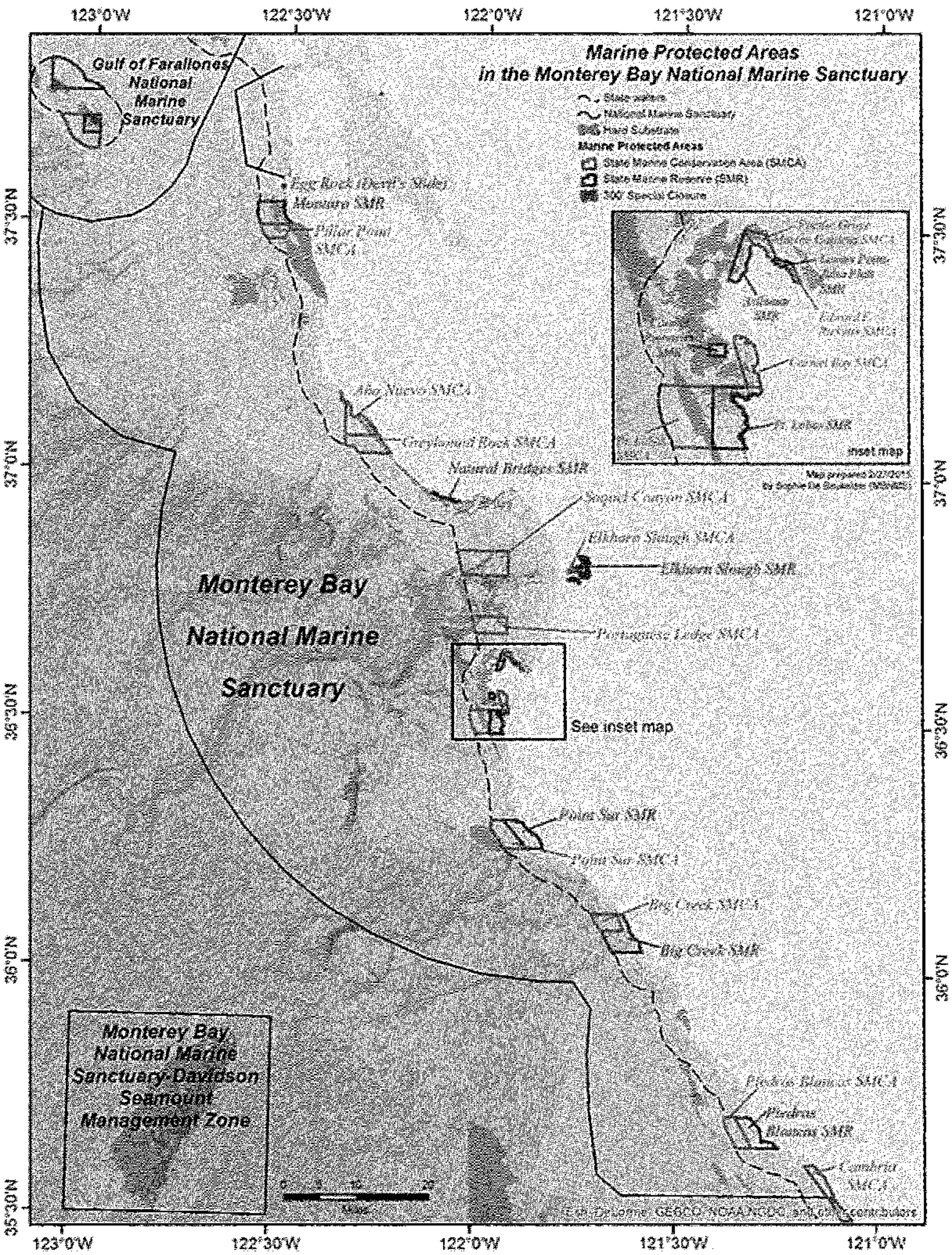
ATTACHMENT 1. PROJECT LOCATION



ATTACHMENT 2. PROJECT COMPONENTS



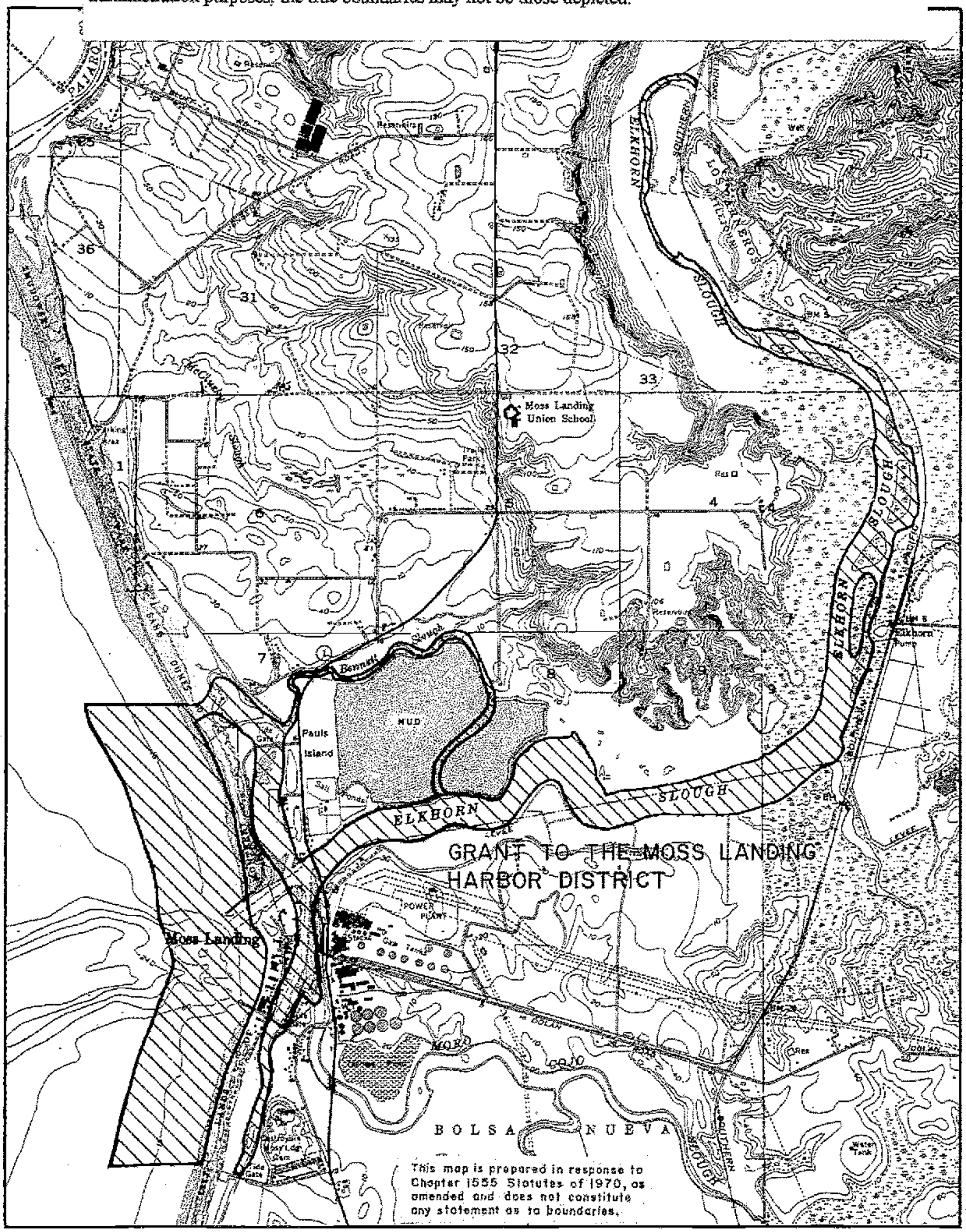
ATTACHMENT 3. MARINE PROTECTED AREAS



Graphic taken from http://montereybay.noaa.gov/materials/maps.html#mlpa

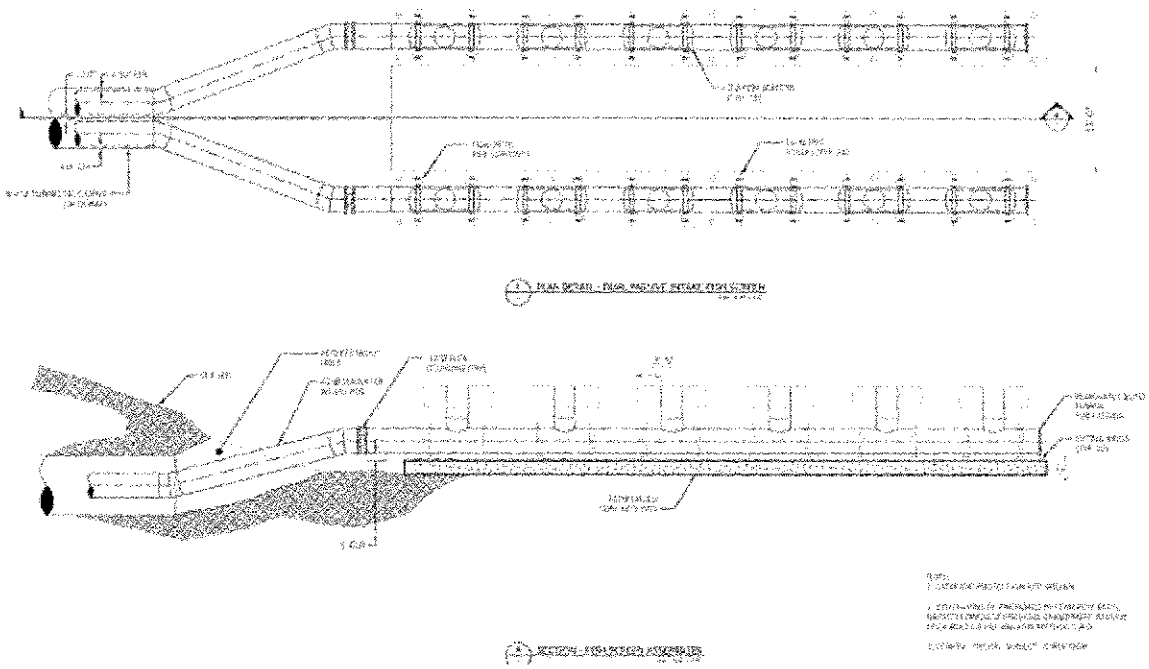
ATTACHMENT 4. CSLC GRANT MAP

This map was prepared by the staff of the California State Lands Commission. The map was based upon information available to the staff at the time of the survey. It does not reflect legislation, court decisions, or other information unavailable to staff at the time of the survey. Therefore, while useful for general grant administration purposes, the true boundaries may not be those depicted.

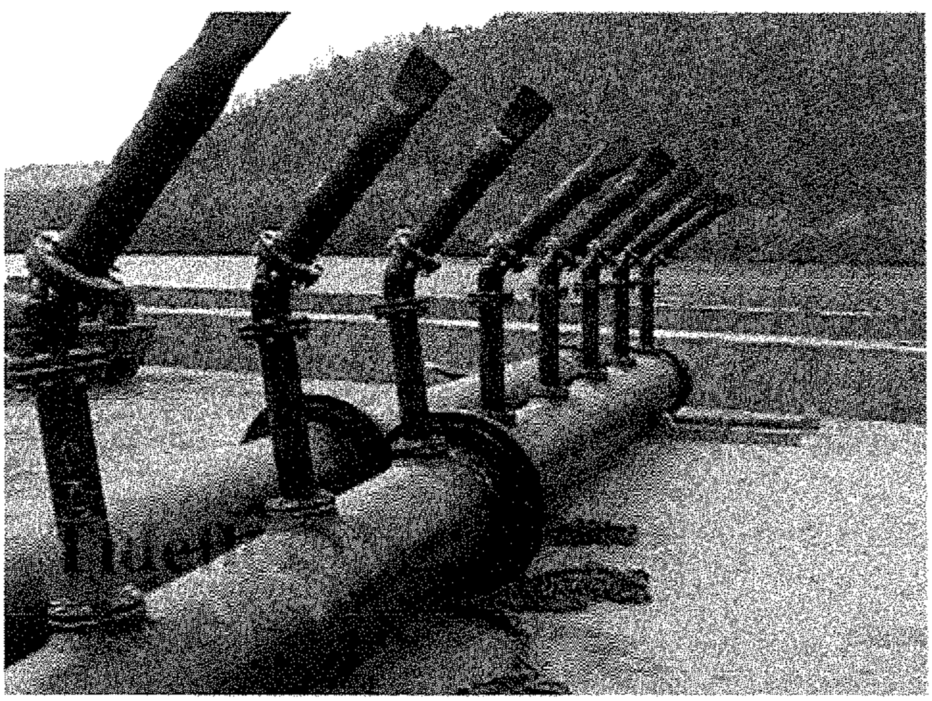


ATTACHMENT 5. EXAMPLE INTAKE AND DISCHARGE STRUCTURES

Proposed Intake Detail



Example of Proposed Linear Diffuser



ATTACHMENT 6. SUMMARY OF PROJECT COMPONENTS

Primary Project Components	
Seawater Reverse Osmosis Desalination Facility (SWRO Facility) and Seawater-Cooled Data Center Campus	• An SWRO Facility would be located on a 110-acre site and capable of producing 25,000 acre-feet per year (AFY) of potable water from 55,000 AFY of seawater. • The site would also house a seawater-cooled, 150-megawatt data center campus and an electrical substation.
Fiber Optic Cable Connections	• The project would interconnect with existing fiber optic cable running along the nearby Union Pacific Railway line east of the Project site.
Onshore Pipelines and Elkhorn Slough Channel Crossing	• Two 42-inch-diameter intake pipelines and two 36-inch-diameter discharge pipelines would be installed underground using an open trench construction method where feasible, from the SWRO Facility to Shaft/Pit #1. • Shaft/Pit # 1 would be sited east of SR-1. • Two parallel pilot tube tunnels would be constructed below State Route 1 (SR-1) using horizontal directional drilling (HDD) technology. The tunnels would house four steel casings (two 54-inch casings for each of the two 42-inch intake lines and two 48-inch casings for each of the two 36-inch discharge lines). Alternatively, based on final engineering design, DWD may install two larger-diameter casings, one for both 42-inch intake lines and one for both 36-inch discharge lines. • All four pipelines would be installed between Shaft/Pit #1, under SR-1, to a gravity-fed wet well and pump west of SR-1. • One 130-inch-diameter steel casing would be installed under the Elkhorn Slough channel using a micro-tunneling system. • Both the dual 42-inch intake pipelines and the dual 36-inch discharge pipelines would run from the wet well/pump, below the Elkhorn Slough channel, to Shaft/Pit #2. • Shaft/Pit #2 would be sited in the parking area at Moss Landing State Beach.
Wet Well	• An onshore gravity-fed wet well and pump would be sited west of SR-1 and existing Dynegy and PG&E facilities. The wet well would allow seawater intake flow to fill a reservoir to facilitate pumping of the seawater to the SWRO Facility.
Offshore Pipelines and Intake/Discharge Structures	HDD • Two 42-inch-diameter intake pipelines and two 36-inch-diameter discharge pipelines would be installed using HDD technology. HDD operations would be initiated at Shaft/Pit #3. However, the offshore and onshore pipelines would connect at Shaft/Pit #2. • Shaft/Pit #3 would be sited within a restaurant parking lot across a small channel east of Moss Landing State Beach. The site was selected due to space limitations on Moss Landing State Beach and the depth of the proposed Elkhorn Slough tunnel crossing. • DWD would remove temporary casings placed between Shaft/Pit #3 and Shaft/Pit #2 once the pipelines are in place.

Primary Project Components	
Offshore Pipelines and Intake/Discharge Structures (continued)	Intake • Two 42-inch HDPE intake pipelines would be installed between Shaft/Pit #2 and a deepwater ocean intake. • The intake would be located on the uppermost northern slope of the Monterey Submarine Canyon and mounted at the terminus of the pipeline approximately 2,565 feet offshore of the Ordinary High Water Mark (OHWM). This intake would be screened. Discharge • Two 36-inch steel pipelines installed between Shaft/Pit #2 and a deepwater discharge structure. • The discharge location would be approximately 5,675 feet offshore of the OHWM. The structure would include a series of duckbill diffusers designed to assure rapid and thorough mixing with ambient seawater. The system includes a linear, five-jet riser/diffuser located at depth within the oceanographic area near the terminus of the existing oil pipeline on the north flank of the Monterrey Submarine Canyon. The diffusers would be attached to a distribution manifold and spaced at approximately 3 feet apart.
Potential Product Water Pipelines/Routes[2]	
Monterey Peninsula Product Water Pipeline	• Begins at southeast corner of SWRO Facility • Extends 9 miles south along the Union Pacific Railroad through Castroville • Follows the Transportation Agency for Monterey County right-of-way to Beach Road in Marina • Continues in a southerly direction for 7 miles connecting with the Seaside and Monterey Pipelines just north of the intersection of Auto Center Parkway and Del Monte Boulevard
Castroville and Salinas Product Water Pipeline	• Exits SWRO Facility east to the Union Pacific Railroad corridor southward • Continues approximately 12 miles to the Cal Water Salinas distribution system
Santa Cruz County Product Water Pipeline	• Exits SWRO Facility to the Vierra Wet Well site • Crosses Elkhorn Slough via Horizontal Directional Drilling • On north side of Elkhorn Slough, parallels an existing reclaim water pipeline to the Pajaro Valley Water Management Agency recycled water plant on Beach Road • Continues along San Andreas Road along an abandoned rail line • Terminates at Soquel Creek Water Management Agency's distribution system in Capitola

[2] The EIR/EIS will programmatically discuss several Product Water Pipelines to deliver water south to Monterey Peninsula communities, east to Castroville and Salinas, and north to Santa Cruz County. These Product Water Pipelines would be separately proposed, permitted, and constructed by the individual water suppliers.